

April 1, 1969

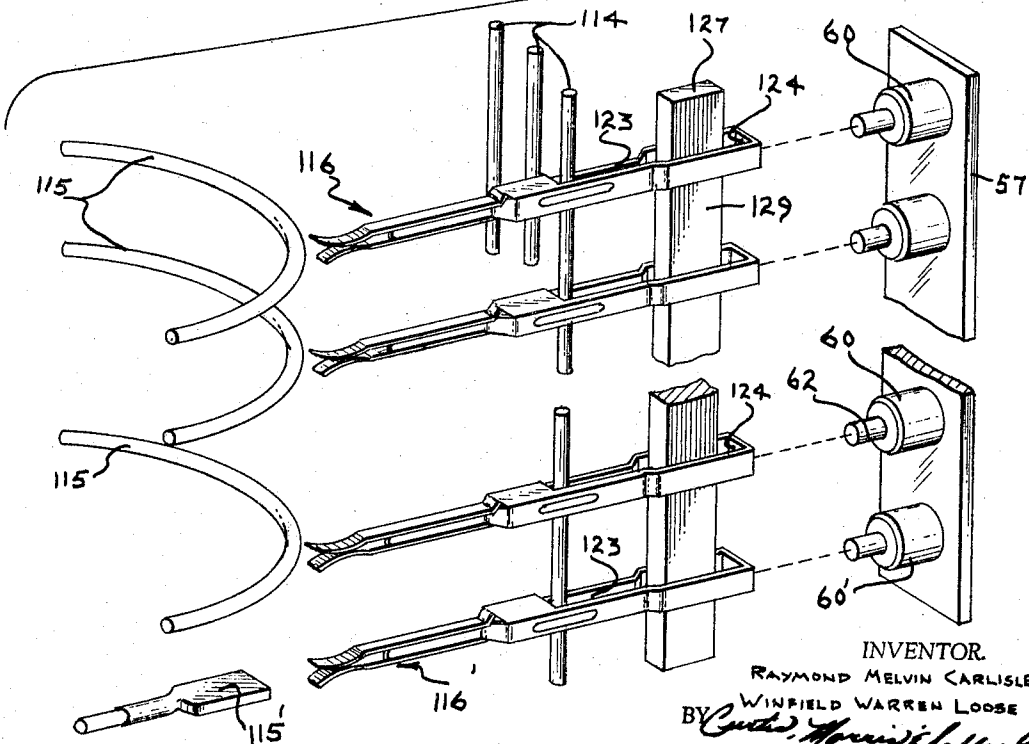
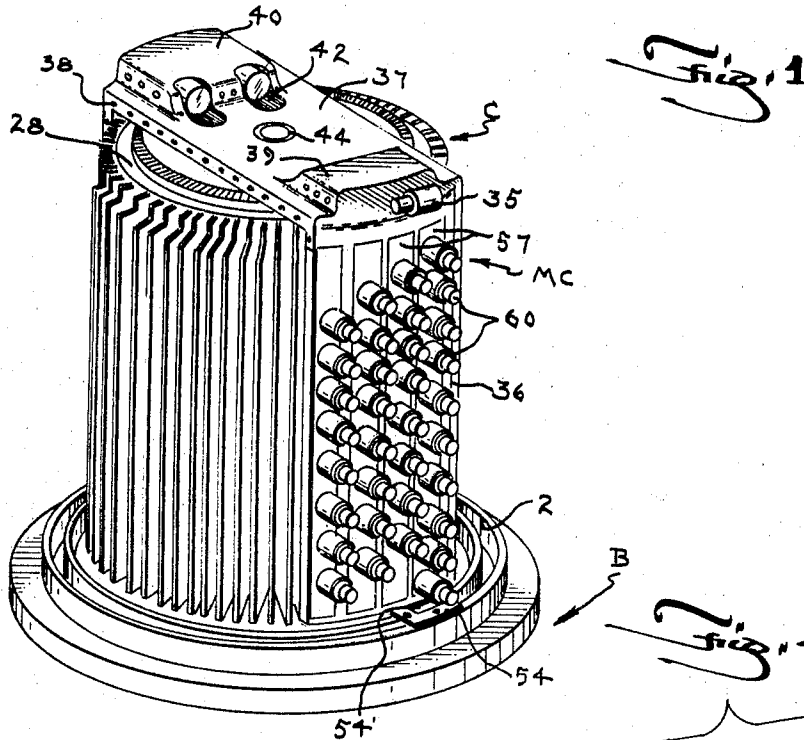
R. M. CARLISLE ET AL

3,436,696

SELECTOR SWITCH PROVIDED WITH SELECTABLY ACTUABLE CONTACT MEANS

Filed Aug. 21, 1964

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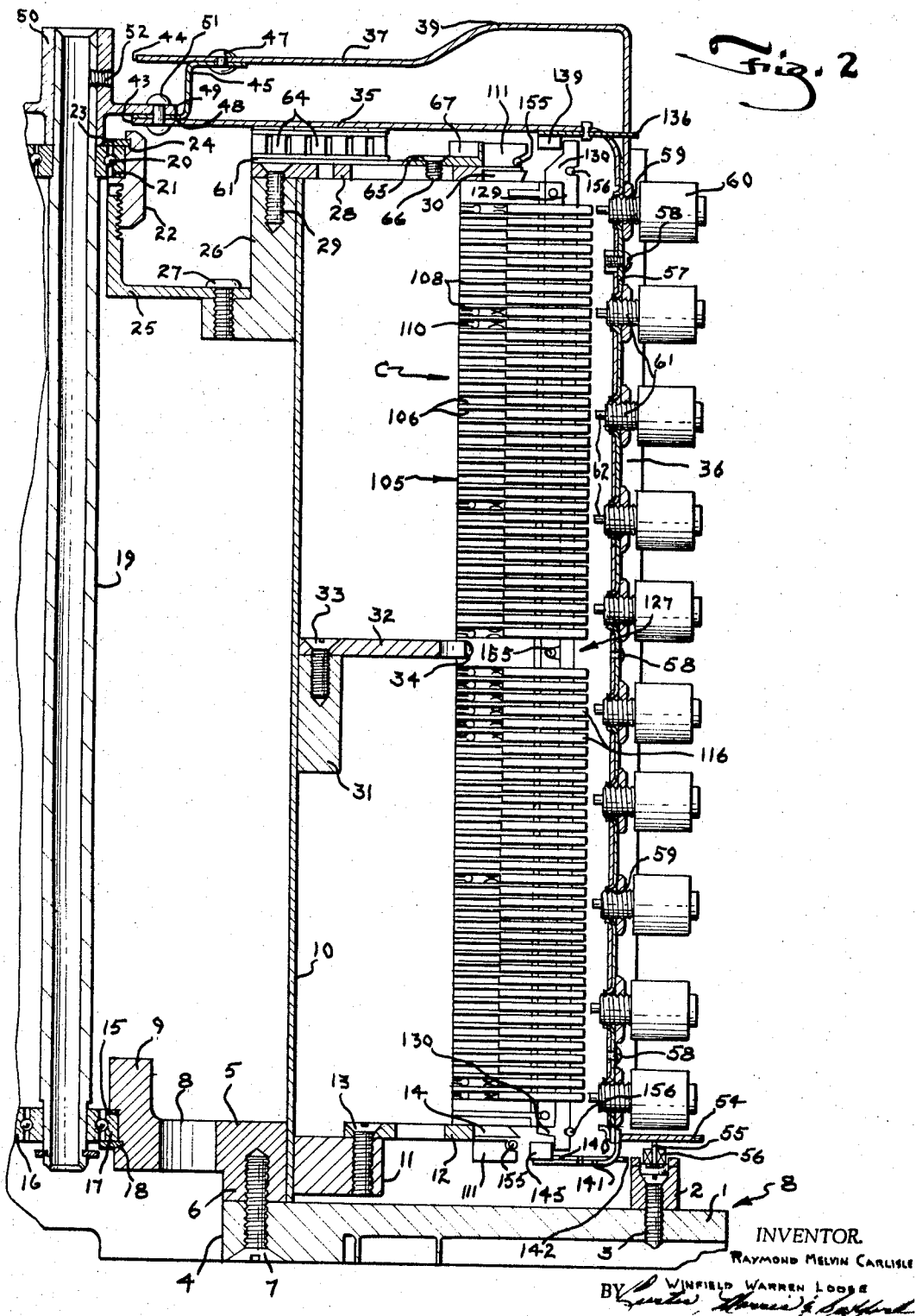
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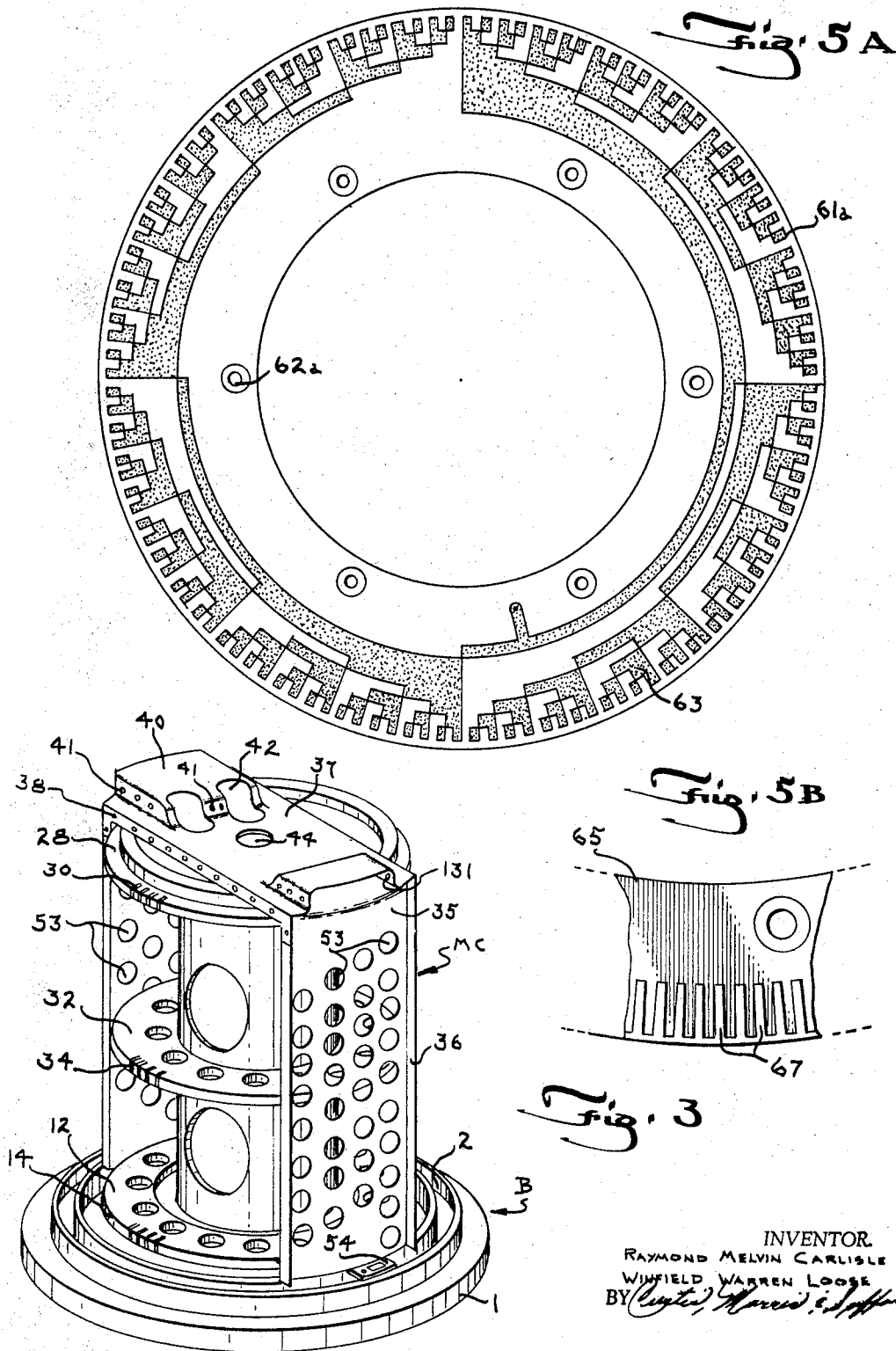
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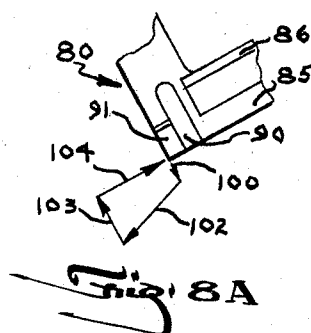
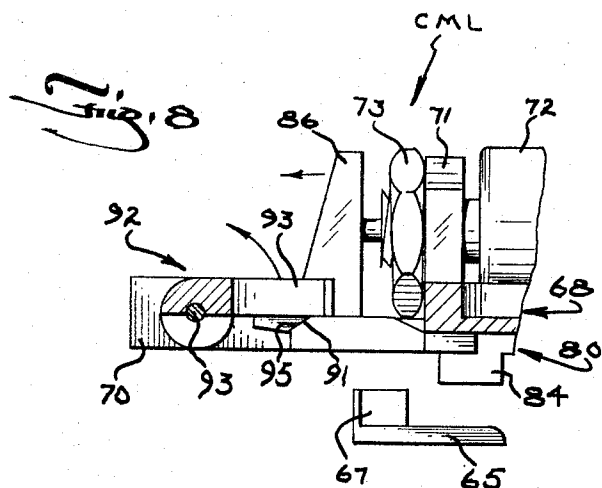
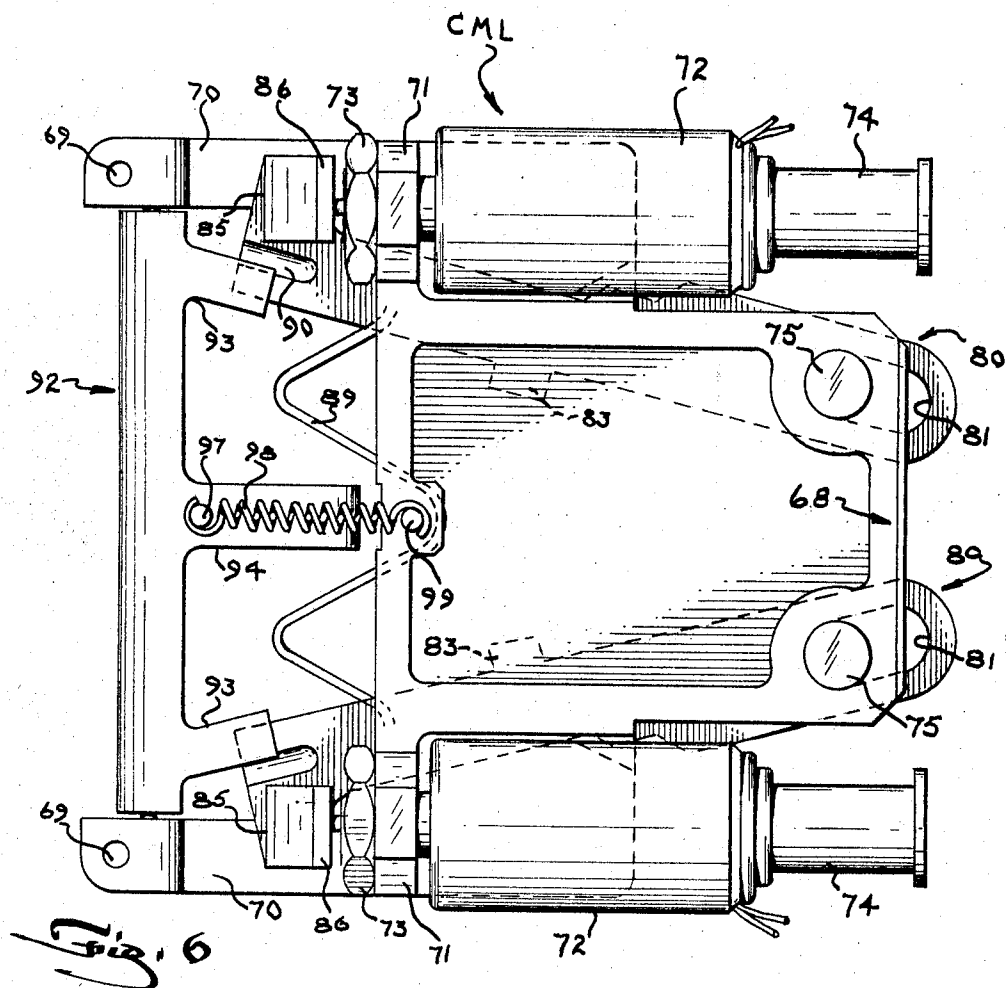
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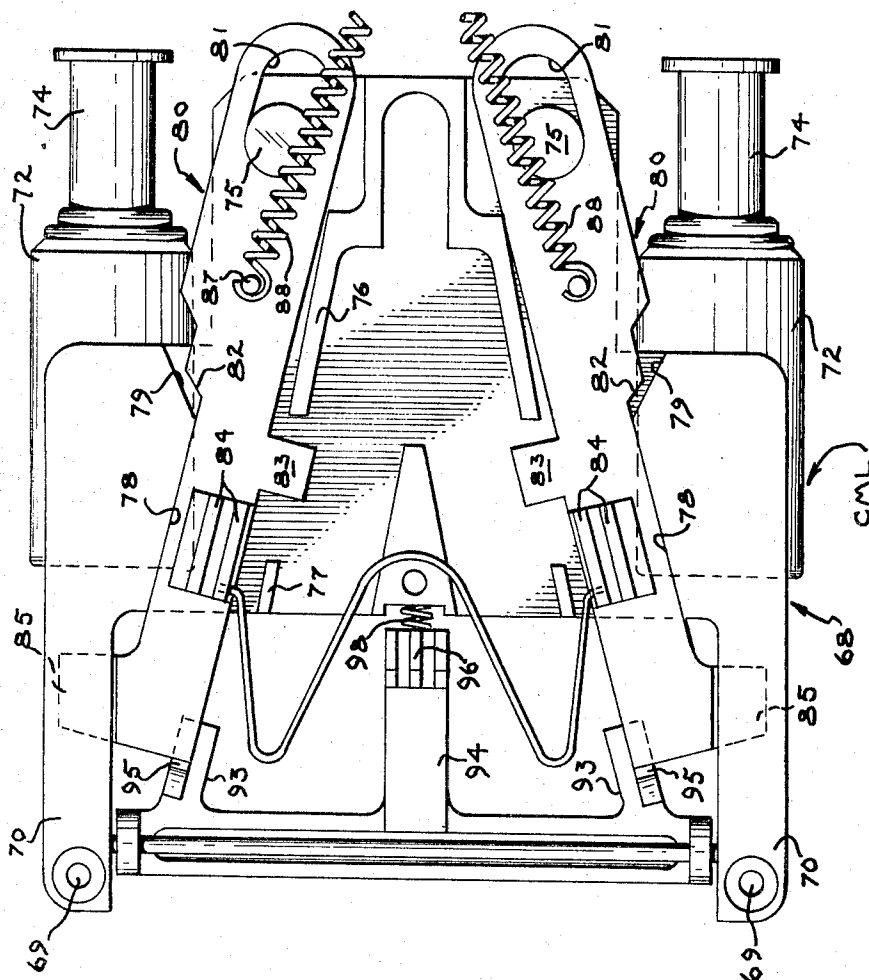


