April 13, 1965 J. S. BURTON 3,178,699

DIGITAL CODE ALPHA-NUMERIC INDICATOR

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FIG. 1.

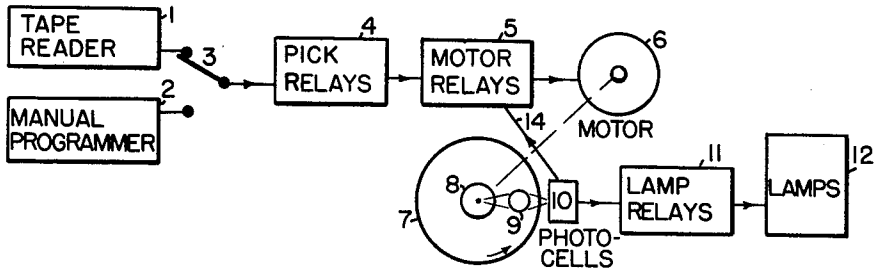


FIG. 5.

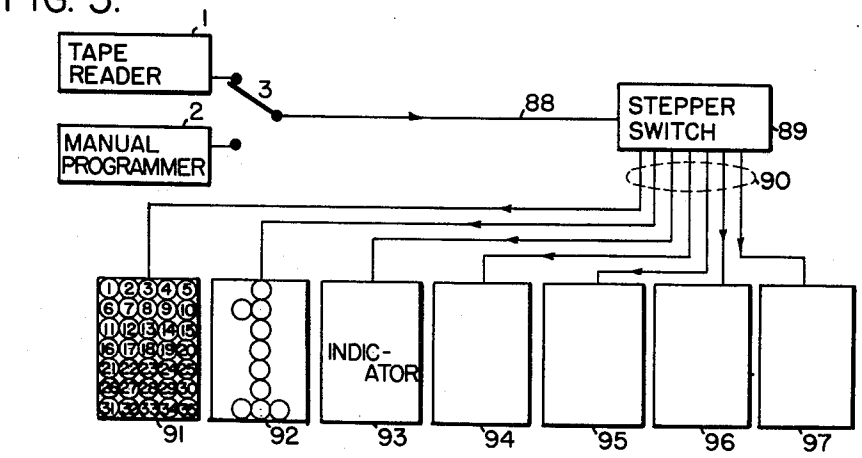
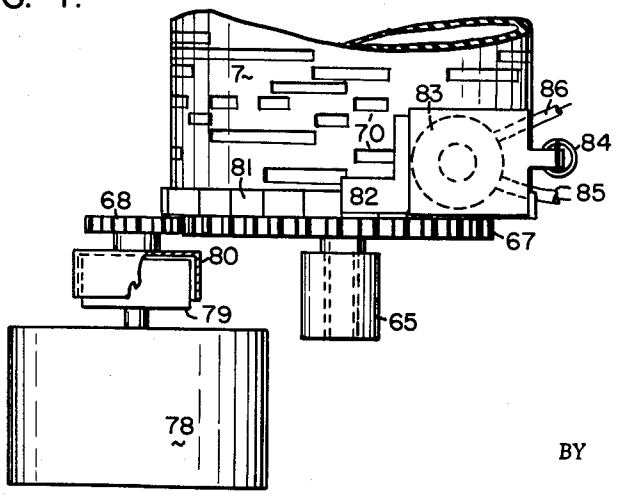


FIG. 4.



