United States Patent [19]

Matsumoto et al.

[11] **3,747,537**

[45] **July 24, 1973**

[54] **TURNABLE DIRECTIONING APPARATUS IN AUTOMATIC CARRYING SYSTEM**

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[73] Assignee: **The Tsubakimoto Chain Mfg. Co., Ltd.**, Joto-ku, Osaka, Japan

[22] Filed: **Nov. 23, 1971**

[21] Appl. No.: **201,442**

Related U.S. Application Data

[62] Division of Ser. No. 769,320, Oct. 21, 1968, Pat. No. 3,646,613.

[30] **Foreign Application Priority Data**

Oct. 31, 1967 Japan 42/69578
Oct. 31, 1967 Japan 42/17298

[52] **U.S. Cl.** **104/38,** 104/88
[51] **Int. Cl.** **B01j 1/00**
[58] **Field of Search** ..... 104/35, 36, 38, 96, 104/98, 99, 88; 214/16.1 A

[56] **References Cited**

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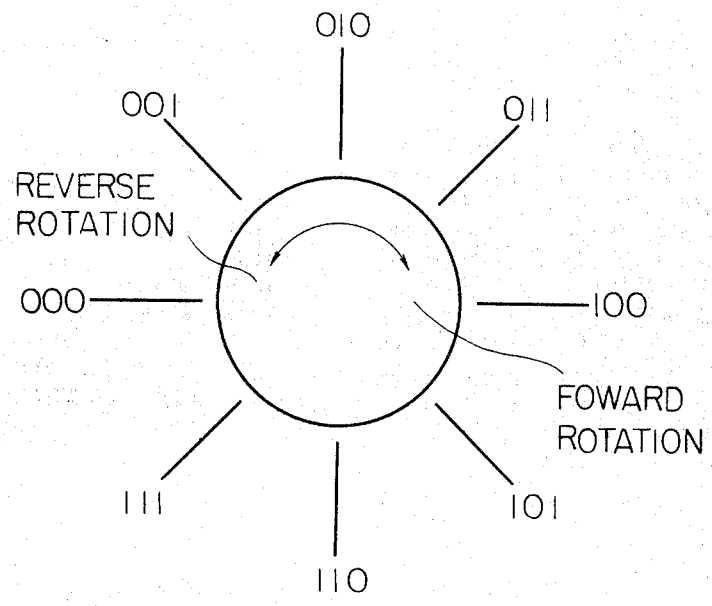
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Assistant Examiner—George H. Libman
Attorney—E. F. Wenderoth et al.

[57] **ABSTRACT**

A turnable directioning apparatus for use in an automatic carrying system including an electromotive carrying apparatus adapted to run on rails, said apparatus comprising a turnable member having one section of rail mounted thereon and located at a location at which the end portions of said rails converge and further comprising a direction finder for detecting the direction in which the electromotive carrying apparatus is approaching the turnable directioning apparatus, said turnable member being responsive to the direction finder so that the rail of the turnable member is automatically turned to a direction in line with the rail along which the carrying apparatus is approaching the turnable directioning apparatus.

1 Claim, 16 Drawing Figures



PATENTED JUL 24 1973

3,747,537

SHEET 01 OF 12

Fig. 1A

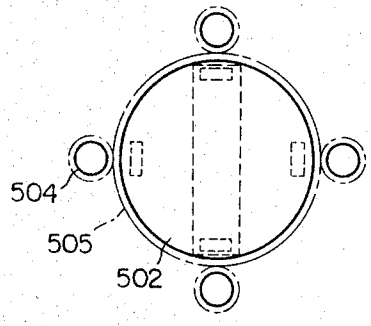


Fig. 1B

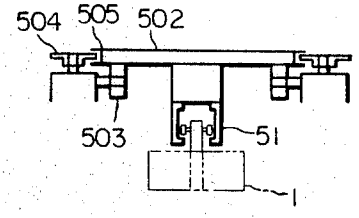
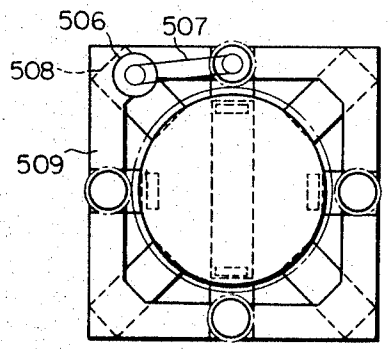


Fig. 1C



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Fig. 2A-(1)