Fig. 7

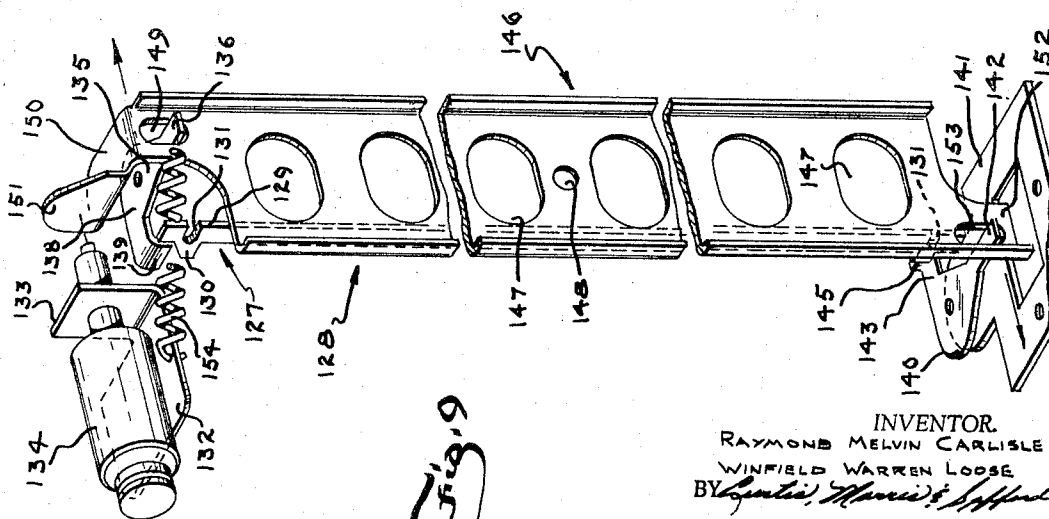


Fig. 9

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BY *Charles H. Moore & S. J. Siffert*

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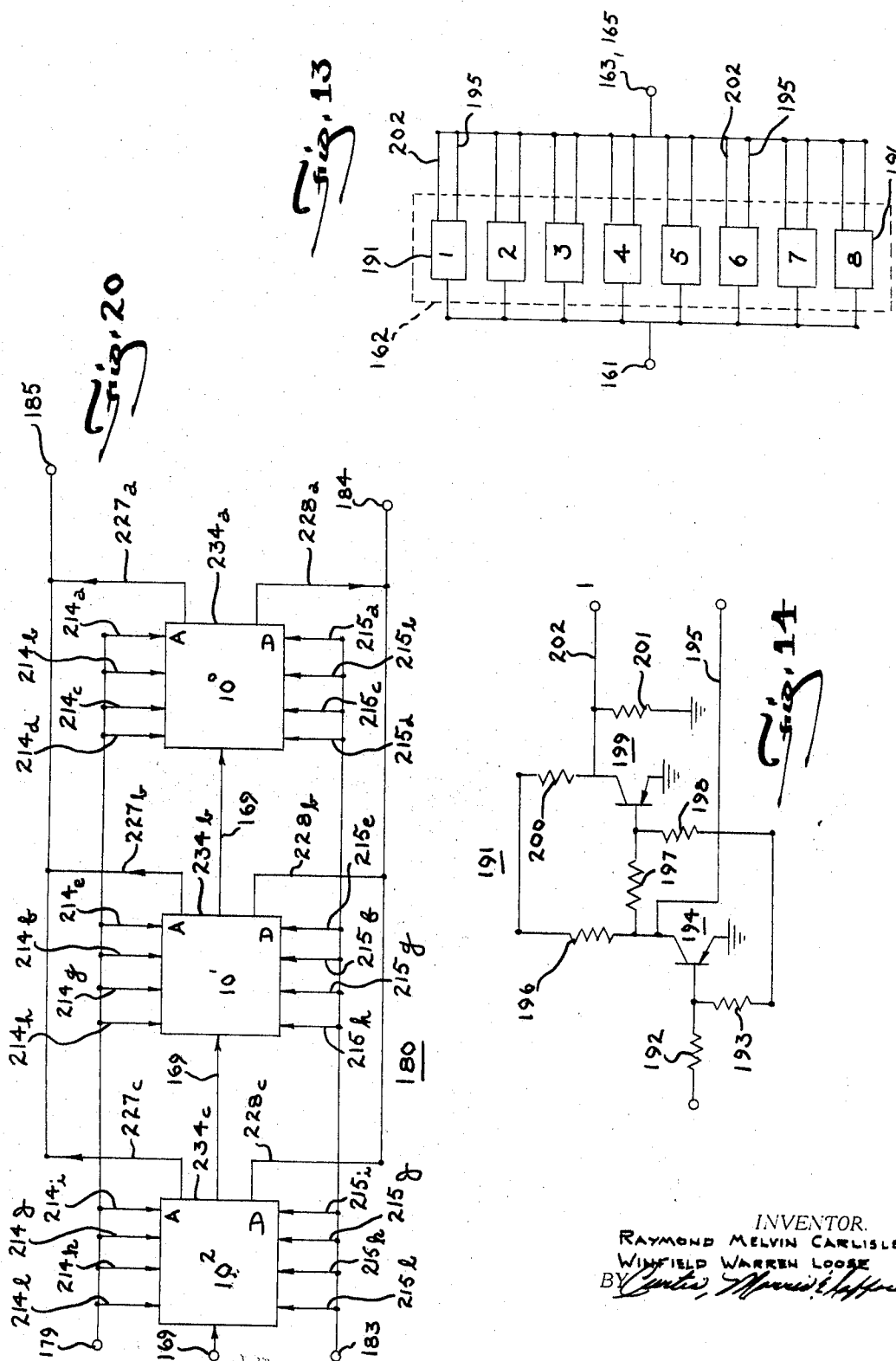
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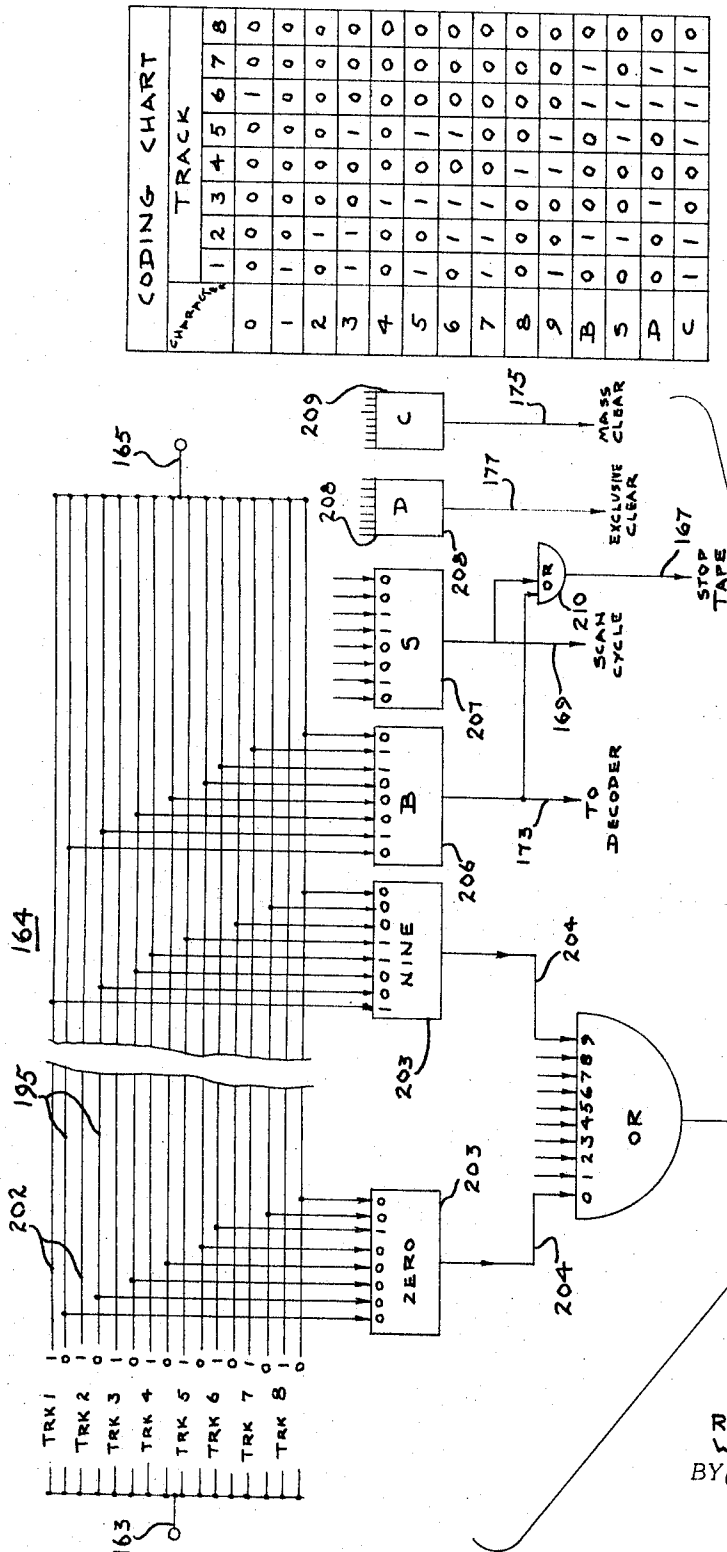


Fig. 13

CODING CHART									
SHIFTER	TRACK								
	1	2	3	4	5	6	7	8	
0	0	0	0	0	0	1	0	0	0
1	1	0	0	0	0	0	0	0	0
2	0	1	0	0	0	0	0	0	0
3	1	1	0	0	1	0	0	0	0
4	0	0	1	0	0	0	0	0	0
5	1	0	1	0	1	0	0	0	0
6	0	1	1	0	1	0	0	0	0
7	1	1	1	0	0	0	0	0	0
8	0	0	0	1	0	0	0	0	0
9	1	0	0	1	0	0	0	0	0
B	0	1	0	0	1	1	0	0	0
S	0	1	0	0	1	1	0	0	0
D	0	0	1	0	0	1	1	0	0
C	1	1	0	0	1	1	1	0	0

LEGEND
 B-BUS DECODER
 S-SCAN
 D-EXCLUSIVE CLEAR
 C-MASS CLEAR

Fig. 16

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April 1, 1969

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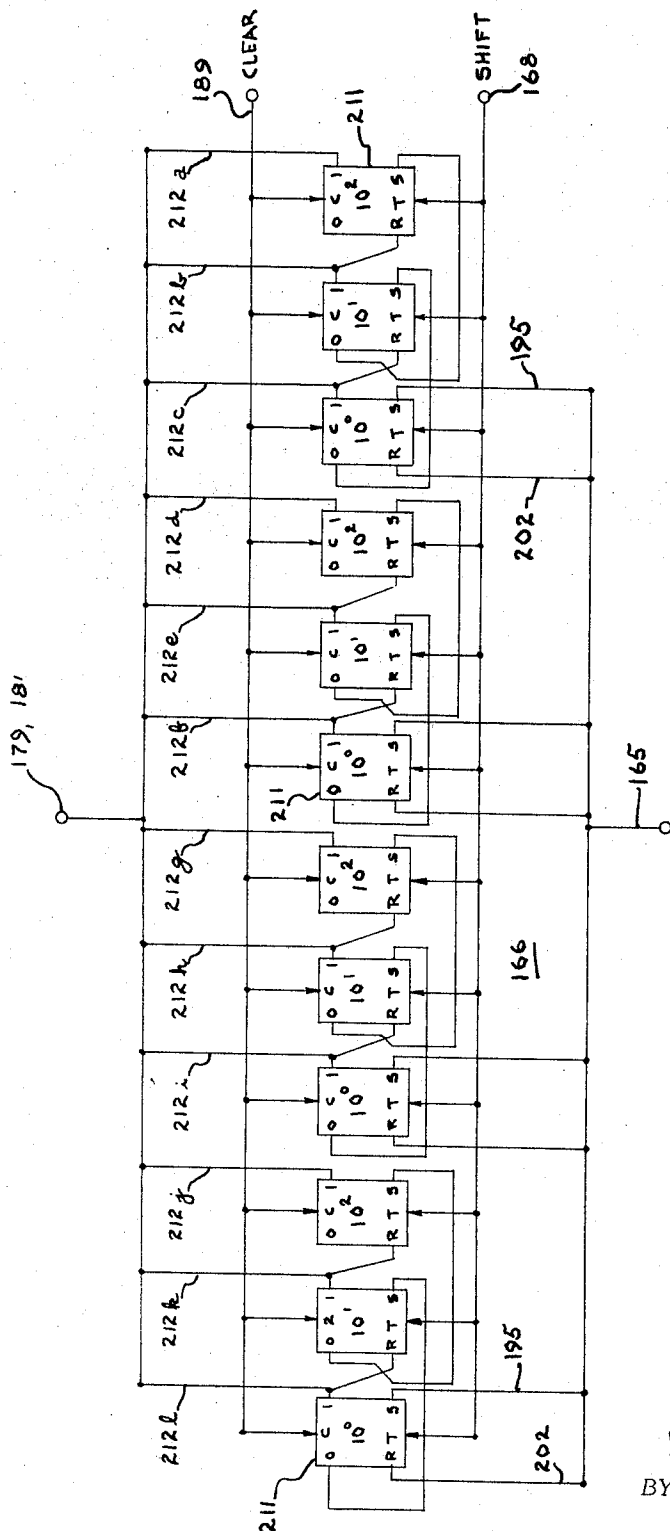