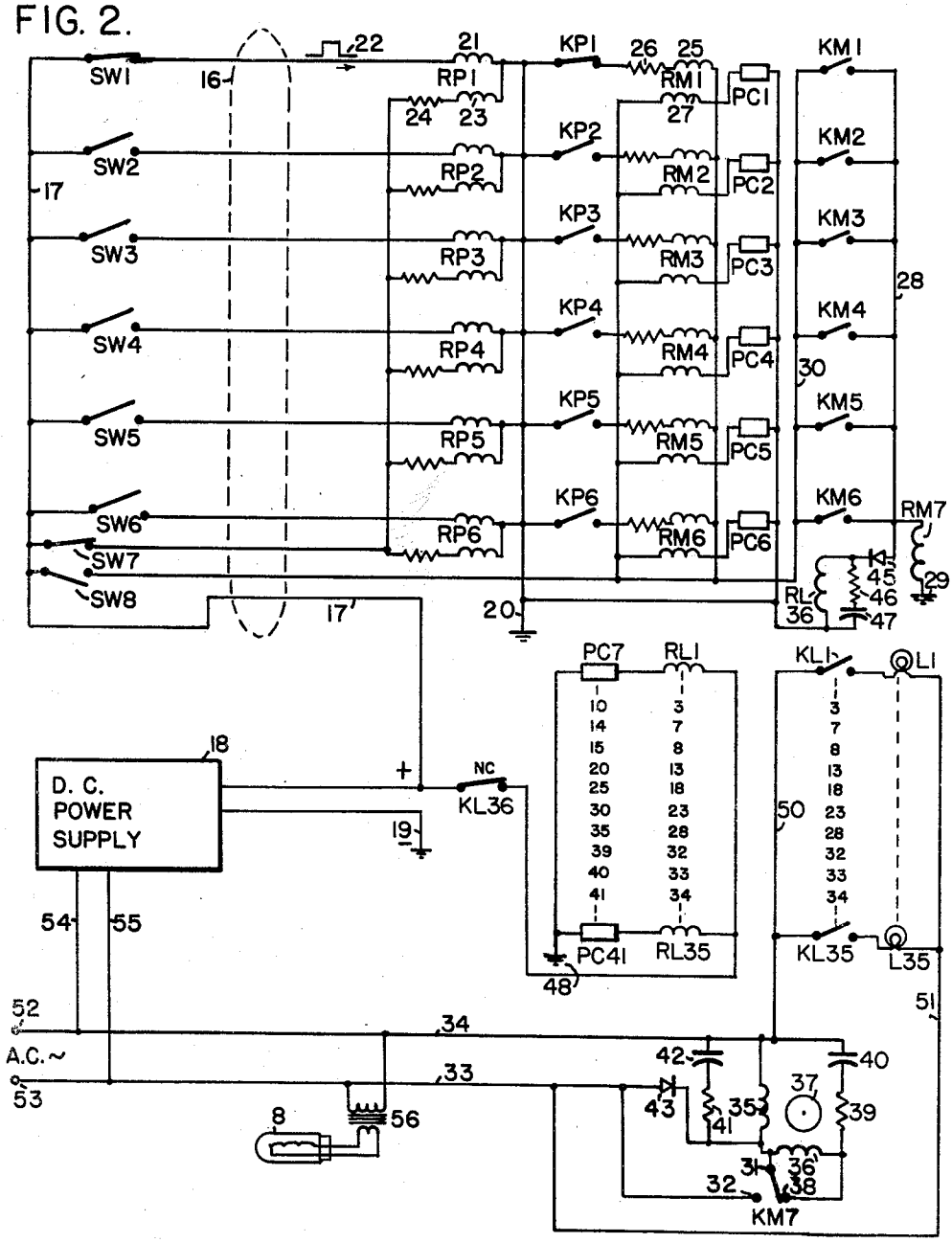
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DIGITAL CODE ALPHA-NUMERIC INDICATOR

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FIG. 2.



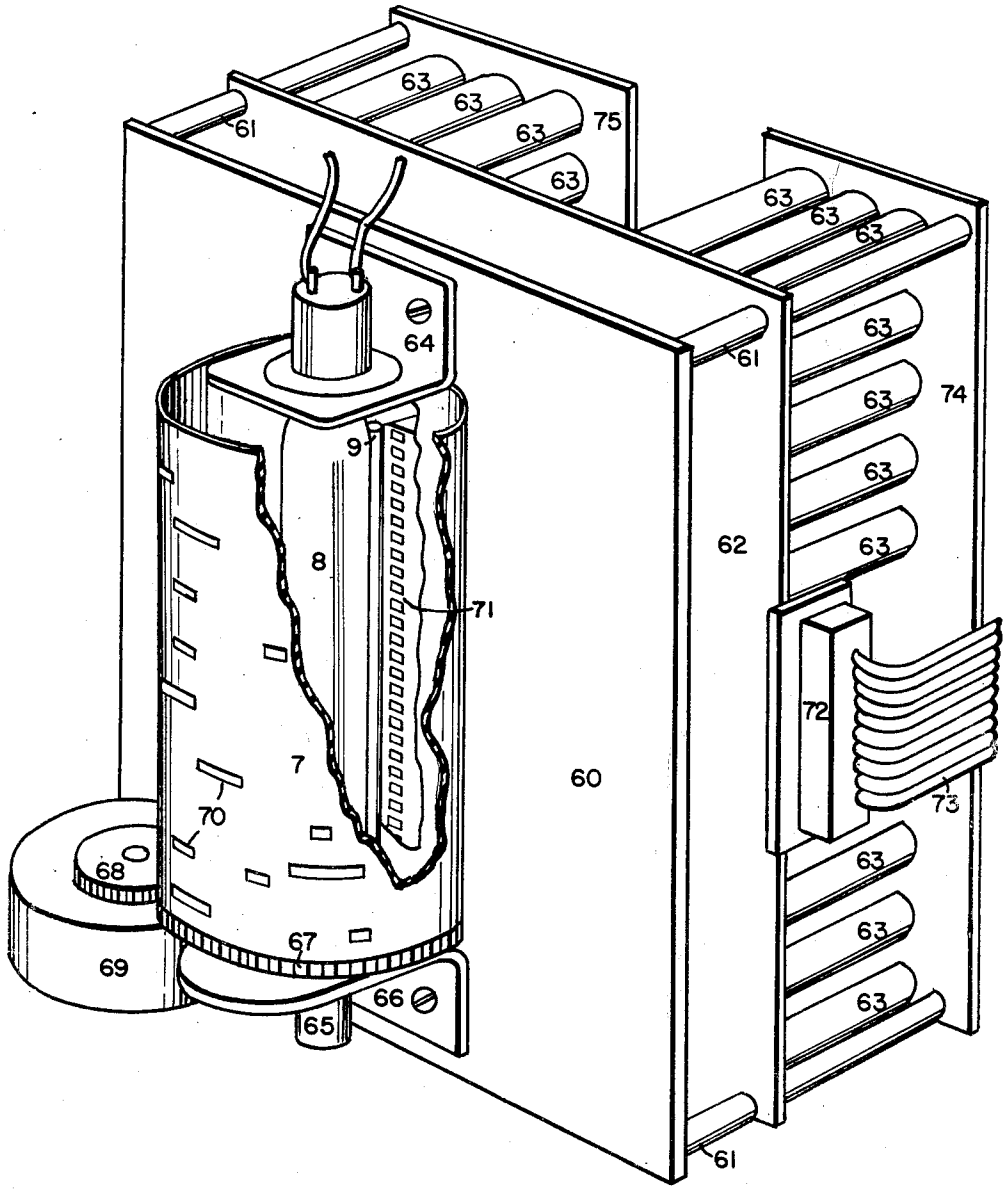
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DIGITAL CODE ALPHA-NUMERIC INDICATOR

Filed March 26, 1963 3 Sheets-Sheet 3

FIG. 3.