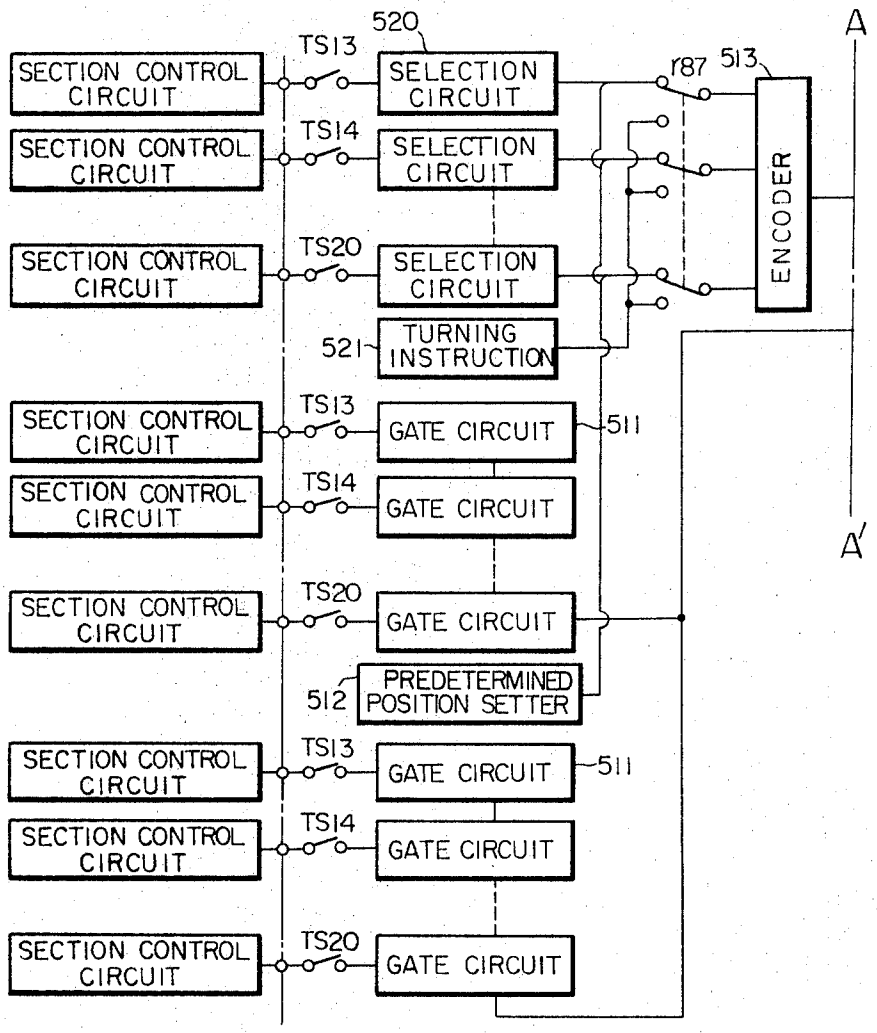


Fig.2A-(1) | Fig.2A-(2)

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Fig. 2A-(2)