Fig. 17

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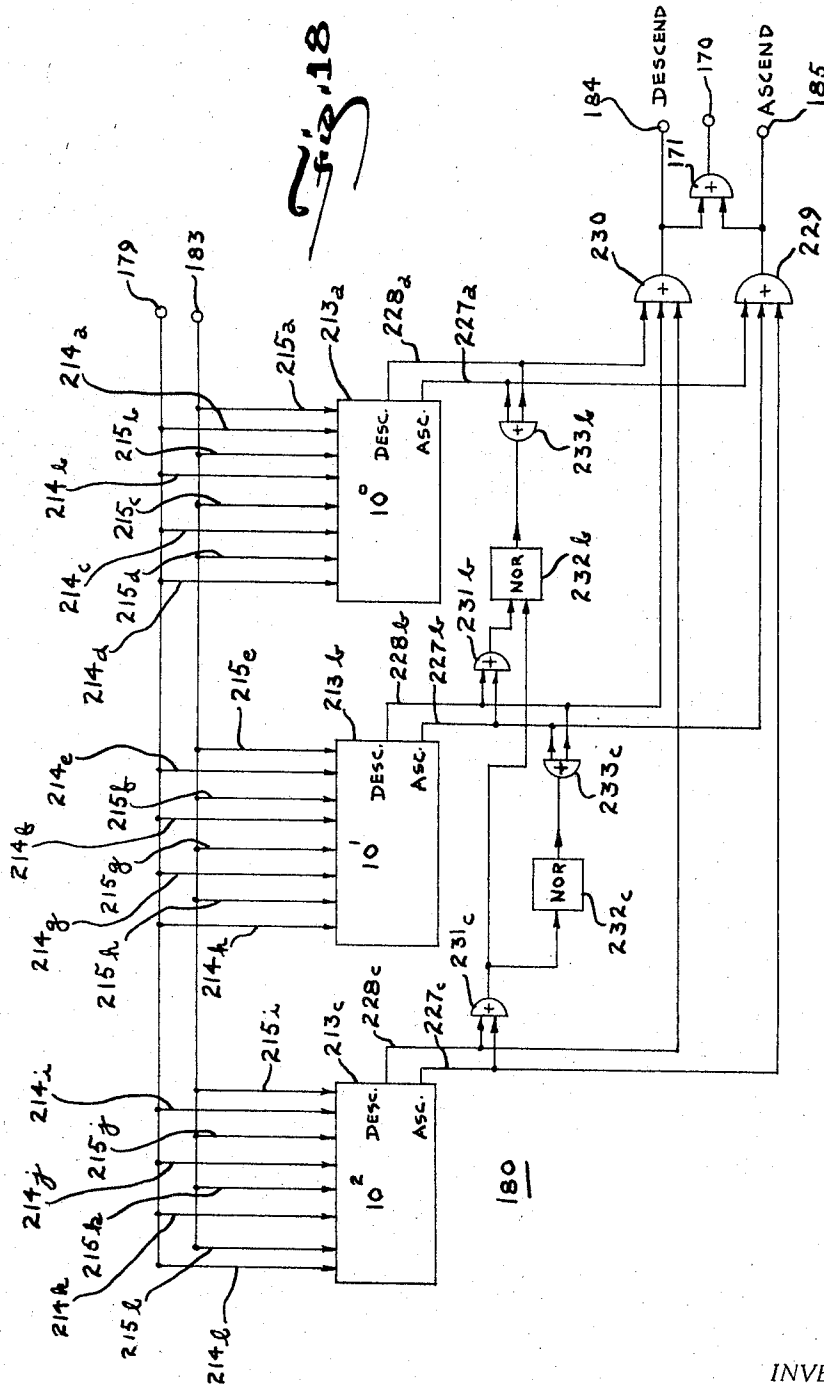
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INVENTOR.
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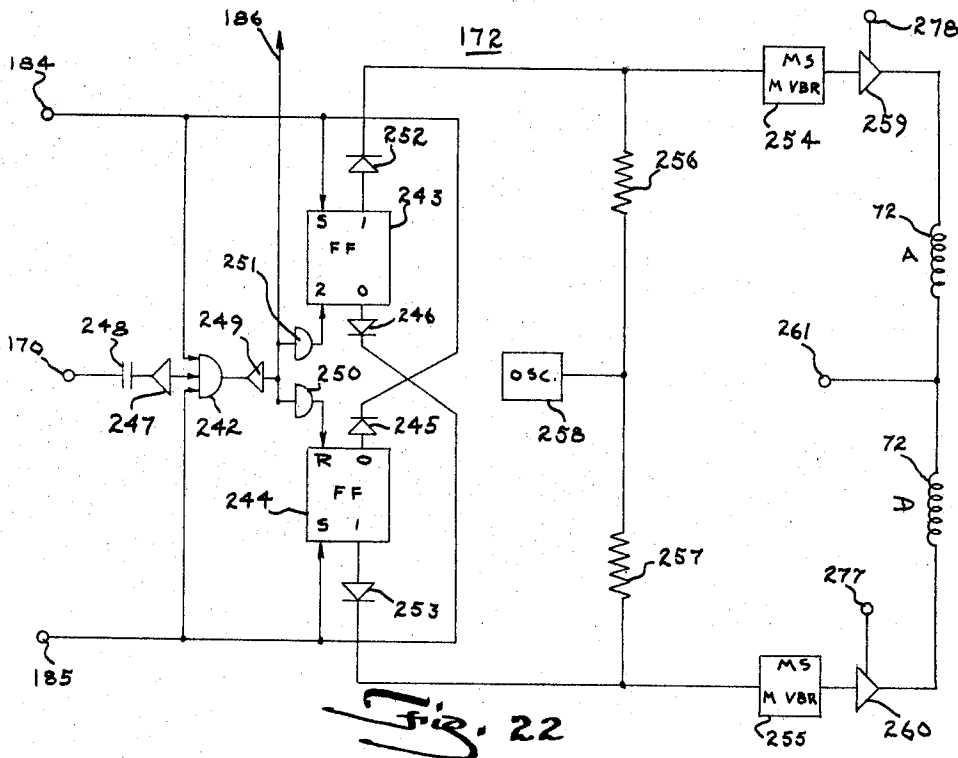