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United States Patent Office 3,178,699 Patented Apr. 13, 1965

3,178,699

DIGITAL CODE ALPHA-NUMERIC INDICATOR

John S. Burton, Los Angeles, Calif., assignor to Monitron Manufacturing Corp., El Segundo, Calif., a corporation of California

Filed Mar. 26, 1963, Ser. No. 268,206
5 Claims. (Cl. 340—337)

My invention relates to a method and means for producing alpha-numeric indications from information which is in the form of a digital code.

There are many places where information boards are required to present messages in letters of the alphabet and numerals to large groups of people; such as at stadiums, racetracks, airports, shopping centers and the like. Suitably controlled banks of incandescent lamps are perhaps best suited for exhibiting this information. However, heretofore the wiring to selectively power these banks of lamps has been complicated and extensive. The relays, switches and other components required have been bulky and expensive. Frequently, switches have been multiple operated mechanically with cams and remote operation at a convenient control point has been impossible. Also, operation from information in digital form, as now widely employed in other arts, has been impossible.

I employ a novel method and apparatus to form the desired information into a digital format, store such information for an interval by electrical means, form a pattern of photo-quantum energy corresponding to the information electrically stored, close electrical circuits in correspondence with the stored information and electrically energize a plurality of indicators to give the desired alpha-numeric visual indication of the message.

I prefer to employ a code mask in card, drum or flexible tape loop form having a plurality of apertures according to the code, which, coactively with a plurality of aligned photoelectric elements and a light source, provides a highly practical small and inexpensive control device. Assuming the drum form for convenience of explanation, it is rotated by a geared motor which is detented to stop at any of many circumferential positions according to the alpha-numeric symbol required to be shown. The motor stopped by photoelectric means and the energization of the electric lamps to exhibit the desired signal symbol is accomplished by photoelectric means energizing appropriate relays.

An object of my invention is to provide a new method of operating alpha-numeric indicators.

Another object is to provide simple and small-sized apparatus for operating alpha-numeric indicators.

Another object is to employ photoelectric means to actuate any of a large plurality of relays in accordance with digital information.

Another object is to provide a rapid access memory for apparatus of this kind so that a row of indicators can be set within a fraction of a second and the lamps thereof energized simultaneously.

Another object is to interconnect photoelectric cells and relays in the large plurality required by printed circuit means of low cost.

Other objects will become apparent upon reading the following detailed specification and upon examining the accompanying drawings, in which are set forth by way of illustration and example certain embodiments of my invention.

FIG. 1 shows a block diagram of my digital code alpha-numeric indicator,

FIG. 2 shows a schematic electrical diagram of the same,

FIG. 3 shows in perspective a typical embodiment of the same,

FIG. 4 shows in side elevation an embodiment employing a mechanical detent, and

FIG. 5 shows a block diagram of a multiple indicator unit wherein the control apparatus is employed for plural exhibiting indicators by successive connection thereto through a stepping switch.

In FIG. 1 numeral **1** represents a tape reader of the digital type. This may be the known paper tape reader having, say 6 bits (parallel lines of output), or a magnetic tape reader, or a card reader.

Rectangle **2** represents a manual programmer, which may be a keyboard with a large plurality of buttons, one for each letter, numeral or punctuation mark. Each such button closes a switch bank of six switches in the selective manner required to give the digital electrical connection or open circuit for each line according to the particular code employed. I have found the six line modified Friden SPS Flexowriter code to be satisfactory.

Switch **3** allows either of programming sources **1** or **2** to be connected to the succeeding apparatus. The switch has 6 arms and six sets of contacts for the digital connections, a seventh for reset of the memory pick relays, and an eighth for memory hold. The latter connection makes it possible to turn on all of the indicators in a row at once.

Pick relay entity **4** is comprised of a plurality of relays, say 6, to accept the electrical signals controlled by the tape reader or manual programmer. These relays form a memory unit to hold the electrical signals from the tape or manual keyboard until these are utilized by succeeding apparatus. This will be detailed in connection with the description of FIG. 2.

The pick relays are connected to actuate the same plurality of motor relays, rectangle **5** in FIG. 1. The motor relays act to stop the motor in any one of plural magnetically or mechanically detented positions, say 12, according to the setting imposed upon the motor relays. I prefer to have a greater number of stop positions on the code mask or drum **7**, say 48, this being accomplished by employing a four to one gear reduction drive between motor **6** and drum **7**. This drive is represented in FIG. 1 by the dashed line connecting the two.