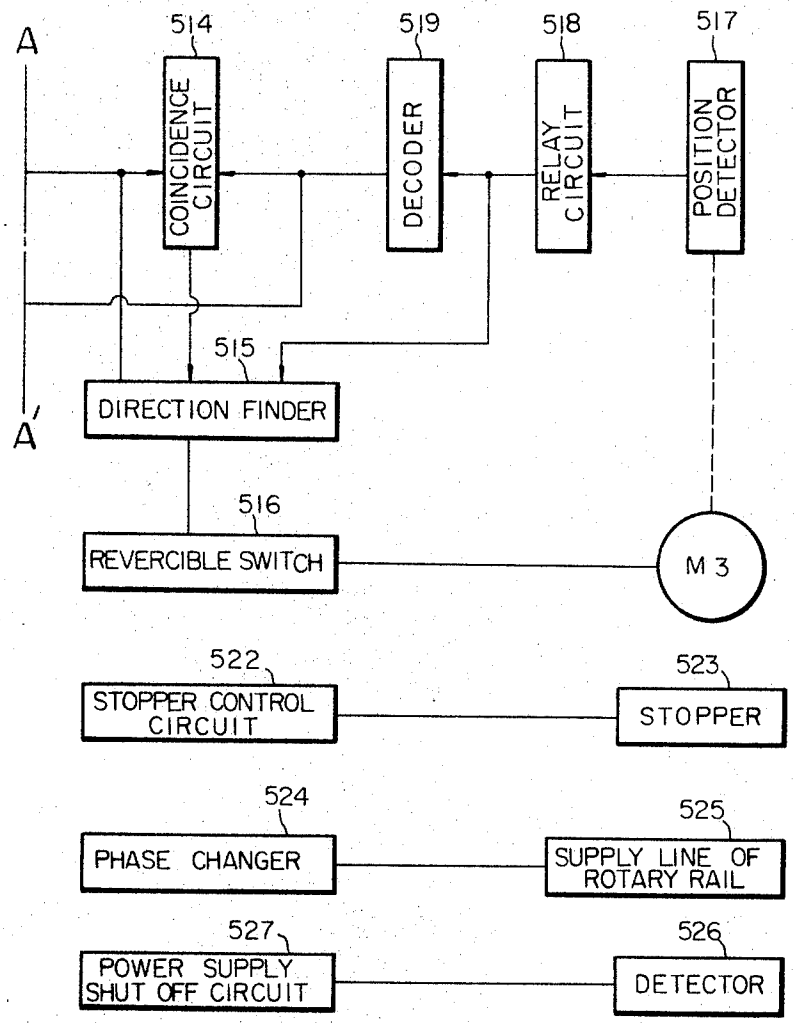


Fig. 2A-(1) | Fig. 2A-(2)

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Fig. 2B-(1)

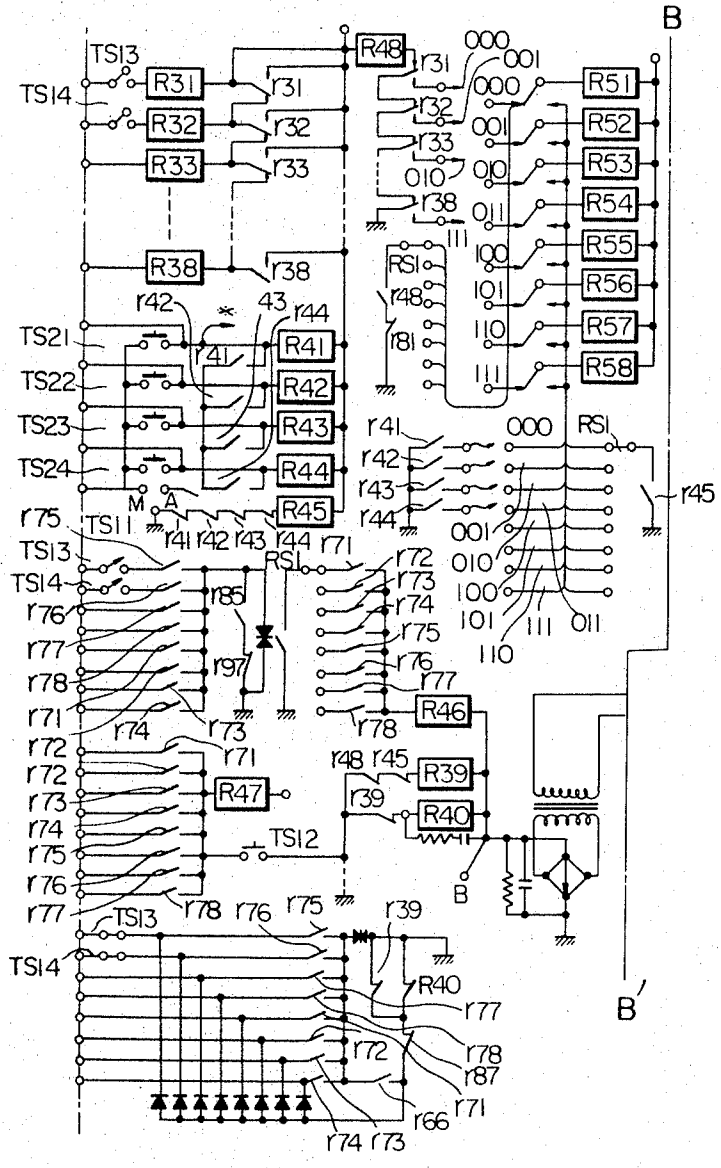


Fig.2B-(1) | Fig.2B-(2)

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Fig. 2B-(2)