Fig. 22

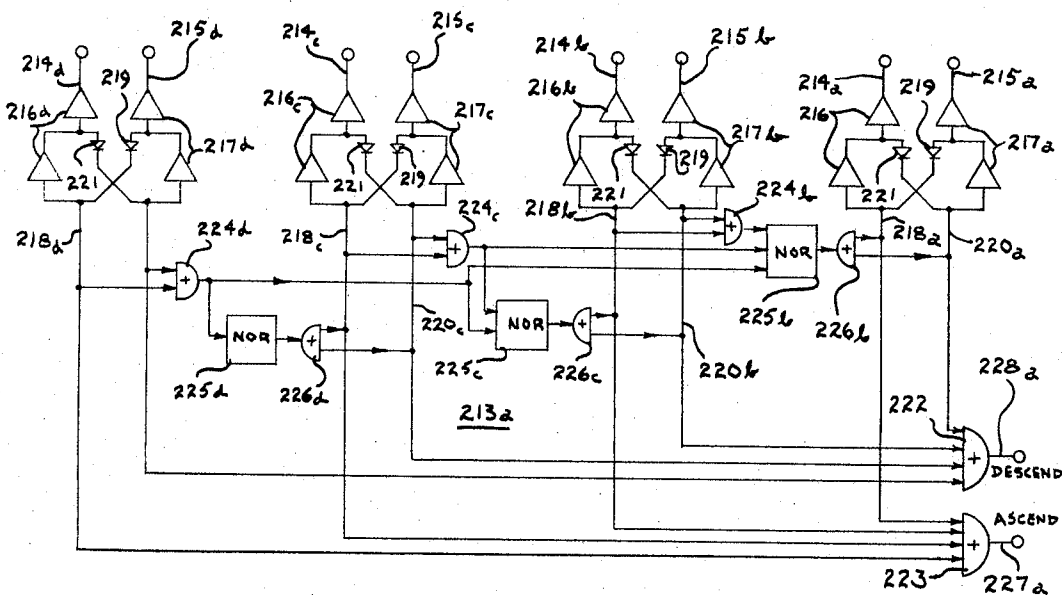


Fig. 19

INVENTOR.
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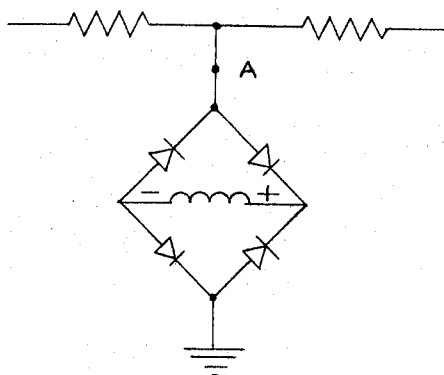
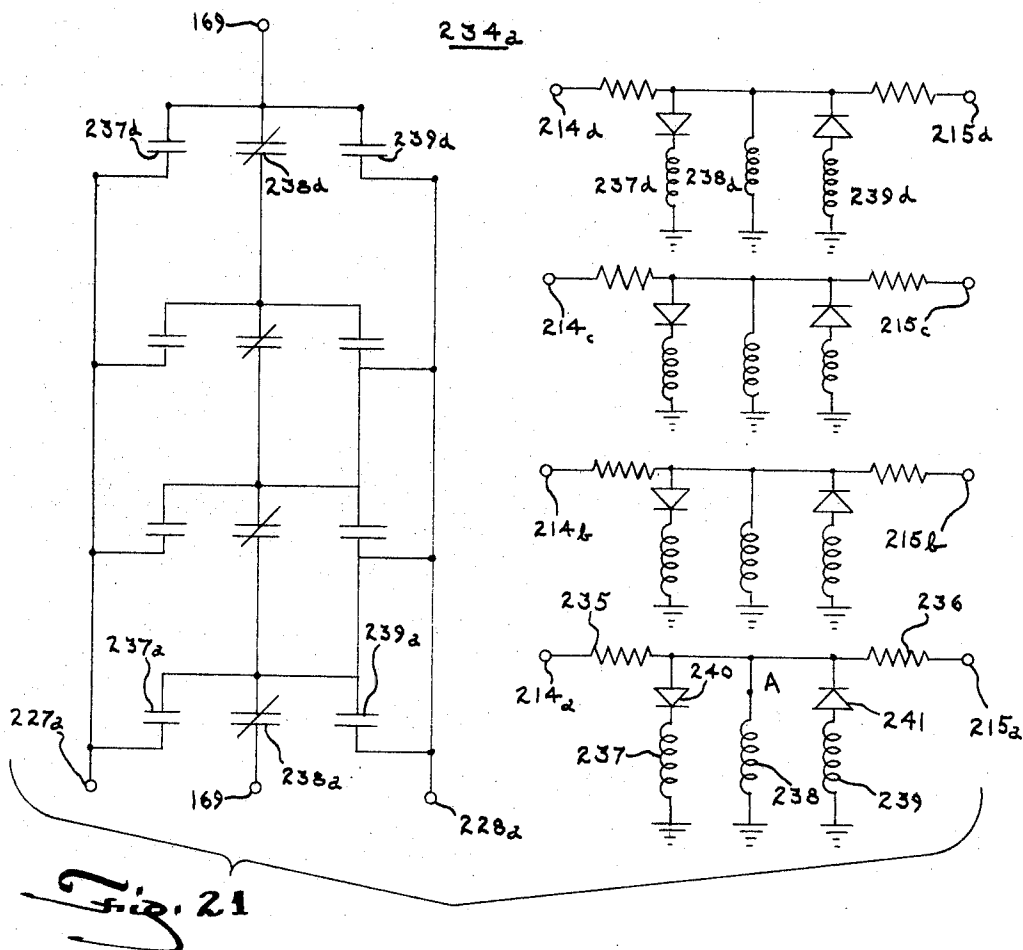
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INVENTOR.
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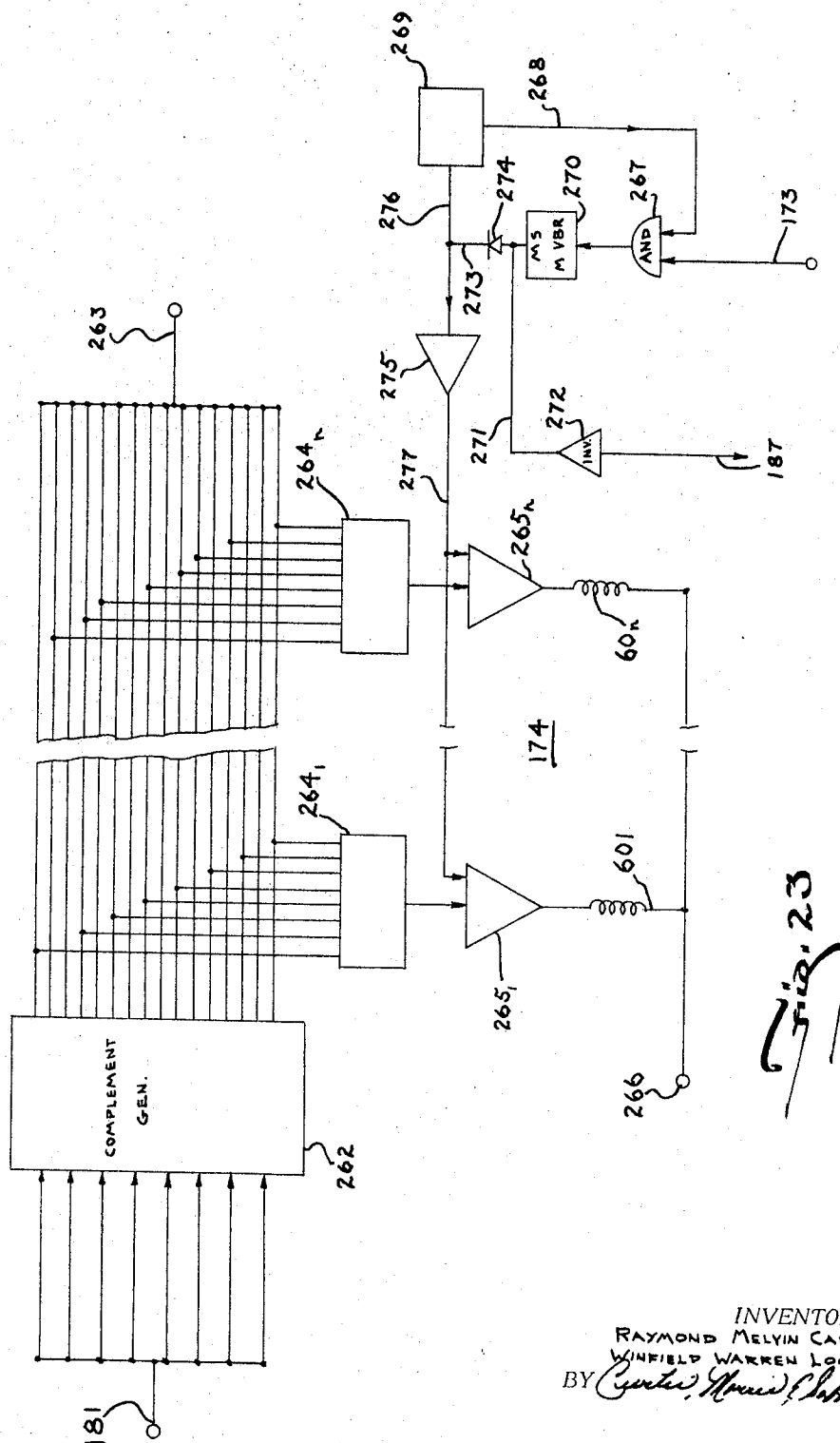
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INVENTOR.
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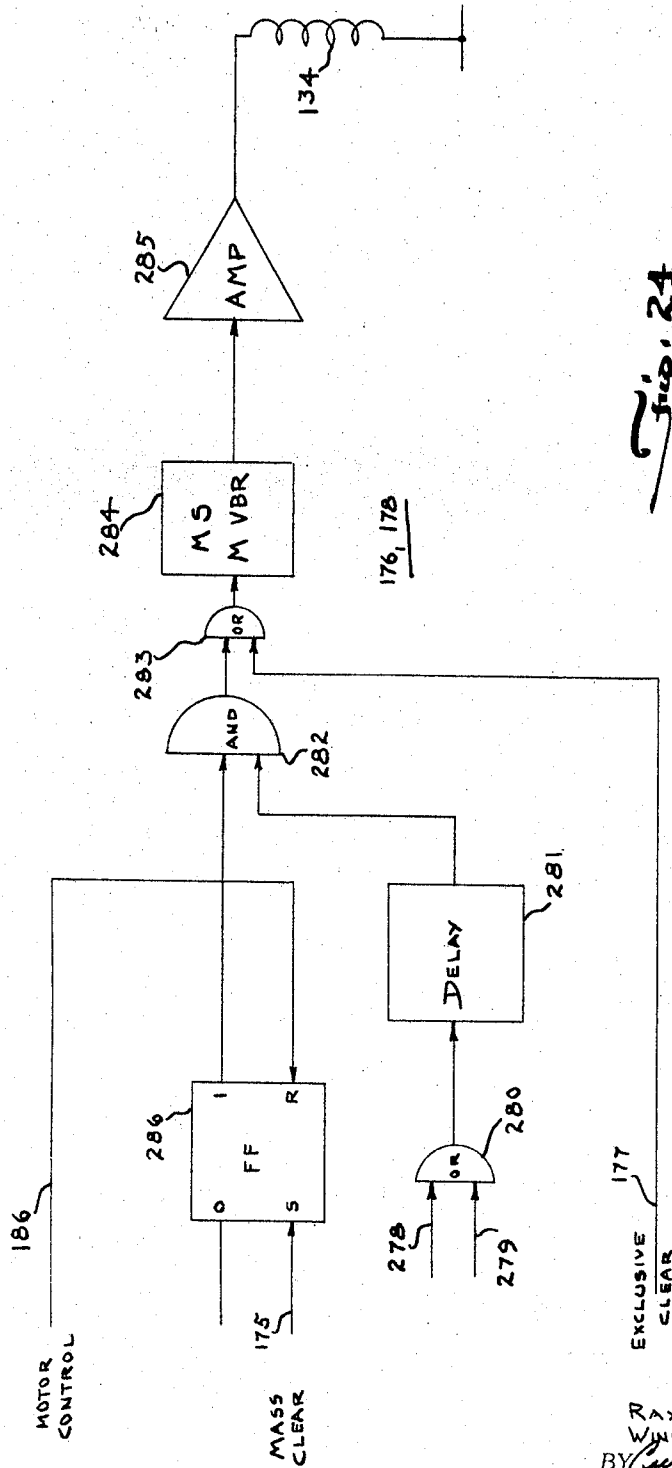
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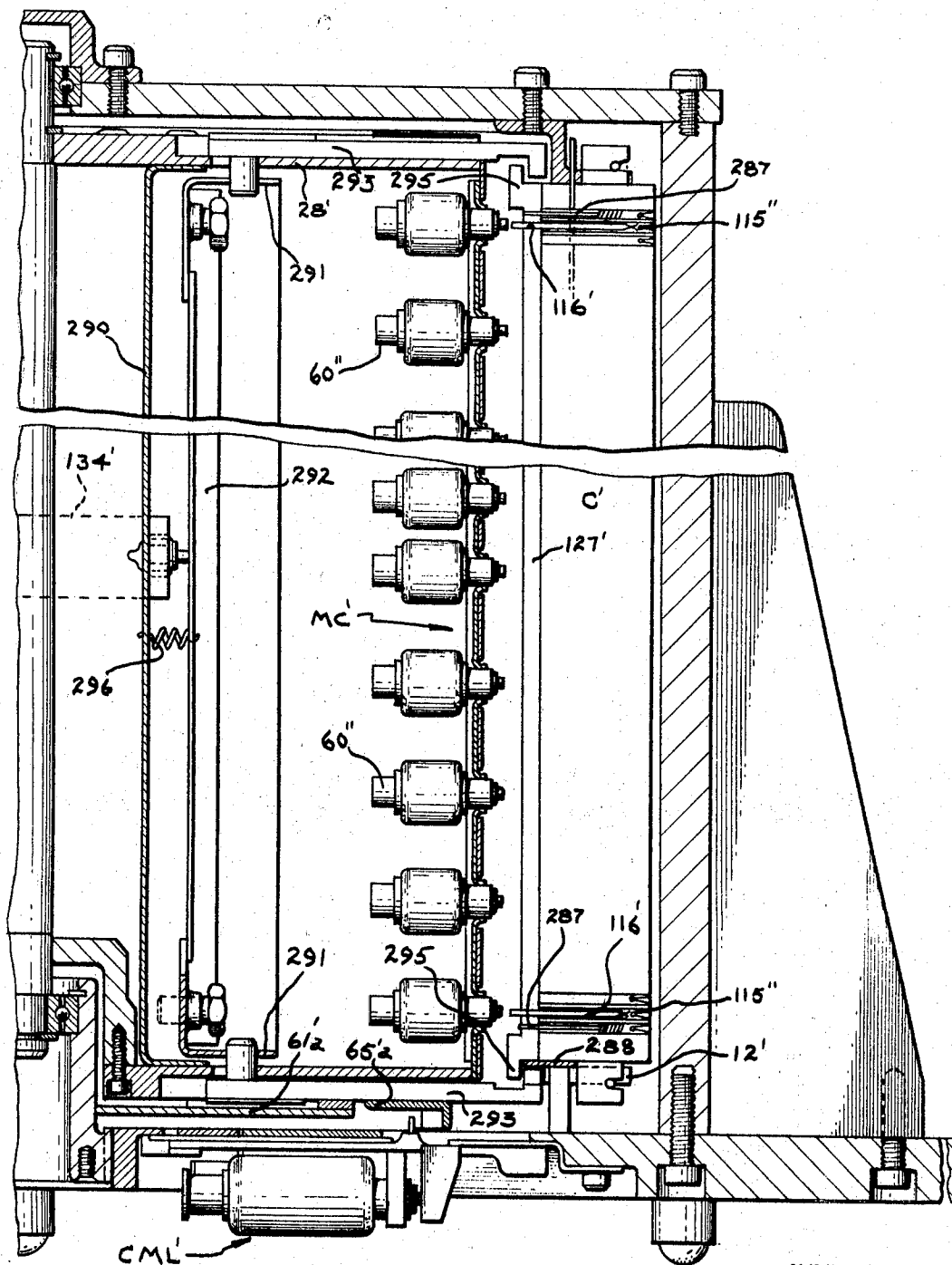


Fig. 25

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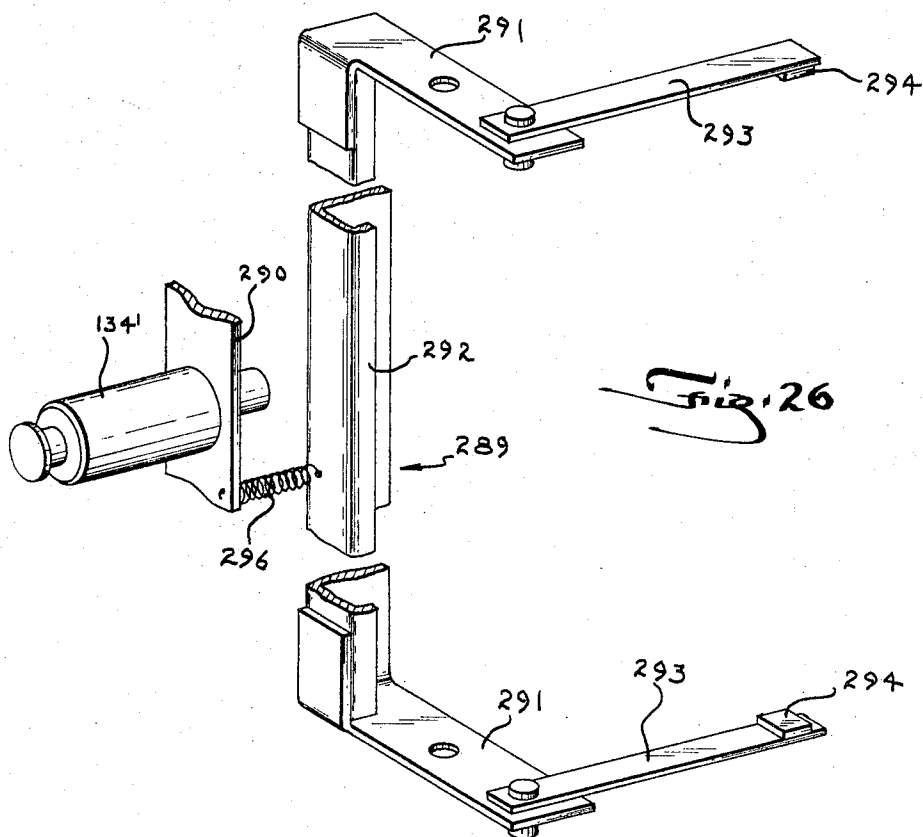


Fig. 26

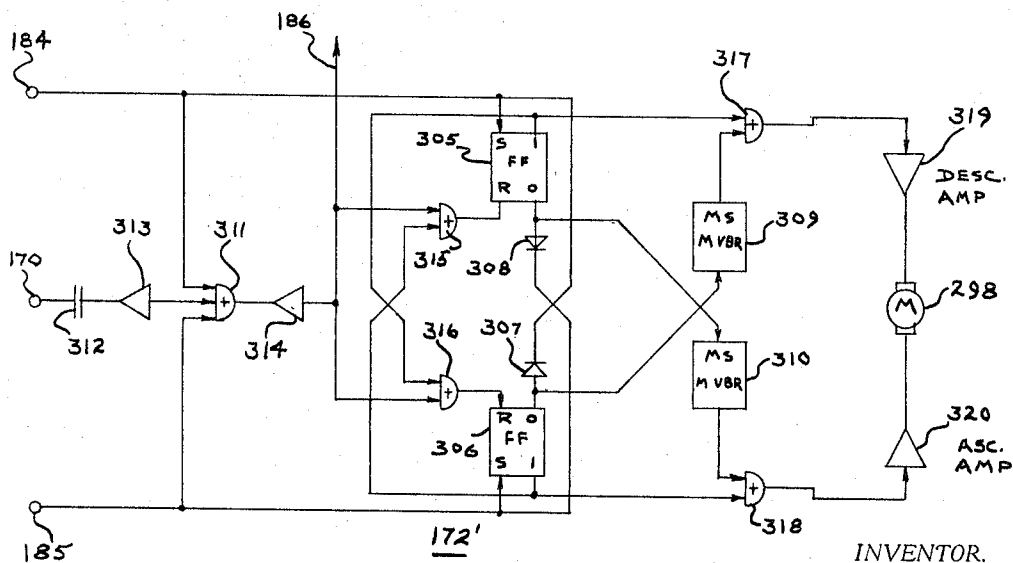


Fig. 29

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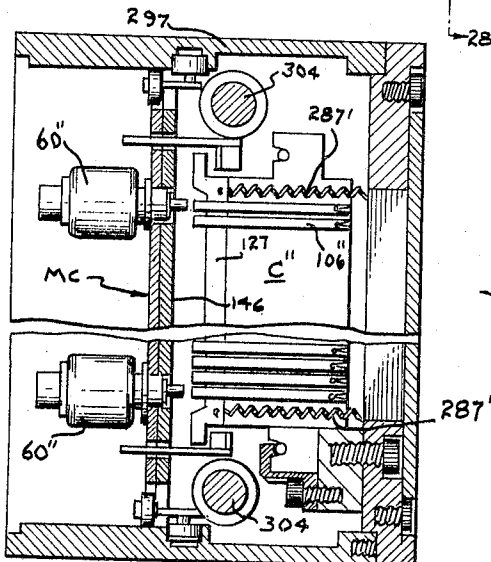
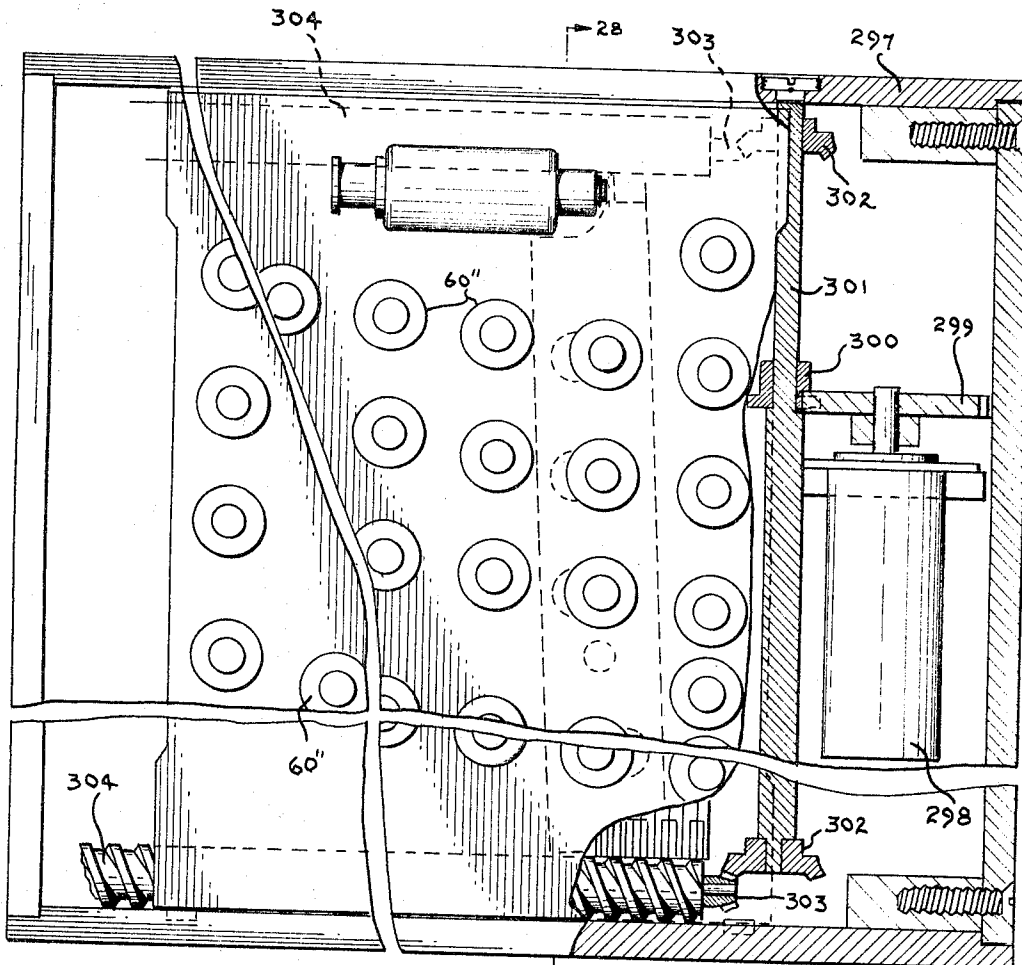