At **48** circumferential positions around drum **7**, and six longitudinal positions for the motor control, plus a large plurality of longitudinal positions, say **35**, for the lamp control, I place apertures according to the digital code chosen (as the Flexowriter code previously mentioned). This results in there being, for any given circumferential position, apertures at certain longitudinal locations and the opaque material of the drum at others. The drum has the appearance of a section of the old player-piano roll.

The digital information is passed on to the rest of the apparatus by electro-optical means. A long-filament (vertically upward out of the paper) lamp **8**, or equivalent photo-energy source, is located substantially axially of opaque drum **7**. Cyindrical lens **9** is co-extensive with the lamp filament, axially of the drum, and provides a focussed image of the filament, or an approximate focus, upon the group of aligned photocells **10**. Typically, 41 small photo-conductive cells **10** are aligned vertically; one opposite each longitudinal location of the drum where an aperture according to the code may be placed. In this way, on there begin an aperture there located, light or equivalent photo-quantum energy, will pass from source **8** to the appropriate photocell in the aligned group **10**. This will reduce the resistance (increase the conductance) of the cell in series with the particular relay coil of the lamp relays **11** and a direct current power supply, thus operating the relay contact of the particular lamp relay. Typically, the dark resistance of the cell is many times that of the relay coil, so that the latter has only a frac-

tion of the voltage of the power supply across it. The illuminated resistance of the cell is from one-third to equal the resistance of the relay coil, thus raising the voltage across the coil to its operating value.

The cells 10 may be of the cadmium selenide type, which are commercially available in aligned closely-spaced form. Of course, any type of photo-emissive, photovoltaic or other photosensitive device may be employed according to my method.

One lamp relay 11 is provided for each photocell-lamp combination. In order to provide a desirably complete and pleasing rendition of any letter of the alphabet or of any numeral 35 lamps 12 arranged in a bank seven vertically by five horizontally are desirable. As a consequence there are 35 corresponding cells, relays and lamps and 35 wires connect each of these, running from cell to relay and to lamp.

From a smaller plurality, say 6, photocells 10 run wires to the corresponding number of motor relays 5, these being indicated by connection 14.

In the schematic electrical diagram of FIG. 2, momentary ON code switches SW1 through SW6 are either digital contacts on a tape reader or switches actuated in a manner according to the code selected by individual push-buttons or keys on a manual keyboard. Throughout the description of FIG. 2 the switches and relays are shown to exhibit the numeral "1" on a 35 lamp indicator. Accordingly, switch SW1 is closed, while all others are open. It is to be understood that for another code, or for a different numeral or letter with the present code, one or more other switches might be closed, and SW1 might be open.

Six conductors are connected to one of the terminals of switches SW1 through SW6, one conductor to one switch, in a cable generally represented by dotted line 16. Two other conductors are also connected to switch SW7 and SW8, and a common conductor 17 is also included, which common conductor connects to the other terminal of all of the switches thus far recited and to a power supply, such as direct current power supply 18. The latter may have a voltage output of 30 volts and be a regulated power supply in a typical embodiment. The second terminal of this power supply is connected to ground 19, or an equivalent common bus. The negative terminal of power supply 18 is typically the grounded terminal.

The several conductors of cable 16 are connected to one coil of two coils of each of 6 pick relay coils RP1 through RP6, the other terminal of each of the said one coil being connected to a common ground 20. Specifically, the conductor from SW1 connects to coil 21 of pick relay coils RP1. When the manual or tape operation of SW1 occurs an electrical waveform having the shape of a pulse, 22, passes through coil 21 and to ground at 20. This pulse may have any duration as long as this is in excess of about 5 milliseconds as a minimum duration required to actuate the relay, to be later described.

It will be noted that from grounded connection 20 there is also connected relay coil 23 of RP1, the second terminal of which connects to resistor 24 and therethrough to normally closed switch SW7 and therethrough to the positive terminal of power supply 18. Resistor 24 may have a resistance of the order of 7,500 ohms. As long as switch SW7 remains closed a current will flow through this circuit. This current is arranged to be sufficient to hold the contacts associated with pick relay coils of RP1 closed, once pulse 22 has passed through the companion coil, but this current is not sufficient to close the contacts in itself.

The same structure as to pairs of coils, resistors and connections is duplicated for each of the additional pick relay coils RP2 through RP6.

The coils RP1 close contacts KP1 when energized as has been set forth. Since this has taken place in the "1" example being considered, contacts KP1 are closed. Contacts KP2 through KP6 are similarly actuated by corresponding coils RP2 through RP6.

A somewhat similar structure to that which has been described is repeated in motor relay coils RM1 through RM6 and the contacts that are actuated thereby, KM1 through KM6.

In particular, the first coil 25 of RM1 is connected to contacts KP1, such that when these contacts are closed a current flows in the coil. That is, when SW8 switch is closed, the memory hold switch. This current closes contacts KM1; being one in the same rleay. Resistor 26 is in series with coil 25 and relay contacts KP1.

The second coil of the RM1 pair is identified as 27. It is connected at one end to the SW8 memory hold bus and at the other end to photocell PC1. The other terminal of the photocell is connected to ground 20. Resistor 26 has a resistance of the order of 1,500 ohms. This is to approximate the resistance of photocell PC1 when this cell is illuminated; thus making the conductance of the two circuits of the two coils RM1 approximately the same. These two coils are wound and connected in a bucking relation. Thus, as soon as photocell PC1 is illuminated by light passing through an aperture of the code drum, contacts KM1 are opened. When photocells PC2, PC3, PC4, PC5, PC6, are similarly illuminated the contacts of the corresponding relays are closed. This is because none of the other pick relay contacts KP2 . . . KP6 are closed and so the bucking relation does not occur.