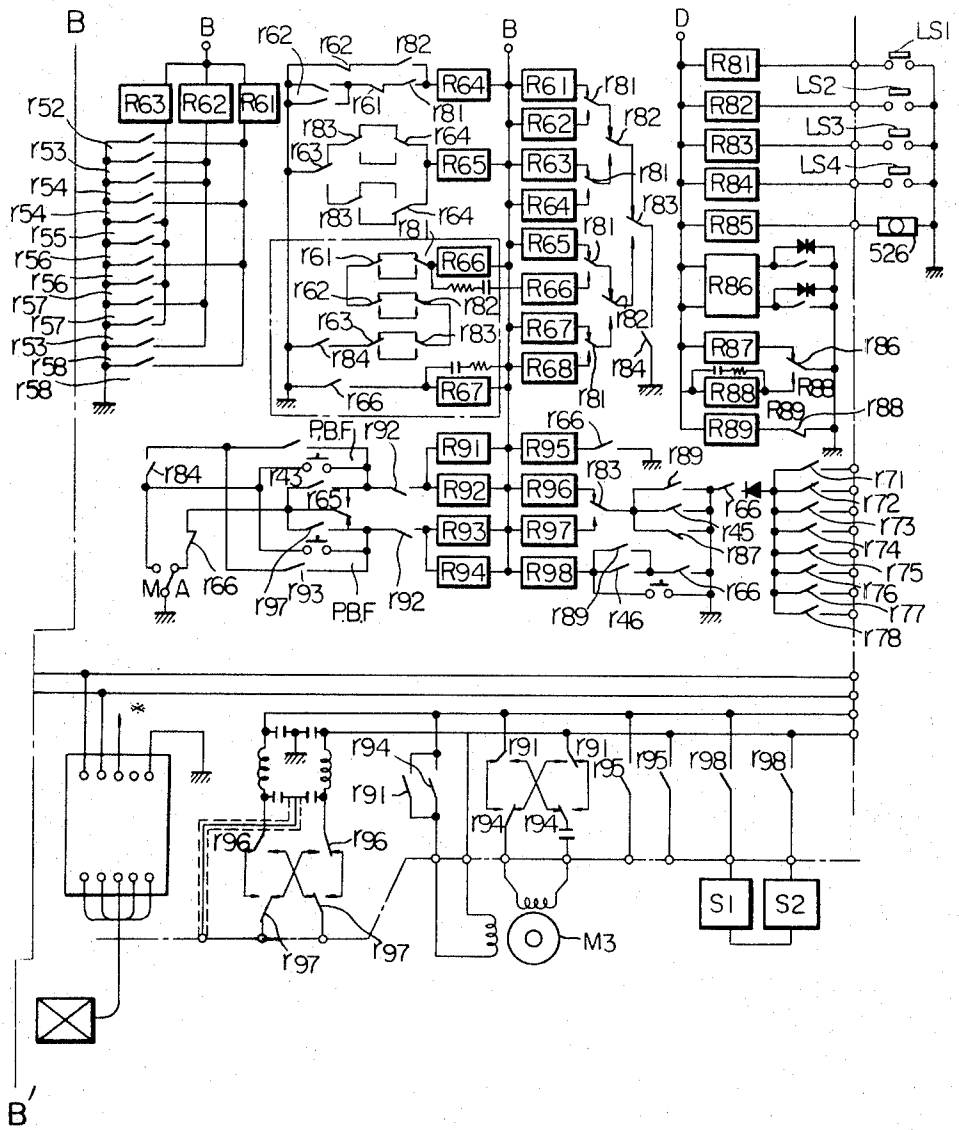


Fig.2B-(1) | Fig.2B-(2)

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Fig. 2C

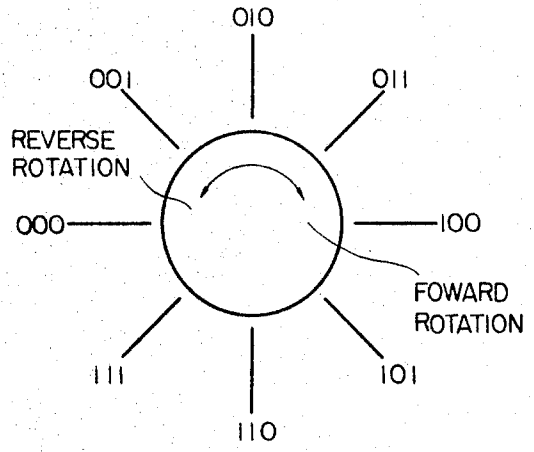


Fig. 2D

PRESENT POSITION \ INTENDED POSITION	(111) 000	(110) 001	(101) 010	(100) 011	(011) 100	(010) 101	(001) 110	(000) 111
0 0 0	111	110	101	100	011	010	011	000
0 0 1	000	111	110	101	100	011	010	001
0 1 0	-001	000	111	110	101	100	011	010
0 1 1	-010	-001	000	111	110	101	100	011
1 0 0	-011	-010	-001	000	111	110	101	100
1 0 1	-100	-001	-010	-001	000	111	110	101
1 1 0	-101	-100	-011	-010	-001	000	111	110
1 1 1	-110	-101	-100	-011	-010	-001	000	111