Fig. 27

Fig. 28

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3,436,696

SELECTOR SWITCH PROVIDED WITH SELECT-ABLY ACTUABLE CONTACT MEANS

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Int. Cl. H01h 67/02; G06f 7/02

U.S. Cl. 335—106

16 Claims

ABSTRACT OF THE DISCLOSURE

A selector switch or multi-circuit connector which comprises frame means on which a plurality of contact-carrying means is disposed side by side. A plurality of conductive means is disposed adjacent the contact-carrying means with each of the contact-carrying means having a plurality of movable contact means. Each of the movable contact means is in alignment with respective conductive means and conductor means is located on each of the contact-carrying means and adapted to be engaged by the contact means. Carriage means is mounted on the frame means with driving means associated with the contact-carrying means and the carriage means to drive one thereof relative to the other to pre-selected positions. Contact movable means is located on the carriage means for engaging selected contact means when the carriage means is opposite selected contact-carrying means to move the selected contact means into engagement with the conductor and conductive means to interconnect same.

This invention relates to programming means for connecting a number of input leads to a number of output leads in a preselected manner and system thereof.

In the field of computers and the like, an essential feature thereof is the programming therefor in order to provide the necessary information by which the computer will operate. A large amount of time is consumed in establishing the program of information to be fed to a computer since the general manner for establishing a program is effected by the manipulation of manual switches capable of making or breaking contact paths formed in desired patterns by patchcord assemblies. The fundamental drawback of this type of programming system is that it is totally manual and cannot, therefore, be programmed automatically to establish a desired program. An additional drawback of the patchcord assemblies for computers is that it is not suitable for remote programming.

Moreover, due to the increasing use of automation of different types of mechanisms by business and industry, a great need and demand has arisen for simple, effective and reliable programming means because a programming means is generally essential in automatic control systems where a number of operations are to be successively performed.

Various types of automatic programming devices have heretofore been devised to effect successive operations of automatic control systems but these have not proved satisfactory for various and sundry reasons, such as, for example: too cumbersome, lack of providing adequate program positions, reliability is questionable, etc.

It is, therefore, an object of the present invention to provide a programming means that is highly flexible and has excellent reliability.

Another object of the present invention is to provide a programming means for automatically and sequentially establishing programs for use by automatic control equipment.

A further object of the present invention is to provide

a programming means for remotely establishing sequential programs for use by automatic control systems.

A still further object of the invention is the provision of a programming means capable of being operated by a tape reader, card reader, push-button and/or switch panel, or the like.

An additional object of the present invention is to provide a storage means for use, for example, as binary information.

Still another object of the present invention is the provision of a multi-circuit electrical connector means.

It is a further object of the present invention to provide a programming means, storage means, connector means, or the like, which has a fast response, is easy to manufacture and has a low manufacturing cost.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there are shown and described illustrative embodiments of the invention; it is to be understood, however, that these embodiments are not intended to be exhaustive nor limiting of the invention but are given for purposes of illustration and principles thereof and the manner of applying them in practical use so that they may modify them in various forms, each as may be best suited to the conditions of a particular use.

In the drawings:

FIGURE 1 is a perspective view of the programming means;

FIGURE 2 is a part cross-sectional and elevational view of the programming means;

FIGURE 3 is a perspective view similar to FIGURE 1 in skeleton form;

FIGURE 4 is a diagrammatic view of the programming means;

FIGURE 5a is a plan view of the carriage position encoder;

FIGURE 5b is a partial plan view of the driving ring;

FIGURE 6 is a top plan view of the carriage-moving and locking means;

FIGURE 7 is a bottom plan view of FIGURE 6;

FIGURE 8 is a partial side elevational and part cross-sectional view of FIGURE 6;

FIGURE 8a is a partial plan view illustrating the movement of a driving member;

FIGURE 9 is a perspective view of the clearing means;

FIGURE 10 is a perspective and part cross-sectional view of a contact-carrying means;

FIGURE 11 is a perspective view of a contact means;

FIGURE 12 is a block diagram of the control circuit means for the programming means;

FIGURE 13 is a block diagram of a complement generator;

FIGURE 14 is a schematic diagram of one module of FIGURE 13;

FIGURE 15 is a block diagram of a command detector circuit;

FIGURE 16 is a coding chart for connection of the modules to the output of the complement generator;

FIGURE 17 is a block diagram of a shift register;

FIGURE 18 is a block diagram of a comparator circuit;

FIGURE 19 is a block diagram of one module of FIGURE 18;

FIGURE 20 is a block diagram of an alternative comparator circuit;

FIGURE 21 is a schematic diagram of a module of FIGURE 20;

FIGURE 21a is a schematic diagram of a circuit for a polarized relay for use in place of the reed relays of FIGURE 21;

FIGURE 22 is a block diagram of a motor control circuit;

FIGURE 23 is a block diagram of a bus decoder circuit;

FIGURE 24 is a block diagram of an exclusive clear and mass clear circuit;

FIGURE 25 is a vertical cross-sectional view of an alternative embodiment of the programming means;

FIGURE 26 is a perspective view of the clearing means of FIGURE 25;

FIGURE 27 is a partial plan view of another embodiment of the programming means;

FIGURE 28 is a view taken along lines 28—28 of FIGURE 27; and

FIGURE 29 is a block diagram of an alternative motor control circuit for use with FIGURES 27 and 28.

Turning now to the drawings, and more particularly, FIGURES 1—4, there is shown a mounting base B having a plurality of contact-carrying means C mounted on the base and a movable carriage means MC also mounted on base B and movable relative thereto and contact-carrying means C as well as movable exteriorly of the contact-carrying means.

Base B comprises a base plate 1 having a channel 2 affixed thereto by screws 3, or the like. Channel 2 is disposed proximate the periphery of base plate 1. An opening 4 is located at the center of base plate 1. A circular plate 5, which is Z-shaped in cross-section, has one section 6 secured to base plate 1 by screws 7 at opening 4, another section 8 overlying opening 4 and a further section 9 extending parallel to the axis of base plate 1.

A tubular member 10 has one end disposed on section 6 and is secured thereto as by screws by circular plate 11. A contact-carrying circular plate 12 is affixed to plate 11 by screws 13. Slots 14 are provided in the outer part of plate 12 and they are equidistantly disposed therearound.

Section 9 has an abutting surface 15 against which the outer race of bearing means 16 engages. A C-shaped locking member 17 is disposed in a slot 18 in section 9 to secure bearing means 16 against surface 15. One end of shaft 19 is affixed to bearing means 16 while the other end is affixed to another bearing means 20 which, in turn, engages a shoulder 21 of a nut member 22. Bearing means 20 is held in engagement with shoulder 21 via a C-shaped locking member 23 disposed in a slot 24 of nut member 22.

One end of flange bushing 25 is threaded and engaged by nut member 22 while the other end is secured to a section of plate 26 by screws 27. Nut member 22 is locked into position on the threaded end of bushing 25 by means of a nylon slug preferably disposed in the threaded area of nut member 22. Of course, other means to secure the nut member in place can be visualized.

The other end of tubular member 10 is secured to plate 26 by screws. A circular plate 28 is affixed to plate 26 via screws 29 and includes equidistantly spaced slots 30 at the outer end thereof. Midway of tubular member 10 a ring 31 is secured thereto as by screws, and on the end of ring 31 adjacent the center is a circular stabilization ring 32 which is affixed to ring 31 via screws 33. Slots 34 are equidistantly disposed along the outer end of ring 32.

Whereas elements 1, 2 and 5 have been disclosed as being separate elements, it is to be understood they may be a unitary structure. The same is true with regard to elements 10, 11, 25, 26 and 31.

Movable carriage means MC comprises a U-shaped member 35 having edges 36 turned outwardly. The sides of member 35 extend parallel to the axis of shaft 19 and the end interconnecting these sides is perpendicular thereto. Another U-shaped member 37 extends parallel to the end of member 35 and is connected to edges 36 by means of rivets 38 or the like. One end of member 37 has an upwardly-directed projection 39 while the other end has a U-shaped element 40 secured to upwardly-directed sections of member 37 via rivets 41. Oblong openings 42 are disposed in element 40 and member 37. Members 35

and 37 have holes 43 and 44, respectively, therein coaxial with shaft 19.

A circular spacer element 45 has one flange 46 secured to member 37 via rivets 47 and another flange 48 secured between member 35 and a flange 49 of a bushing 50 via rivets 51. Bushing 50 is secured to shaft 19 by a set screw 52.

Each side of member 35 has rows of apertures 53 wherein the apertures in one row are offset with respect to the apertures in the other rows. The bottom of each side of member 35 contains an extension 54 having a shaft 55 secured thereto which extends into channel 2. A bearing means 56 is affixed to shaft 55 and bears on the sides of channel 2 in order to stabilize the movable carriage.

A mounting strip 57 is mounted on each side of member 35 over each row of apertures 53 via screws 58. Threaded holes 59 are disposed in strip 57 in correspondence with each of the apertures in each row. A solenoid 60 is threadably mounted in each threaded hole 59 and locked therein via a locking nut 61. Armature 62 of each solenoid is directed inwardly toward shaft 19 and is spring-biased to maintain it in a normally inoperative position within the coil of the solenoid.

An annular carriage position encoder 61a is disposed on circular plate 28 and is secured thereon via screws through holes 62a located adjacent the inner periphery of encoder 61a (see FIGURE 5a). Carriage position encoder 61a is made of a suitable insulating material, such as, plastic and has printed thereon a printed circuit 63 which defines a code in order to position the movable carriage means as will be explained hereafter. Brushes 64 are mounted on the underneath side of member 35 overlying encoder 61a and in engagement with the part thereof containing the printed circuit.

A driving ring 65 is also mounted on plate 28 outwardly from encoder 61a and is affixed thereto via screws 66. Teeth 67 extend upwardly from and completely around the outer part of ring 65 (see FIGURE 5b). This driving ring is preferably made of a suitable plastic material. The outer edge of ring 65 is located just short of the inner end of slots 30.

The carriage-moving and locking means CML, as shown in FIGURES 6—8, is mounted on the end of member 35 beneath element 40. Carriage-moving and locking means CML comprises a plate 68 having holes 69 disposed in the outer ends of legs 70 through which screws pass in order to mount the carriage-moving and locking means on member 35. At the inner end of each leg 70, there is located an outwardly-directed extension 71 which contains a threaded hole therethrough. A solenoid 72 is threadably disposed in the threaded hole of each extension 71 and is locked thereon via a locking nut 73. Armatures 74 of the solenoids are spring-biased in a normally inoperative position as indicated in FIGURES 6—8.

Pins 75 are disposed in plate 68 and extend outwardly from the bottom surface thereof along with inclined projections 76 and 77 which are spaced from each other. Engaging surfaces 78 and cam surfaces 79 also extend outwardly from the bottom surface of plate 68. Driving members 80 are disposed along the bottom surface of plate 68. Each driving member comprises an oblong slot 81 in one end through which one of pins 75 extends, a camming surface 82 disposed opposite cam surface 79, an extension 83, driving teeth 84 and another extension 85 overlying but not engaging one of legs 70 and which has an engaging section 86 extending outwardly therefrom in alignment with the forward part of one of armatures 74.

A pin 87 is located on each driving member and has one end of a spring means 88 connected thereto while the other end of the spring means is connected to member 35. Another spring means 89 has the ends thereof connected to the driving teeth. Both of these spring means maintain the driving members in their normally inoperative positions against pins 75 and against engaging surfaces

78. A guiding channel 90 is disposed in the upper surface of each driving member adjacent extension 85. Each driving member has an inclined surface 91 at the forward and upper edge thereof.

A locking member 92 is pivotally mounted on a shaft 93 which is disposed between legs 70. Locking member 92 comprises leg members 93 and 94. Each of leg members 93 is inclined in the direction of respective driving members 80 and overlies a portion thereof. A cam surface 95 extends outwardly from the bottom surface of each of leg members 93 and engages inclined surface 91 of respective driving members 80 when in a normally inoperative position. The bottom surface of leg member 94 has extending outwardly therefrom locking teeth 96. A pin 97 extends outwardly from the upper surface of leg member 94 and has one end of spring means 98 connected thereto while the other end of this spring means is connected to pin 99 extending outwardly from the upper surface of plate 68. Spring means 98 maintains locking member 92 in a normally locked position with locking teeth 96 in engagement with teeth 67 of ring 65 and cam surfaces 95 in engagement with inclined surfaces 91.

In operation, either one of solenoids 72 of the carriage-moving and locking means may be energized which will drive the movable carriage means in the direction that the energized solenoid is supposed to drive. When one of solenoids 72 is energized, armature 74 thereof engages engaging section 86 which initially moves driving member 80 forward a distance indicated by arrow 100 in FIGURE 8a against the action of spring means 88. This movement causes inclined surface 91, through its movement along cam surface 95, to pivot locking member 92 upwardly as indicated by arrow 101 in FIGURE 8 against the bias of spring means 98 which moves locking teeth 96 out of engagement with teeth 67, brings driving teeth 84 into driving engagement therewith, moves camming surface 82 into engagement with cam surface 79 and brings cam surface 95 on the upper surface of the driving member.

Upon further movement of the driving member by armature 74, camming surface 82 in moving along cam surface 79 moves driving member 80 against the action of spring means 89 in an inward direction at an angle slightly in excess of ninety degrees from the initial movement as indicated by arrow 102 in FIGURE 8a which moves the driving member toward inclined surfaces 76 and 77, causes driving teeth 84 to move the movable carriage means one increment of movement and moves channel 90 into position under cam surface 95 so that it is now disposed and held therein under the action of spring means 98. Channel 90 is deep enough so that when cam surface 95 is disposed therein, locking teeth 96 engage teeth 67 thereby positively locking the movable carriage means at the end of the driving movement of the armature at its new position with driving teeth 84 still meshed with teeth 67. This prevents backlash, and if any backlash occurs, it is defined by the tolerances between teeth 67 and 96. Armature 74 has now reached the end of its driving stroke.