The function of these relays is to stop the code drum at the proper place so that the numeral "1" will be exhibited upon the indicator in the example being considered. Accordingly, an additional motor relay, having coil RM7, and contacts KM7 is provided. Coil RM7 is connected between common bus 28 and ground 29. Bus 28 connects also to one contact of each of contacts KM1 . . . KM6. A second bus 30 connects to the other of these contacts and to memory hold switch SW8.

It is thus seen that when switch SW8 is closed, as long as there be one or more of contacts KM1 . . . KM6 closed there will be a completed circuit from power supply 18 through coil RM7 and that relay will be energized. Referring to the bottom of FIG. 2 for the contacts KM7, these are shown in the de-energized position, according to custom on schematic diagrams. However, with the relay energized, the arm 31 is pulled to the left and makes contact with contact 32. This contact is connected to one side of an alternating current power source, typically, indicated by numeral 33. The other side of this source, 34, is connected to a small motor having two field coils 35 and 36 and an armature 37. This motor revolves the code drum as has been previously mentioned. The junction between the two fields 35 and 36 is connected to arm 31 of the relay contacts. The opposite end of field 36, away from the junction, is connected to relay contact 38 and also to resistor 39 and capacitor 40 in series to side 34 of the alternating current source. Resistor 39 may have a resistance of the order of one hundred ohms and capacitor 40 a capacitance of the order of one-fifth microfarad. Field 35 is shunted by another resistor 41 and another capacitor 42 connected in series; the resistance of the former being of the order of two hundred ohms and the capacitance of the latter being of the order of a half microfarad.

With arm 31 contacting contact 32 it is seen that there is a complete connection of the motor, through the field and adjacent resistors and capacitors, to both sides 33 and 34 of the alternating current source. Consequently, the motor revolves as a two phase device. This condition persists until current through coil RM7 ceases. At this time arm 31 is released as regards magnetic attraction and it is restored to contact with contact 38 by known restoring means, such as a spring. When this occurs it is seen that the connection to side 33 of the alternating current source is broken and at the same time field 36 is shorted.

Also at the same time rectifying diode 43 is unshorted and so rectifies the alternating current to pulsating direct current. Capacitor 42 acts to smooth the pulsations and the result is that field 35 has direct current flowing through it. In this way a magnetic detent functioning is established. Through the magnetic structure of the motor, flux is produced which locks the armature in the position it held when this situation was inaugurated. The motor, and so the code drum which it revolves thus comes to a sudden stop upon relay coil RM7 being de-energized.

The only way that coil RM7 can be de-energized is for all contacts KM1 . . . KM6 to be open (assuming, of course, that SW8 is retained closed during all of this sequence of operation). In the example being considered, each of contacts KM2 . . . KM6 are closed when the code drum turns to such positions because photocells PC2 . . . PC6 are illuminated and there is no bucking current coming from a closed contact in the group KP2 . . . KP6. However, in the circumferential position of the code drum corresponding to the code for numeral "1" light is admitted through an aperture upon photocell PC1 alone and this opens KM1, since an opposing current is flowing from KP1. Thus, coil RM7 is de-energized and the magnetic detent braking explained occurs.

It is also to be noted that the coil of an additional lamp relay, RL36, is connected for energization in the same way as was coil RM7. This is accomplished through rectifying diode 45 and associated resistor 46 and capacitor 47. The former has a resistance of the order of one hundred ohms and the latter a capacitance of the order of twenty microfarads. Elements 45, 46, 47 prevent flickering of the lamps of the visual indicator by keeping coil RL36 energized for an interval of time of the order of from 0.1 to 0.2 second after the motor is stopped by de-energization of coil RM7.

The contacts KL36, coactive with coil RL36, are normally closed, as to pass current to the general lamp circuits, save when coil RL36 is energized; i.e., when the motor is operating. Considering the example at hand and the motor now properly stopped with the digital code in alignment with all of the photocells, the lamp illuminating circuits are as follows.

One terminal of the coils, RL1 through RL35, of lamp relays, having reed switches KL1 through KL35, are connected through additional lamp relay contacts KL36 to the positive terminal of power supply 18. Each of these coils is further connected to corresponding aligned photocells PC7 through PC41. The second terminal of each of these photocells is connected to ground 48. It is seen that when contacts KL36 are closed each of these circuits is supplied with positive potential. Whether or not current flows, as to actuate the respective relay coils depends upon whether or not the photocell in series with the particular relay coil is illuminated. This, in turn, depends upon the presence or absence of an aperture in code mask 7 of FIG. 1. When the photocells are not illuminated the resistance thereof is high, of the order of hundreds of thousands of ohms, when the photocells are illuminated the resistance thereof is low, of the order of 1,500 ohms.

In FIG. 2 the particular numbers of photocells illuminated and corresponding coils in the group RL1 through RA35 are set down for the numeral "1." These are, PC's 10, 14, 15, 20, 25, 30, 35, 39, 40, 41. The corresponding coils are RL's 3, 7, 8, 13, 18, 23, 28, 32, 33, 34. The corresponding reed switches thus actuated to closing are KL's 3, 7, 8, 13, 18, 23, 28, 32, 33, 34.

One terminal of contacts KL1 through KL35 is connected to common conductor 50, which in turn is connected to side 34 of the alternating current source. The other terminal of each of these contacts is connected to one terminal of a corresponding lamp in the visual indicator which those to be given a message observe; such as lamps L1 through L35. The second terminal of each lamp is connected to a common conductor 51, which in turn connects to side 33 of the alternating current source.

The lamps thus numbered are arranged in seven horizontal rows of five lamps each, each row being numbered from left to right and the number 1 lamp being in the upper left hand corner and the number 35 lamp being in the lower right hand corner. This arrangement is numbered from the front of the indicator; as it is seen by the observer. This arrangement of numbers is given in FIG. 5 in the first indicator of the row and the numeral "1" is given in the second indicator.

It is understood, of course, that the numbers of the lamps illuminated, the reed switches closed, etc. is different for each different letter, numeral or symbol presented.

Again in FIG. 2, the terminals of the alternating current source are identified as 52 and 53 and represent a connection to the typical single phase 115 volt sixty cycle power circuit or its equivalent. Regulated power supply 18 is energized with this power by means of conductors 54 and 55. Photocell illuminating lamp 8 is similarly powered from the alternating current source, through step-down transformer 56, the primary of which is connected to side conductors 33 and 34.

It will be understood, in connection with FIG. 2 that fewer or more lamps may be employed by employing fewer or more reed switches, photocells, etc. Also, the number of lines carrying the digital information may be altered from six according to the known principles of digital representation of information and with a corresponding alteration of the pick relays, motor relays, etc.

In FIG. 3 is shown in perspective the apparatus mainly according to FIG. 2, excepting momentary ON switches SW1 through SW8, regulated power supply 18 and similar known elements.

The mechano-optical elements are mounted on a panel 60. This is spaced by spacers 61 from a printed circuit board 62. Upon the latter are printed the circuits leading to and from all of the relays shown in FIG. 2. Certain of the reed relay coils RL1 through RL35 are seen behind circuit board 62, these being generally indicated by the numeral 63. Lamp 8 is seen in the center of code drum 7. The former is mounted on bracket 64 fastened to the top of panel 60 and the latter is journaled in bearing 65, which is mounted on bracket 66 at the lower part of panel 60.

The code drum is provided with gear 67 at the bottom thereof, which gear meshes with pinion 68, having one-fourth the diameter of gear 67 in the example described herein. The motor, comprised of elements 35, 36, 37 in FIG. 2, is illustrated as element 69, the housing thereof, in FIG. 3.

At the front of the code drum a vertical grouping of apertures 70 is shown, corresponding to one of the 48 such groups employed in the exemplary embodiment herein. Essentially opposite thereto in the particular position of the drum shown, is the bank of photocells PC1 through PC41, which are identified generically as 71 in FIG. 3. Between bulb 8 and cells 71 is vertically disposed cylindrical lens 9. Part of drum 7 is broken away to show these internal elements.

An electrical connector 72 is provided to connect the circuits of the printed circuit board 62 to conductors 73, which go to lamps L1 through L35 in the indicator not shown in FIG. 3, but as shown in FIG. 5. Rear panels 74 and 75 complete the mechanical structure of this control entity. In FIG. 3 motor 69 is of the magnetic detent type, as described in connection with the circuit of FIG. 2.

FIG. 4 shows a side elevation of an alternate mechanical embodiment of the motor and code drum in which a mechanical detent is employed instead of the electrical and magnetic detent previously described.

In FIG. 4, code drum 7, journal 65, gear 67 and pinion 68 are as in FIG. 3. However, motor 78 is of the usual continuously rotating type. It continuously rotates a known strong permanent magnet 79 and a high retentivity metal cup 80 surrounds the same, as shown in the partial

section of this magnetic clutch assembly. A friction type of clutch may be used substitutionally for this element.

In any event, the clutch rotates pinion 68 and through gear 67 the code drum 7 while the search is being made for the proper digital code alignment, as was explained in connection with the circuit of FIG. 2. In this embodiment, a ratchet 81, which may be of mechanically strong plastic, also surrounds drum 7 adjacent to gear 67. A pawl, or detent flapper 82 is provided in the known manner to engage any one of the teeth of ratchet 81. Which tooth is chosen is determined by the code switches and the pick relays of FIG. 2 being all de-energized.

A magnetic core and coil 83 are adjacent to the detent flapper 82, which is pivoted as a lever with spring 84 on the opposite side of the pivot from the end of the flapper shown near numeral 82. It will be understood that when all the relays of FIG. 2 are de-energized the the coil 83 will be similarly de-energized, being connected in the circuit by leads 86 and 85. Coil 83 keeps flapper 82 away from ratchet 81 by magnetic attraction thereof when the coil is energized with electric current. When the current ceases, spring 84 forces the flapper into the tooth of the ratchet and drum 7 is brought to a sudden stop. This allows the apertures and photocells associated with the lamp circuits per se to be effective and the closing of relay reed switches KL1 through KL35 in FIG. 2 to be accomplished to exhibit the desired alpha-numeric symbol.