The action of spring means 88 now becomes operative, and it moves the driving member in a rearward direction at an angle of about ninety degrees with respect to the movement illustrated by arrow 102; this movement is indicated by arrow 103 in FIGURE 8a and is effected as a result of cam surface 95 riding in guiding channel 90. As soon as the movement indicated by arrow 103 has terminated, driving member 80 has reached its rearward-most position under the action of spring means 88 with the driving teeth completely disengaged from teeth 67 and the innermost end of slot 81 engaging pin 75. Spring means 89 now moves the driving member in a direction indicated by arrow 104 in FIGURE 8a until the driving member engages engaging surface 78 and inclined surface 91 is opposite cam surface 95 which is the normally inoperative position of the driving member. Extension

sions 83 stabilize the driving members during their driving movement, because the driving members in being engaged at a position offset from the axes thereof and the driving force being at an angle with respect to the movement of the driving members, they have a tendency to undergo a torsional force.

Turning now to FIGURES 2 and 10, contact-carrying means C comprises a generally rectangularly-shaped element 105 of suitable insulating material having channels 106 equidistantly disposed in parallel relationship on each side of a center section 107 and separated by ribs 108 on one side of element 105. Channels 106 extend the entire width of element 105. A single channel 109 is disposed in center section 107 and ribs 108 and extends the entire length of element 105 in perpendicular relationship with respect to channels 106 proximate one side thereof. As can be discerned, the penultimate rib at each end of element 105 has a continuous outer surface; however, they do have an opening therethrough. About midway between these penultimate ribs and center section 107, another rib on each side of section 107 is formed in the same manner as these penultimate ribs.

Slots 110 are disposed in one side of element 105 and each slot is in communication with a respective channel, and the inner end of each slot is part circular. Extending outwardly from each end of element 105 is an extension 111 which has an arcuate-shaped slot 112 in one side thereof. An arcuate-shaped slot 113 is also disposed in section 107.

A conductive member 114 is disposed in channel 109 and held therein by means of the ribs having the continuous outer surface. Another conductive member 115 is disposed in each slot 110 and is seated in the part-circular inner section thereof. A contact means 116 is disposed in each channel 106 for reciprocal movement therein.

Contact means 116, as illustrated in FIGURES 10 and 11, is formed from a single piece of metal having excellent spring characteristics and includes a first section 117 and a second section 118. Section 117 includes sides 119 disposed normal thereto, and each side includes an outwardly-directed spoon-shaped section 120. The outer end of section 120 includes an engaging portion 121 and as can be discerned, engaging portions 121 are directed toward each other and with the ends thereof being directed away from each other.

A tongue 122 extends outwardly and upwardly from section 117 and is disposed between sections 120 in order to maintain them out of contact with each other and to prevent one section from applying an excessive force to the other section.

From the inner ends of sides 119, sections 117 and 118 define a conductive-engaging part 123 at which location sections 117 and 118 are relatively close together and a substantially rectangular part 124. Sides 119 have lugs 125 which are bent over the free end of section 118 to hold same captive. A recess 126 is disposed in section 117 between sides 119 to provide strength therefor.

As illustrated in FIGURES 2, 4 and 10, contact means 116 is disposed in each channel 106 of element 105 with conductive member 114 being disposed in conductive-engaging part 123 and a clearing bar 127 being disposed in rectangular part 124. Conductive-engaging part 123 is always in engagement with its respective conductive member 114, and when the contact means is moved within its channel via a respective armature 62 of solenoid 60, engaging portions 121 engage conductive member 115 disposed in slot 110 to interconnect these conductive members. Alternatively, however, conductive-engaging parts 123 may stay out of engagement with conductive member 114 and be cammed into engagement therewith by suitably-shaped channels or in any other desirable manner. Due to the ends of engaging portions 121 being turned outwardly, this facilitates the engagement of these portions with conductive members 115. Thus, channels 106 define a guide means for the movement of the contact

means therein to make and break contact with one conductive member while maintaining continuous contact with the other conductive member.

Once a contact means has moved into contact with a conductive member 115 through the action of a solenoid 60 and it is desired to disconnect the contact means therefrom, a clearing means 128, such as illustrated in FIGURE 9, is actuated to engage clearing bar 127 to move the contact means out of contact with conductive member 115.

Clearing bar 127 has an elongated section 129 that is disposed within rectangular parts 124 of contact means 116 and abuts against the outer side of element 105. Extensions 130 are located proximate each end of section 129, and these extend over the ends of element 105 in order to guide the clearing bar during movement thereof. The upper extension supports the clearing bar on element 105. Opposite extensions 130 are grooves 131.

Clearing means 128 comprises a plate 132 which is mounted on member 35 under projection 39. Plate 132 includes an extension 133 disposed normal thereto in which a solenoid 134 is mounted. A bell crank lever 135 is pivotally mounted on the underneath side of member 35 and has one arm 136 extending through an opening 137 (see FIGURES 2 and 3) of member 35. Another arm 138 of lever 135 has a projection 139 which lies on a line opposite the upper ends of the clearing bars.

A similar bell crank lever 140 is pivotally mounted on the upper surface of a plate 141 which is affixed to the underside of extension 54. Lever 140 includes arms 142 and 143. Arm 142 lies over an opening 144 in plate 141, and this opening is in communication with a corresponding opening 54' in extension 54. Arm 143 has a projection 145 which lies on a line opposite the lower ends of clearing bars 127.

A lever-operating member 146 comprises elongated openings 147 corresponding to the number of solenoids 60 in the outermost row when looking at FIGURE 1. Member 146 is pivotally mounted over this row of solenoids through openings 147, and a screw means (not shown) passes through hole 148 into the side of member 35. Thus, member 146 is able to move relative to the solenoids about pivot point 148. Member 146 is not shown in position for purposes of clarity.

An opening 149 is disposed in member 146 and arm 136 of lever 135 extends therethrough. An extension 150 of member 146 is bent to overlie lever 135 and has a projection 151 extending outwardly therefrom which is in alignment for engagement by the armature of solenoid 134.

The other end of member 146 has an extension 152 having a slot 153 therein and arm 142 of lever 140 passes therethrough. Spring means 154 has one end affixed to plate 132 and the other end connected to member 146 which causes extension 152 to engage one end of openings 54' and 144 to maintain member 146 in a normally inoperative position.

Upon energization of solenoid 134, the armature thereof engages projection 151 which causes member 146 to pivot about point 148. Arms 136 and 142 move in the direction of movement of the respective ends of member 146 which causes projections 139 and 145 to engage the respective ends of a clearing bar which, in turn, moves any contact means 116 in engagement with conductive members 115 out of engagement therewith.

The contact-carrying means, which has the contact means and clearing bar thereon, are disposed in respective slots 14, 30 and 34 of plates 12 and 28 and ring 32. Wires 155 or similar means are disposed in slots 112 of extensions 111 and slot 113 of section 107 of the contact-carrying means and these serve to secure the contact-carrying means in their slots. Ring 32 serves to stabilize the contact-carrying means. Elastic material 156 is disposed in each groove 131 of the clearing bars in order to maintain them against element 105 in a normally inoperative

position and they will return thereto after being moved into a clearing operation by clearing means 128.

It should be pointed out that the number of solenoids 60 mounted on the movable carriage means corresponds to the number of contact means 116 disposed in each contact-carrying means C. Since space requirements are an essential ingredient of todays, as well as future equipment, the solenoids, as a result of their configuration, cannot be disposed in a single row but are arranged in a number of rows on each side of the movable carriage means.

If, for example, the number of contact means 116 in each contact-carrying means is sixty-four, then the number of solenoids would be sixty-four and they would be arranged in four rows on each side of the movable carriage means which would give a total of eight rows. The solenoids in each row are offset with respect to the solenoids in the other rows in accordance with a predetermined pattern so that each solenoid is in alignment with a level of contact means; e.g., solenoid #1 is in alignment with the top contact means or first contact means in each contact-carrying means which defines level one, solenoid #9 is in alignment with the second contact means in each contact-carrying means which defines level two, etc.

Of course, a circular and continuous conductive member 115 is inserted within slots 110 of all the contact-carrying means of each level and there define busses which are connected to conductor means (not shown) extending exteriorly of the assembly. Each conductive means 114 of each contact-carrying means defines a terminal point and is connected to conductor means (not shown) extending exteriorly of the assembly.

In order to expand the flexibility of the system, one or more solenoids 60' (see FIGURE 4) may be disposed on one or more of mounting strips 57, a contact means 116' is placed in each contact-carrying means in alignment and on the same level as solenoid 60' and a contact member 115' is disposed in each contact-carrying means in alignment with the respective contact means. Contact members 115' are connected to external conductor means (not shown). Conductor means are also connected to each solenoid in order to actuate same; however, for purposes of clarity, these are not illustrated. While the carriage means has been disclosed as being movable, it is within the purview of this invention that the carriage means be stationary while the alignment of contact-carrying means be movable. It is desirable to enclose the programming means by a suitable cover in order to keep dust and other foreign substances from coming into contact with the movable parts which might interfere with the operation thereof.

Turning now to the block diagram of FIGURE 12, there is shown a control circuit arrangement for operating the programming means, storage means, multicircuit connector means, switching means, or the like, heretofore described. An input 157 is fed into a conventional flip-flop circuit 158. An output 159 is supplied to a well-known type of tape reader 160 or similar type of storage means.

The information from tape reader 160 is supplied via lead 161 to a complement generator 162. The information sensed by complement generator 162 is fed via lead 163 to a command detector 164 and via lead 165 to a shift register 166. One output 167 from command detector 164 is connected to flip-flop circuit 158 in order to operate same to stop the tape reader. A second output 168 from the command detector is connected to shift register 166 to shift information therealong. A third output 169 from command detector 164 is connected to an output circuit 170 extending from an OR gate 171 to a motor control circuit 172.

A fourth output 173 from the command detector is connected to a bus decoder 174. A fifth output 175 from command detector 164 is connected to a mass clear con-

trol 176. Sixth output 177 out of the command detector 164 is connected to an exclusive clear control 178. The information emanating from shift register 166 is fed via lead 179 into comparator circuit 180 and by means of lead 181 into bus decoder 174. A carriage position encoder 182 feeds information via lead 183 into comparator circuit 180.

An ascending output 184 and descending output 185 from comparator circuit 180 are respectively fed into OR gate 171 and motor control 172. Output 186 from motor control 172 and output 187 from bus decoder 174 are fed into OR gate 188. Outputs 189 and 190 from OR gate 188 are fed respectively into shift register 166 to clear same and flip-flop 158 to start the tape reader again. While there has been disclosed a tape reader of conventional construction from which the information is derived, it is to be understood that any suitable type of storage or scanner means may be utilized.

There are eight tracks of information read from the tape reader storage means represented by lead 161. Each track lead is fed into a respective sensing circuit 191 as indicated in FIGURE 13. It is not essential that there be eight tracks; this applies only to binary code. Other codes may be used, i.e., BCD, octal, gray, etc., depending on customer requirements. Sensing circuits 191 are inversion circuits of the type illustrated in FIGURE 14. Information from track lead 161 is fed to resistors 192 and 193. The base of transistor 194 is connected to the junction of resistors 192, 193 while the emitter thereof is connected to ground. The collector of transistor 194 is connected to output lead 195 which will be indicative of a zero and to the junction of resistors 196 and 197. The other side of resistor 193 is connected to one side of resistor 198. The base of transistor 199 is connected to the junction of resistors 197, 198 while the emitter thereof is connected to ground. The collector of transistor 199 is connected to the junction of resistors 200 and 201. The other side of resistor 200 is connected to the other side of resistor 196 while the other side of resistor 201 is connected to output lead 202 which will be indicative of a one. Thus, for example, the outputs on leads 202 will be the complement of the outputs on leads 195 and vice versa, i.e., if the outputs on leads 195 represent 01010011, then the outputs on leads 202 represent 10101100.

Command detector circuit 164 is illustrated in FIGURE 15 and comprises leads 195 and 202 from each circuit 191 representing output lead 163 which amounts to a total of sixteen leads, two for each track. AND gates 203 of the conventional diode type representing numbers zero-nine (only the zero and nine being shown) are connected to leads 195, 202 in accordance with a predetermined binary code and the AND gate for each character is connected to leads 195, 202 in the manner set forth in the chart of FIGURE 16. Output lead 204 from each AND gate 203 is connected to a conventional OR gate 205 which provides output shifting voltage on lead 168.

Additional AND gates 206, 209 which are similar to AND gates 203 are connected to leads 195, 202 in accordance with the code set forth in the chart of FIGURE 16. Outputs 173, 169, 177 and 175 are connected, respectively, to AND gates 206, 207, 208 and 209. Each of outputs 173, 169, 177 and 175 is also connected to an OR gate 210 and output 167 is connected to OR gate 210. The first eight leads of leads 195, 202 are connected to shift register 116 via output 165.

Shift register 166, as illustrated in FIGURE 17, is a conventional 12 bit binary code decimal shift register which is of the serial input and parallel output variety and utilizes flip-flop circuitry. Leads 195, 202 are connected to the first of three serially connected flip-flop means 211, and the output 212 therefrom represents three bits of information. The next pair of leads 195, 202 are connected to the first of the next three serially connected

flip-flop means 211 and so forth until twelve flip-flop means in groups of three are properly connected to represent a twelve bit shift register with twelve outputs 212a . . . 212b. In other words, there is disclosed four, three bit serial input parallel output shift registers of which each successive bit represents successive powers of 10, i.e., 10^0 , 10^1 , 10^2 , and each three bit register represents successive powers of 2, i.e., 2^0 , 2^1 , 2^2 , 2^3 .

Lead 168 from command detector 164 is connected to each flip-flop means 211 in order to shift same upon shifting voltage being transmitted therein. Lead 189 from OR gate 188 is also connected to each flip-flop means 211 in order to clear same upon clearing voltage being present therein. While shift register 166 has been described as utilizing conventional flip-flop means, it may take the form of magnetic shift register means or the like without departing from the spirit of the invention.

Comparator 180 is illustrated in FIGURES 18 and 19. Turning now to FIGURE 18, there is shown a twelve bit binary code decimal comparator circuit wherein three four bit binary comparator means 213a . . . 213c each of which has eight input leads. Four input leads 214 are connected in appropriate manner with output leads 212 of the shift register represented by lead 179. Four input leads 215 are connected in proper relationship with the leads in lead 183 which are connected to the carriage position encoder 183 which is code disc 61a of FIGURE 5a or other appropriate coded means.

Each binary comparator means, with comparator means 213a being shown in FIGURE 19, comprises a pair of inverter circuit means 216a . . . 216d connected respectively in series with each lead 214a . . . 214d and a similar pair of inverter circuit means 217a . . . 217d connected in series with each lead 215a . . . 215d. Each of outputs 218a . . . 218d from the second of inverter circuit means 216a . . . 216d is connected in series with the first of inverter circuit means 217a . . . 217d via a diode 219. Each of outputs 220a . . . 220d from the second of inverter circuit means 217a . . . 217d is connected in series with the first of inverter circuit means 216a . . . 216d via a diode 221.

Outputs 218a . . . 218d and 220a . . . 220d are connected respectively to OR gates 222 and 223. Outputs 218b . . . 218d and 220b . . . 220d are connected respectively to OR gates 224b . . . 224d. The output from OR gate 224d is connected respectively to NOR gates 225d . . . 225b. The output from OR gate 224c is connected to NOR gates 225c and 225b, and the output from OR gate 225b is connected to NOR gate 225b. The outputs from NOR gates 225b . . . 225d are, respectively, connected to diode limiters 226b . . . 226d. The outputs of diode limiters 226b . . . 226d are, respectively, connected in shunt with outputs 218a, 220a; 218b, 220b and 218c, 220c. Outputs 227a and 228a emanate, respectively, from OR gates 223 and 222.

Turning now back to FIGURE 18, outputs 227a . . . 227c and 228a . . . 228c are, respectively, connected to OR gates 229 and 230. Outputs 227b, 227c and 228b, 228c are, respectively, connected to OR gates 231b and 231c. The output from OR gate 231c is connected to NOR gates 232c and 232b. The output from OR gate 231b is connected to NOR gate 232b. The outputs from NOR gates 232b, 232c are, respectively, connected to a diode limiter 233b and 233c. The outputs from diode limiters 233b, 233c are, respectively, connected in shunt with outputs 227a, 228a and 227b, 228b.

Description of operation of comparator 180

The following describes how a four bit binary word at terminals 214a . . . 214d is compared with a four bit binary word at terminals 215a . . . 215d.

214d and 215d represent the highest order digit (2^3) in characters represented within inputs 214a . . . 214d and 215a . . . 215d, respectively, 214c and 215c the sec-

and highest order (2^3), . . . 214a and 215a the lowest (2^0).

If a one appears at 214d and not 215d, the character at inputs 214 is larger than that of inputs 215 and a signal is required at 227a to indicate this. All lower order terms are insignificant as the difference of the highest order is sufficient to indicate which is the larger word, and, therefore, the lower order inputs 214c and 215c, 214b and 215b, and 214a and 215a, must be prevented from reaching the outputs 227a and 228a. If there is no difference, the highest order inputs 214d and 215d, the next highest order inputs control the outputs. This is accomplished by the order, i.e., "power of two" discriminator circuit composed of OR gate 224, NOR gate 225, and limiter circuit 226, in the following manner:

If there is a signal at 214d or 215d, but not at both, a signal will appear at 218d or 220d and at 227a or 228a. A signal at 218d or 220d will generate an output signal from OR gate 224d which is fed into NOR gates 225d, 225c and 225b. The NOR gate provides an output signal of ZERO, i.e., ground, in response to a ONE at any of its inputs; thus, 218c and 220c are clamped to ground through limiter 226d and 220b and 220a are clamped to ground through limiter 226c, and 218a and 220a are clamped to ground through limiter 226b. The only signals permitted to reach the output are those of the highest order having a difference at its input terminals. Indication as to whether 214 or 215 is the larger word is given by a signal at 227a or 228a, respectively. If digit 214d equals digit 215d, either ones or zeros, 218d and 220d will be at ground level by means of the double inversion in the case of zero inputs, or by means of the diode clamps in the case of one inputs. In both cases, the output of NOR gate 225d is a one, and any difference between the inputs of 214c and 215c generates the corresponding signal at 218c and 220c and still lower order signals are grounded, as described above.

In brief, if word 214 is larger than word 215, a signal indicative of this will appear at 227a, and, if word 215 is larger than word 214, indication will appear at 228a, and if 214 equals 215, there will be no signal at either 227a or 228a.

The four bit binary comparator of FIGURE 19 can be cascaded, as illustrated in FIGURE 18, to form a BCD comparator with "power of ten" discrimination similar to the "power of two" discrimination described above. The two BCD words to be compared are fed into 179 and 183 and the output will appear at 184 if 183 is larger or at 185 if 179 is larger. There will be no output if word 179 equals 183.

An alternative comparator 180' is illustrated in FIGURE 20 with one of the modules thereof shown in FIGURE 21. As shown in FIGURE 20, input leads 214a . . . 214b, which are similar to those shown in FIGURE 18 and are connected in proper manner to lead 179, are connected in groups of four to modules 235a . . . 234c; the same being true for input leads 215a . . . 215b connected to lead 183. Each module is the same and module 234a will be described in conjunction with FIGURE 21. Between inputs 214a, 215a there are serially connected resistors 235, 236. Three relays 237, 238, 229, preferably of the reed-type, are connected between the junction of resistors 235, 236 and ground with diodes 240, 241 connected, respectively, in series with relays 237, 239. Diode 240 is connected in opposite relationship to that of diode 241.

Normally open contacts 237a, 239a, which are respectively associated with relays 237 and 239, are respectively connected between output leads 227a, 228a and lead 169. Normally closed contacts 238a, which are associated with relay 238, are connected in lead 169. The circuitry between leads 214b, 215b; 214c, 215c and 214d, 215d and in association therewith are the same as that between and in association with leads 214a, 215a, and, therefore, need not be further described. Output leads 227a . . . 227c, 228a . . . 228c are the same as those of FIGURE

18 except that the OR and NOR gates and the diode limiters in FIGURE 18 is, of course, not needed and the same is true with regard to these gates and diode limiters in FIGURE 19. It is pointed out that lead 169, when connected to comparator 180' of FIGURES 20 and 21, is not connected thereto through OR gate 171 as is the case with comparator 180, because such is not necessary in relay comparator 180'.

Description of operation of FIGURES 20 and 21

Referring to FIGURE 21, there is illustrated a comparator composed of relays, diodes and resistors.

Four bit word 214 is to be compared with word 215. 214 is of positive polarity with respect to ground and word 215 is of negative polarity with respect to ground. 214d represents the highest order digit (2^3) . . . 214a represents the lowest order digit (2^0).

If a one appears at 214d and a zero at 215d, a positive voltage will be developed at the junction of resistors 235 and 236 which activates relays 237d and 238d causing contacts 237d to close and 238d to open and allowing the signal at 169 to be passed to 227a by means of contacts 237d and isolating lower order terms by means of contacts 238d moving to an open position.

If there is a one at both 214d and 215d, these voltages, which are equal in magnitude but opposite in polarity, will balance across resistors 235 and 236 causing point A to be at ground with, of course, no response by relays 237d, 238d, 239d, and permitting the next highest order to control the outputs. These modules can be connected in series to obtain a BCD comparator of FIGURE 20. Each group of four inputs represents the binary-coded multiplier for the corresponding "power of ten." "Power of ten" discrimination is accomplished in a similar manner as "power of two" discrimination, i.e., the normally closed contacts 238. FIGURE 21a illustrates utilization of polarized reed relays at point A.

Thus, as can be discerned, there has been disclosed alternative comparator circuits for interchangeable use in conjunction with the overall circuit arrangement of the invention. Of course, other types of comparator circuits may be used which are within the purview of the skilled artisan.

FIGURE 22 shows control circuit 172 for operation of the carriage-moving and locking means of FIGURES 6-8. Leads 184, 185 are connected to an OR gate 242 and, respectively, to flip-flop circuits 243, 244. Lead 184 is also connected to flip-flop circuit 244 via diode 245, and lead 185 is connected to flip-flop circuit 243 via diode 246. Lead 170 is connected to an inverter circuit 247 via switch contacts 248. Switch contacts 248 comprise spaced contacts on disc 61 of the encoder (FIGURE 5a) each of which is engaged by a brush in order to establish a vernier switching arrangement to properly locate the movable carriage means. The output of inverter circuit 247 is connected to OR gate 242 and the output thereof is connected to inverter circuit 249. The output of inverter circuit 249 is, respectively, connected to flip-flop circuits 243, 244 via OR gates 250, 251. Lead 186 also emanates from the output of inverter circuit 249. Diodes 252, 253 are contained in respective outputs of flip-flop circuits 243, 244 which, in turn, are respectively connected to monostable multivibrator circuits 254, 255.

Resistors 256, 257 are serially connected across the outputs of flip-flop circuits 243, 244 and a conventional oscillator 258 has its output connected to the junction of resistors 256, 257. The outputs of multivibrator circuits 254, 255 are connected, respectively, to amplifiers 259, 260, and the outputs thereof are connected to respective coils of solenoids 72 which are connected in series. A source of supply 261 is connected to the junction of the coils of solenoids 72. Thus, there has been described a stepping motor control circuit.

Description of operation of FIGURE 22

In the quiescent state, the "ONE" outputs of flip-flops 243 and 244 are at ground level and the signal from oscillator 258 through resistors 256 and 257 to monostable multivibrators 254 and 255, respectively, is clamped to ground through diodes 252 and 253.

When a signal appears at 184, flip-flop 243 assumes the "SET" state where the "ONE" output develops a signal and the "ZERO" output goes to ground. Input 185 is now clamped to ground via diode 246 preventing any unwanted signals from "SETTING" flip-flop 244. With flip-flop 243 in the "SET" state, the signal from oscillator 258 is allowed to develop at the input of monostable multivibrator 254. This signal triggers monostable multivibrator 254 (at a rate determined by oscillator 258) which supplies pulses to solenoid 72A via amplifier 259 and drives the carriage in the proper direction.

When carriage arrives at approximately the proper position, as indicated by encoder disc 61a comparator 180 will remove the signal from input 184. Now the only signal into OR gate 242 is that from inverter 247, but when the carriage arrives at precisely the proper position vernier switch contacts 248 will close driving the output of inverter 247 to ground. Now the output from OR gate 242 is at ground and a signal is developed at the output of inverter 249 which resets flip-flop 243. The circuit is now in the quiescent state described above.

If, for any reason, the carriage should not stop on proper position and proceed to the next position, comparator 180 will recognize this and produce a signal at input 185 and remove the signal from 184, but the signal at 185 will be clamped to ground via diode 246 and set flip-flop 243 which has its "ZERO" output at ground. Thus, there will be no signal at either 184 or 185, and, when the vernier switch contacts close, the output of inverter 247 will go to ground and flip-flop 243 will become reset as described above. Now diode 246 can no longer clamp input 185 to ground and a signal develops at 185 "SETTING" flip-flop 244 which drives solenoid 72D to move carriage in the opposite direction. Thus, the carriage cannot stop on an improper position due to tolerance or random make and/or break conditions of the encoder readout brushes.

Bus decoder 174 is shown in FIGURE 23 and comprises a complement generator 262 similar to that shown and described in FIGURES 13 and 14. Eight inputs from shift register 166 and represented by lead 181 are fed into complement generator 262 and sixteen outputs represented by 263 emanate therefrom. AND gates 264₁ . . . 264_n of the diode type are connected to outputs 263 in accordance with a code so that the appropriate AND gate will be actuated whenever the code corresponding thereto appears in outputs 263. The outputs from AND gates 264₁ . . . 264_n are, respectively, connected to amplifiers 265₁ . . . 265_n. The outputs from amplifiers 265₁ . . . 265_n are, respectively, connected to one side of solenoids 60₁ . . . 60_n which are the solenoids located on movable carriage means MC. The other side of solenoids 60₁ . . . 60_n is connected to a source of supply 266.

Output 173 from command detector 164 is connected to AND gate 267. Output 268 from a conventional square wave generator 269 is also connected to AND gate 267 and the output therefrom is connected to a monostable multivibrator 270. Output 271 from multivibrator 270 is connected to an inverter 272. Output 187 is connected to inverter 272. Output 273 from multivibrator 270 is connected via diode 274 to amplifier 275 along with output 276 from square wave generator 269. Output 277 is connected to each of amplifiers 265₁ . . . 265_n.

Description of operation of FIGURE 23

FIGURE 23 is a conventional AND gate decoder with gating circuits and pulsing circuits to increase the re-

liability of solenoids 60₁ . . . 60_n. The conventional AND gate decoder selects the proper solenoid in accordance with the code at its inputs and that solenoid is driven into action by the gating and pulsing circuits as follows:

A signal is applied via output 173 to AND gate 267, and, when the next synchronizing pulse from square wave generator 269 is applied to AND gate 267, monostable multivibrator 270 triggers. The period of multivibrator 270 is a multiple of the period of square wave generator 269.

Before multivibrator 270 triggers its output, it is at ground level and the output of square wave generator is clamped to ground via diode 274. After multivibrator 270 triggers, the output of square wave generator 269 is no longer clamped to ground and the solenoid selected by AND gate decoder receives a number of pulses via amplifier gate 275. The number of pulses is determined by the ratio of multivibrator period to square wave generator period. Applying two or more pulses to solenoids 60₁ . . . 60_n greatly increases the reliability thereof.

At the end of the multivibrator period, inverter 272 develops a signal at its output which signals the control system that the bus decoder 174 has performed its duty and the program may proceed.

Description of operation of entire system

Assuming that carriage MC is initially at zero position and tape reader 160 has no output signals, a signal is applied at line 190 which starts the tape reader. Assume that it is desired to move carriage MC to position 120 and upon arrival at position 120 actuates bus solenoids 60₁ and 60₁₆, then proceed to position 135 and actuate bus solenoid 60₁₆, next to position 115 and actuate bus solenoid 60₁.

The first character to be read from tape is a binary coded one which is fed into complement generator 162. All eight bits of information are fed into command detector 164, and only the first four bits (eight lines containing both message and complement) are fed into shift register 166. Command detector 164 recognizes the character ONE and sends a shift pulse to shift register 166 which accepts the coded ONE in its 10⁰ sections. The next character to be read from the tape is a binary coded TWO. Command detector 164 recognizes this and sends a shift pulse to shift register 166 which shifts the ONE to the 10¹ section and accepts the TWO into the 10⁰ section. The output of shift register 166 now reads a binary coded decimal TWELVE. The next character to be read from the tape is a binary coded ZERO. Command detector 164 recognizes this and sends a shift pulse to shift register 166, which shifts the previously received ONE, to its 10² section, the TWO to its 10¹ section, and accepts the ZERO in its 10⁰ section. The output of shift register 166 now reads a binary coded decimal ONE HUNDRED-TWENTY which is fed into comparator 180 via line 179. Comparator 180 compares this with the information it receives from carriage position encoder 182, which is the BCD character representing ZERO (since it has been assumed that the carriage was initially at ZERO position) as described in the operation of FIGURES 18 and 19, and a signal is developed at 184. This signal is clamped to ground by means of limiter 171 and lead 169 which is at ground at all times unless the appropriate character S, in this example, is recognized by command detector 164. The next character to be read from tape is a coded S which is recognized by command detector 164 and a signal appears at 169, and also at 167 which stops movement of tape. Now line 184 is not limited to ground and the signal transmitted by comparator 180 is passed into motor control 172, which responds, as described in the operation of FIGURE 22.

When carriage CM arrives at the position commanded by the tape reader, a signal is transmitted from motor control 182 via shift register 166 and starts tape via flip-flop 158 and line 159. Tape reader 160 again begins

functioning and the next character to be read is a binary coded ONE. This is recognized by command detector 164 and a shift pulse is transmitted to shift register 166 which accepts this ONE in its 10^0 section. The output of shift register 166 now reads a BCD character representing ONE. The next character to be read from tape is a coded B which is recognized by command detector 164 which transmits a signal via line 167 and stops the tape and transmits a signal via line 173 to bus decoder 174 which responds, as described in the description of operation of FIGURE 23, selecting solenoid 60₁, since the input code at 181 from shift register 166 represents the BCD character ONE. At the end of this cycle, bus decoder 174 transmits a signal via line 187 and OR gate 188 to clear shift register 166 and start tape reader via line 190 and flip-flop 158.

In operating another bus solenoid, i.e., solenoid 60₁₆, tape reader 160 again advances tape to the next character which is binary coded ONE. This is recognized by command detector 164 and a shift register pulse is transmitted to shift register 166 accepting ONE in its (10^0) section. The next character read from the tape is a binary code for SIX; command detector 164 recognizes this and sends a shift pulse to shift register 166 shifting the ONE to the 10^1 section and accepts the SIX in the 10^0 section. The output of shift register 166 now reads a BCD character representing SIXTEEN. The next character read from tape is a coded B which is recognized by command detector 164 and transmits a signal via line 167 to stop the tape, and signal via line 173 to bus decoder 174 and energizing solenoid 60₁₆, as described in relation with FIGURE 23. At the end of this cycle, bus decoder 174 transmits a signal via line 187 and OR gate 188 to clear shift register 166 and start the tape reader via line 190 and flip-flop 158. Thus, contact means 116 at the first and sixteenth positions in the contact-carrying means at position 120 are engaged with conductors 114 and 115.