It is easily possible to make the operation of the whole electro-optical-mechanical apparatus of FIG. 2 for exhibiting a given symbol take place within a fraction of a second, thus allowing rapid presentation of a message having many letters to form words and sentences.

In the prior considerations herein a single indicator has been discussed and illustrated; i.e., a bank of 35 lamps controlled to exhibit any letter, numeral or symbol. It is usually desirable to have a sign board of such letter exhibiting indicators, so that one row, or several rows of symbols can be exhibited at once to spell out a whole message. This multiplicity is attained by an arrangement of apparatus according to FIG. 5.

In FIG. 5, tape reader 1 and manual programmer 2, along with multi-contact switch 3 are as described in connection with FIG. 1. Cable 88 is essentially the same as cable 16 of FIG. 1, but it has, say, ten conductors, the additional two being employed for a shorting relay connection to insure that the memory hold function of FIG. 2 is not momentarily broken as circuits are switched by stepper switch 89, and for conveying electrical energy from power supply 18 from one part of the apparatus to another.

Stepper switch 89 has at least six decks of multicontact step by step switching facility and is an element known to the art. This allows the six digital lines connected to SW1 through SW6 in FIG. 2 to be connected to any one of plural indicators 91 through 97 as shown in FIG. 5. An eight wire cable indicated as a group by numeral 90 connects these six digital lines, the reset (SW7) and the hold (SW8) of FIG. 2 to each of the indicators 91 through 97 in sequence. Directly behind, or closely adjacent to, each indicator is the apparatus of FIG. 3; namely, the motor code drum, aligned photocells and accompanying relays.

In FIG. 5 the arrangement of apparatus shifts the information-supplying elements 1 or 2 from connection to indicator 91, to connection to indicator 92, to connection to indicator 93, and so on. Once this has been accomplished, the information is stored in the device of FIG. 3 for each indicator so that connection to the digital information-conveying conductors of the cables is no longer required and these connections from the tape reader or manual programmer can be disconnected from the apparatus of one indicator and connected to the apparatus of another indicator. The stepper switch is capable of operating in a small fraction of a second and the information can be accepted by the apparatus of FIG. 3 for each indicator in a fraction of a second, so that a number of indicators such as shown in FIG. 5 can be serviced in one second. A "display" connection which energizes all of the lamp circuits at once may then be made and a whole line or a whole sign of message information is presented in what appears to be an instantaneous manner.

Old letters of a message may be removed from view and new letters substituted according to the following process employing the multiple indicator apparatus of FIG. 5 as detailed in FIG. 2.

According to FIG. 2, the memory hold switch SW8 and reset switch SW7 are opened for a whole line of indicators. This wipes out the memory of the last letter contained within the pick relays but leaves that letter still displayed upon the indicator involved. The reset switch SW7 is then closed, which energizes the hold coils (as 23 of RP1) in all of the pick relays. Assuming that the tape reader is being employed to furnish the information, this reader is progressed one digital word; i.e., a new set of holes is brought forward to actuate switch contacts SW1 through SW6. Then stepper switch 89 of FIG. 5 is energized to step all of the code lines to the second indicator. The reset and memory hold switches SW7 and SW8 for this indicator are then opened, reset switch SW7 is again closed, and the tape reader progressed to the next set of holes to provide the digital word for insertion into the pick relay memory of the second indicator. This process is repeated for each indicator wherein a change in the letter exhibited is to be accomplished.

When the end of this group is reached, as at the end of a line, the memory hold switch SW8 is closed. This causes all of the lamps in that line to go out and each of the code drums to start spinning to find the new row of apertures in the code drum to be presented to the photocells for energizing the proper lamps in the indicator to form the new letter, numeral or symbol. As soon as this is accomplished, plus a small fraction of a second to prevent the lamps from flickering on, the lamps for that indicator are energized and the new letter is exhibited. This occurs because of contacts KL36 going to their normally closed condition as soon as the current stops flowing in coil RL36, as has been previously explained.

The above recited manipulations may be accomplished by appropriate switches actuated by push-buttons on a control console. The operator may learn how to rapidly actuate these in sequence, as does a typist to operate a typewriter. As an alternate, the functions recited can be carried out in sequence by sequence type relays and connections, so that the repeated sequencing of operations can be carried out as long as a control button is depressed.

The pick and other relays in my apparatus per se may be of the fully enclosed mercury contact reed within glass type. The coils for the same surround the glass. This makes my apparatus largely insensitive to malfunction because of dust and dirt, such as may be carried by the wind in the outdoor locations where signs of this type are required.

It will be understood that modifications may be made in the arrangement, size, proportions and shape of the apparatus without departing from the scope of my invention. Also, various modifications may be made in the characteristics of the electrical circuit elements, details of circuit connections and alteration of the coactive relation between elements without departing from the scope of my invention.

Having thus fully described my invention and the manner in which it is to be practiced, I claim:

1. A system of alpha-numeric visual indication comprising

means to electrically represent the desired indication in a digital code,

a direct current power supply,
a plurality of pick relays,
each having two coils and having contacts, one said coil being an operating coil and the other said coil being a holding coil,
said operating coils connected to be energized by said direct current power supply according to said digital code in accordance with successive desired indications,
the same plurality of motor relays, each having first and second coils and having contacts,
each contact of each said pick relay connected to the corresponding first motor relay coil to energize the same,
the same plurality of aligned photocells,
each said photocell connected between the corresponding second said motor relay coil and a common connection to said direct current power supply,
a motor having first and second field coils and an armature,
an opaque movable mask mechanically connected to said armature,
an additional motor relay having a coil and contacts,
an additional lamp relay having a coil and contacts,
each of said motor relay contacts connected between said common connection to said direct current power supply and the coil of said additional motor relay and the coil of said additional lamp relay for energizing both of these relays when any one of the same plurality of motor relay contacts are closed by said first coils thereof being energized,
an alternating current power source,
said first and second field coils connected together and to said alternating current power source for two phase alternating current operation of said motor,
the arm contact of said additional motor relay connected to the junction connection of said fields and a first contact thereof connected to said alternating current power source and a second contact thereof connected to short said second field of said motor when said arm contact is in contact with said second contact,
the first contact of said additional motor relay and said arm contact connected when said coil thereof is energized to thereby connect said alternating current power source to said fields,
and the second contact of said additional motor relay and said arm contact connected when said coil thereof is not energized to thereby short said second field and provide a magnetic detent to inhibit the motion of said mask,
normally closed contacts of said additional lamp relay arranged to be opened by energization of the coil thereof upon any one of said same plurality of motor contacts being closed to thereby disconnect said direct current power supply,
a large plurality of indicating lamps arranged adjacently to form alpha-numeric visual indications,
the same large plurality of aligned photocells each connected to said normally closed contacts,
the same large plurality of lamp relays each having a coil and a reed switch,
each said aligned photocell connected to the coil of a corresponding said lamp relay,
each said reed switch connected to said alternating current power source and individually to one of said large plurality of indicating lamps to selectively energize said lamp from said alternating current power source upon said selected reed switch being closed,
said opaque movable mask having apertures selectively disposed opposite each said same plurality of aligned photocells,
a source of light having a cylindrical lens to illuminate the said mask from the side opposite said same plurality of photocells to actuate said motor until

selected apertures of said mask are opposite appropriate photocells of said same plurality to thereby release the said same plurality of motor relay contacts,
whereby also a given selection of said large plurality of further apertures is positioned between said lens and said aligned large plurality of photocells to energize accordingly the said coils of appropriate said lamp relays to close the reed switch thereof and thereby to energize corresponding indicating lamps upon said motor being stopped.

2. A system of alpha-numeric visual indication comprising:

(*a*) first means to electrically represent digital information having a first plurality of bits for each digital character,
(*b*) a memory connected to said first means to accept said information, said memory comprised of a plurality of relays equal in number to said plurality of bits,
(*c*) a first plurality of motor relays,
(*d*) second means to connect each said motor relay to a relay of said memory,
(*e*) a said first plurality of linearly aligned photocells,
(*f*) third means to connect each said photocell to a said motor relay,
(*g*) an opaque rotatable mask having transparent apertures,
(*h*) a motor mechanically connected to said mask to rotate the same,
(*i*) fourth means to illuminate the apertures of said mask,
(*j*) brake means disposed to halt the rotation of said mask,
(*k*) said brake means electrically connected to said motor and actuated by said illumination passing through at least one of said apertures and impinging upon at least one of said first plurality of aligned photocells,
(*l*) a second plurality of electric lamps arranged individually in a display to form a visual indication,
(*m*) a said second plurality of further aligned photocells disposed to receive illumination through further said apertures in said rotatable mask,
(*n*) a said second plurality of lamp relays,
(*o*) separate means to electrically connect each said further aligned photocell to a corresponding said lamp relay, and each said lamp relay to a corresponding lamp in said display to selectively energize said lamps in accordance with the distribution of said further apertures in said mask for forming an alpha-numeric visual indication corresponding to said digital information.

3. The system of alpha-numeric visual indication of claim 2 which additionally includes:

(*a*) a stepper switch having multiple contacts for each step,
(*b*) electrical connections from said first means to said stepper switch for conducting said digital information from said first means to said stepper switch,
(*c*) a third plurality of said memories, motor relays, second means, first plurality of photocells, third means, masks, motors, fourth means, brake means, second plurality of electric lamps, second plurality of photocells, and second plurality of lamp relays, disposed and connected as in claim 2,
(*d*) a said third plurality of connections to connect each of said third plurality of memories to said multiple contacts of one said step of said stepper switch, and
(*e*) actuating means to step said switch, whereby said digital information is successively impressed upon said third plurality of memories to present a said third plurality of displays of said alpha-numeric visual indications.

4. The system of alpha-numeric visual indication of claim 2 wherein said motor has first and second field coils for two phase alternating current operation and has an armature, in which said brake means comprises;

(*a*) first contact means to short said first field coil for substantially immobilizing said armature,

(*b*) rectifier means, and

(*c*) second contact means operable concurrently with said first contact means to immobilize said armature at a selected rotational position.

5. The system of alpha-numeric visual indication of claim 2 in which said brake means comprises;

(*a*) a cylindrical ratchet attached to said rotatable mask,

(*b*) a pawl disposed to engage said ratchet,

(*c*) electromagnet means electrically connected to said first plurality of aligned photocells for actuating said pawl to engage said ratchet upon said illumination passing through at least one of said apertures and impinging upon at least one of said first plurality of aligned photocells.

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