The next character to be read from tape is a binary coded ONE which is fed into complement generator 162, then into command detector 164, then into shift register 166 in the 10^0 section. Succeeding tape characters THREE and FIVE will effect shifts until ONE shifts into the 10^2 section, THREE into the 10^1 section and FIVE into the 10^0 section. The output of shift register 166 then reads a coded ONE HUNDRED THIRTY-FIVE which is fed into comparator 180 via line 179. Comparator 180 compares this output with encoder 182 which is in coded position 120. With the next tape coded character S recognized by command detector 164, a signal appears at 169 as well as 167 which stops movement of the tape. Now line 184 is not limited to ground and the signal transmitted from comparator 180 is passed into motor control 172, and responds as described in the description of operation of FIGURE 22.

As carriage CM arrives at position 135, a signal is transmitted from motor control 172 via line 186 and OR gate 188 clearing the shift register 166 and starting the tape via flip-flop 158 via line 159.

The several successive functions occur as previously indicated to operate bus solenoid 60₁₆, following which the shift register is cleared and the tape advances to accumulate coded signals into shift register 166 for drawing the cartridge CM back to position 115 with signals through the descending line 185 instead of 184. Subsequent tape advancing will deliver coded signals to the shift register to activate bus solenoid 60₁ as outlined above.

The next successive characters to be read from the tape include ONE, FOUR, THREE, and S, in order to drive the carriage to position 143 in the manner set forth above.

When the carriage CM arrives at position 143, a signal is transmitted to start the tape via line 186, OR gate 188 and flip-flop 158. The next character on the tape is 0 which is recognized by command detector 164 and a signal is sent to exclusive clear control via line

177. This signal appears at the input of monostable multivibrator 284 in FIGURE 24 via OR gate 283, and monostable multivibrator 284 generates a pulse which activates clear solenoid 134 via amplifier 285. Thus, there has been described the exclusive clear function.

To mass clear the system between any two terminal points (carriage positions), the movable carriage is sent to a position at one end of the area to be cleared by the driving solenoids of the carriage-moving and locking means. When the carriage arrives at this position, the tape gives the mass clear command C. Command detector 164 sends a signal to mass clear control via line 175 which sets flip-flop 286 and a signal appears at one input of AND gate 282. Now the tape orders the carriage position at the other end of the area to be cleared and the carriage responds as described above.

At the end of each drive pulse, either ascending or descending, a pulse is sent to OR gate 280 via leads 278 or 279. This pulse is sent to the other input of AND gate 282 via OR gate 283. Delay 281 adjusts the time between drive pulse and clear pulse. Thus, after every drive pulse, the clear solenoid is pulsed until flip-flop 286 is reset.

When the carriage arrives at the other end of the area to be cleared, a signal is transmitted from motor control 172 via line 186 to reset flip-flop 286; this resets mass clear control. Thus, any area or the entire system may be cleared in this manner.

Turning now to FIGURE 25, there is illustrated an embodiment of the programming means. In this embodiment, movable carriage MC' is disposed interiorly of the circular arrangement of contact-carrying means C' so that the movable carriage can be positioned opposite individual contact-carrying means C' in order that solenoids 60'' when actuated will drive contact means 116'' in a direction away from the axis of the programming means. This differs from the heretofore described embodiment in which the solenoids are adapted to drive contact means 116'' in a direction toward the axis of the programming means. The embodiment of FIGURE 25 is similar in every respect to that of the embodiment of FIGURE 1 except for the differences set forth hereinbelow.

The carriage-moving and locking means CML' is stationarily mounted on the bottom plate of the programming means. Carriage positioning encoder 61a' and driving ring 65' are mounted on the bottom of the movable carriage. The driving and locking teeth of the carriage-moving and locking means extend through an opening in the bottom plate for driving and locking engagement with the teeth of driving ring 65', and the printed circuit arrangement on carriage positioning encoder 61a' engages a brush assembly (not shown) stationarily mounted on the bottom plate of the programming means. Clearing bar 127' is held against each contact-carrying means C' by means of a hook and spring means 287 located at each end of the contact-carrying means. Each clearing bar 127' rests on circular plate element 288 which is affixed to the bottom contact-carrying circular plate 12'.

Clearing means 289, which is more clearly illustrated in FIGURE 26, comprises a plate 290 extending between lower plate 12' and top plate 28' and secured thereto. Solenoid 134' is secured centrally of plate 290. An arm 291 is pivotally connected to inside surface of plates 12' and 28', respectively. A bar 292 is connected to one end of arms 291 and is in alignment with solenoid 134'. An engaging arm 293 has one end pivotally connected to the other end of arms 291. An inwardly-directed projection 294 is located at the other end of each of engaging arms 293. Projections 294 normally lie on a line on the outermost sides of extensions 295 of clearing bars 127 and slightly removed therefrom. Upon actuation of solenoid 134', the armature thereof engages bar 292 causing arms 291 to move about their pivots. This moves engaging arms 293 in a direction toward the axis of the

programming means bringing projections 294 into engagement with extensions 295 of a clearing bar 127'. The clearing bar is moved outwardly from its respective contact-carrying means C' against the bias of the hook and spring means 287. This action moves the contact means 116'' out of engagement with a conductive member 115'' with which it was or they were in engagement. A spring 296 connected between plate 290 and bar 292 moves clearing means 289 back to its normally inoperative position. Hook and spring means 287 likewise move clearing bar 127' back to its normal position.

FIGURES 27 and 28 illustrate another embodiment of the invention. This embodiment is similar to the above-disclosed embodiments except that instead of contact-carrying means C'' being disposed in a circular disposition, they are linearly disposed within a mounting means 297. Movable carriage MC'', instead of being arcuate shape and divided into two sections, is flat so as to move in a linear manner above the linear disposition of contact-carrying means C''. Solenoids 60''' are mounted in movable carriage MC'' in accordance with a predetermined arrangement so that when the movable carriage is moved opposite a selected contact-carrying means C'', the selected solenoid will be in proper alignment with a contact means 116'''.

The clearing means is similar to that disclosed in FIGURE 9 with lever-operating member 146' pivotally mounted on the undersurface of movable carriage MC'' in surrounding relationship with respect to the second line of solenoids 60'''. The operation of this clearing means is similar to that of FIGURE 9, and, therefore, need not be repeated. Clearing bars 127'' are held onto each respective contact-carrying means C'' by means of hook and spring means 287' in a manner similar to that set forth in FIGURE 25.

The driving means for the embodiment of FIGURES 27 and 28 is different from that of the embodiments of FIGURES 1 and 25. The driving means includes a DC motor 298 of the type manufactured by Globe Industries, Incorporated, Dayton, Ohio, and disclosed in U.S. Patent Nos. 2,842,692 and 2,846,541. This motor is suitably mounted within mounting means 297 and has a driving gear 299 secured to the shaft thereof. Driving gear 299 is in mesh with a gear 300 which is affixed to a shaft 301 rotatably mounted between the sides of mounting means 297. Bevel gears 302 are secured to each end of shaft 301. Each bevel gear 302 is in mesh with another bevel gear 303. Each gear 303 is affixed to one end of a traversing driveworm 304. A projection 305 extends downwardly from the inner surface of each end of movable carriage MC'' in alignment with respective traversing driveworms 304 and is threadably mounted thereon. Similar projections (not shown) extend downwardly from the inner surface of the movable carriage at the other ends and surround the respective driveworms in order to maintain the movable carriage in proper alignment. Thus, upon actuation of drive motor 298, driveworms 304 drive movable carriage MC'' in one direction or the other depending upon the direction of rotation of drive motor 298. The carriage position encoder (not shown) is suitably mounted in the mounting means adjacent the contact-carrying means so that code thereon positions the movable carriage through brushes (not shown) while a DC motor has been disclosed in conjunction with FIGURES 27 and 28, the above disclosed carriage-moving and locking means in FIGURES 6-8 may also be used on the embodiment of FIGURES 27 and 28.

FIGURE 29 shows an alternative control circuit 172' for operation of drive motor 298. Leads 184, 185 are connected, respectively, to flip-flop circuits 305, 306. Lead 184 is also connected to flip-flop circuit 306 via diode 307, and lead 185 is connected to flip-flop circuit 305 via diode 308. An input to monostable multivibrator 309 is connected between flip-flop circuit 306 and diode 307. Likewise, an input to monostable multivibrator circuit

310 is connected between flip-flop circuit 305 and diode 308. Leads 184, 185 are also connected to an OR gate 311. Lead 170 is connected to an inverter circuit 313 via vernier switch contacts 312 which are similar to contacts 248 disclosed in FIGURE 22. The output of inverter circuit 313 is connected to OR gate 311, and the output thereof is connected to an inverter circuit 314. The output of inverter circuit 314 is, respectively, connected to flip-flop circuits 305, 306 via OR gates 315, 316 as inputs thereto. The output of flip-flop circuit 305 is, respectively, connected to OR gates 316, 317. The output of flip-flop circuit 306 is, respectively, connected to OR gates 315, 318. The output of multivibrator circuit 309 is connected to OR gate 317 while the output of multivibrator circuit 310 is connected to OR gate 318. The output of OR gate 317 is connected to a descending amplifier 319 which, in turn, is connected to one side of motor 298. The output of OR gate 318 is connected to an ascending amplifier 320 which, in turn, is connected to the other side of motor 298.

Description of operation of FIGURE 29

It is to be assumed that the system is initially in a quiescent state. If a signal appears at lead 184, this sets flip-flop circuit 305 causing a signal to appear through OR gate 317 and onto amplifier 319 causing motor 298 to drive the movable carriage in the descending direction. The zero output from flip-flop circuit 305 is at ground potential and lead 185 is clamped to ground through diode 308 preventing any unwanted signals, i.e., noise, from setting flip-flop circuit 306. When the desired carriage position is reached, comparator circuit 180 will remove signal from lead 184 and vernier switch contacts 312 will close thereby transmitting the signal to inverter circuit 313 which causes the output thereof to be grounded. This produces a signal in the output of inverter circuit 314 which is transmitted through OR gates 315, 316 resetting flip-flop circuit 305 (flip-flop circuit 306 is already reset). When flip-flop circuit 305 resets, a signal appears in the zero output thereof triggering monostable multivibrator circuit 310 which provides a deceleration pulse to motor 298. The deceleration pulse reduces stopping time of motor 298 and positive positioning of the movable carriage.

If, for any reason, (encoder brush failure, dirt, etc.) motor 298 should fail to stop on position and proceed to the next position where the encoder reads correctly, comparator circuit 180 will produce a signal on lead 185 and remove the signal from lead 184. The signal on lead 185 will be clamped to ground through diode 308 by virtue of flip-flop circuit 305 being set. When vernier contacts 312 close, a signal will appear in the output of inverter circuit 314 resetting flip-flop circuit 305. Lead 185 will rise to signal potential when diode 308 is reverse-biased by the zero output signal of flip-flop circuit 305, thus, setting flip-flop circuit 306 and reversing motor 298. The movable carriage will oscillate about the selected position one station above and one station below until carriage position encoder 182 reads correctly or an operator stops the device. When the movable carriage arrives at the desired position, a signal appears on lead 186 to stop the tape reader.

Thus, there has been described a programming means, storage means, selecting means, or the like, and control means, therefore, which is unique and novel, which facilitates remote and automatic electromechanical programming in a fairly small package with random access and multiple address capabilities to give the device rapid and flexible operation.

It will, therefore, be appreciated that the aforementioned and other desirable objects have been achieved; however, it should be emphasized that the particular embodiments of the invention, which are shown and described herein, are intended as merely illustrative and not as restrictive of the invention.

What is claimed is:

1. A programming means comprising a plurality of contact-carrying means disposed side-by-side, each contact-carrying means having a plurality of movable contact means, first conductive means on each of said contact-carrying means and adapted to be engaged by said contact means, second conductive means disposed adjacent said contact-carrying means and in alignment with a contact means of each contact-carrying means and adapted to be engaged thereby, movable carriage means spaced from said contact-carrying means, driving means associated with said carriage means to move same relative to said contact-carrying means opposite selected ones thereof, and means on said carriage means for selectively engaging said contact means to move same into conductive engagement with said conductive means.

2. A programming means according to claim 1 wherein said contact-carrying means are disposed in a circular configuration and said movable carriage means is adapted to move exteriorly therealong.

3. A programming means according to claim 1 wherein said contact-carrying means are disposed in a circular configuration and said movable carriage means is adapted to move interiorly therealong.

4. A programming means according to claim 1 wherein said contact-carrying means are disposed in a linear disposition and said movable carriage means is adapted to move therealong.

5. A programming means according to claim 1 wherein clearing means is associated with the contact means of each contact-carrying means, means for engaging said clearing means to move said contact means out of engagement with said second conductive means.

6. A programming means according to claim 1 wherein said driving means includes locking means to maintain said carriage means in a locked position when the driving means is in a quiescent state.

7. A programming means according to claim 1 wherein control means are connected to said driving means and said engaging means to drive said carriage means to a preselected position along said contact-carrying means and to selectively operate said engaging means to engage said contact means opposite thereto.

8. A programming device comprising conductive means arranged in rows, conductor means arranged in rows substantially normal to the rows of conductive means, contact means disposed adjacent each row of conductive means with each contact means in alignment with a respective conductor means, carriage means selectively movable opposite said contact means, and means on said carriage means for engaging selected contact means to bridge said conductive and conductor means.

9. A selector switch comprising frame means, a plurality of contact-carrying means on said frame means disposed side-by-side, a plurality of conductive means disposed adjacent said contact-carrying means, each contact-carrying means having a plurality of movable contact means, each of said movable contact means being in alignment with a respective conductive means, conductor means on each of said contact-carrying means and adapted to be engaged by said contact means, carriage means on said frame means, driving means associated with

said contact-carrying means and said carriage means to drive one thereof relative to the other to preselected positions, and contact movable means on said carriage means for engaging selected contact means when said carriage means is opposite selected contact-carrying means to move said selected contact means into engagement with said conductor and conductive means to interconnect same.

10. A selector switch according to claim 9 wherein means are provided to move said contact means out of engagement with said conductive means.

11. A selector switch according to claim 9 wherein said contact-carrying means are disposed in a circle with said contact means therein being movable toward the axis of the circle to interconnect said conductor and conductive means, said carriage means being movable along the exterior of said circle of contact-carrying means.

12. A selector switch according to claim 9 wherein said contact-carrying means are disposed in a circle with said contact means therein being movable away from the axis of the circle to interconnect said conductor and conductive means, said carriage means being movable along the interior of said circle of contact-carrying means.

13. A selector switch according to claim 9 wherein said contact-carrying means are linearly disposed, said carriage means being movable along the linearly disposed contact-carrying means in parallel relationship thereto.

14. A multi-circuit connector comprising a matrix of contact means disposed in rows and levels within mounting means, said contact means being movable along said mounting means, first conductive means disposed in rows in said mounting means and in alignment with the rows of contact means, second conductive means disposed in levels adjacent said mounting means and in alignment with the levels of contact means, carriage means movable relative to said mounting means, and operating means on said carriage means for selectively engaging the contact means to move same into engagement with said conductive means.

15. A multi-circuit connector according to claim 14 wherein driving means are operatively connected to said carriage means to selectively move same to positions opposite the rows of contact means.

16. A multi-circuit connector according to claim 14 wherein clearing means are provided on the rows of contact means, engaging means are provided to selectively engage said clearing means to move said contact means out of engagement with said conductive means.

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