REVERSE ROTATION

FOWARD ROTATION

FOWARD ROTATION

REVERSE ROTATION

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Fig. 2E

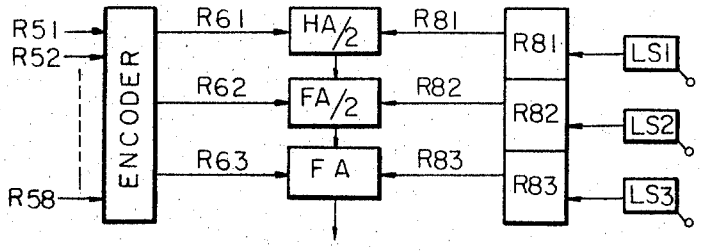
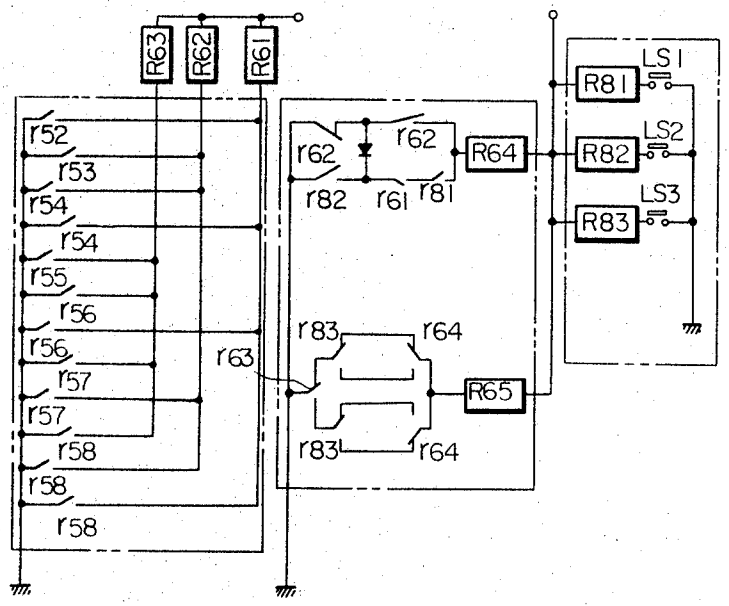


Fig. 2G

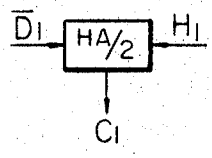


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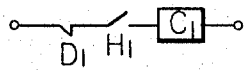
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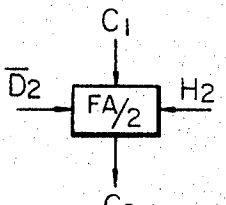
Fig. 2F

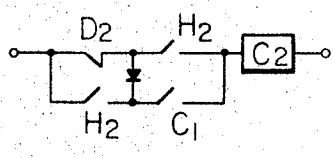


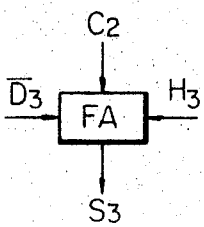
$C_1 = \bar{D}_1 H_1$



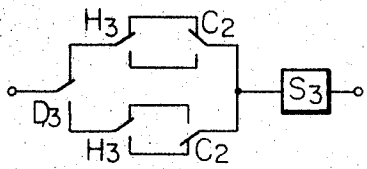
$$C_2 = H_2\bar{D}_2 + C_1(H_2D_2 - \bar{H}_2\bar{D}_2)$$
$$= H_2\bar{D}_2 + C_1H_2D_2 + C_1\bar{H}_2\bar{D}_2$$
$$= H_2(\bar{D}_2 + C_1D_2) + C_1\bar{H}_2\bar{D}_2$$
$$= H_2(\bar{D}_2 + C_1) + C_1\bar{H}_2\bar{D}_2$$
$$= \bar{D}_2(H_2 + C_1\bar{H}_2) + H_2C_1$$
$$= \bar{D}_2H_2 + \bar{D}_2C_1 + H_2C_1$$







$$S_3 = (\bar{H}_3\bar{D}_3 + H_3D_3)C_2 + \overline{(H_3\bar{D}_3 + \bar{H}_3D_3)}C_2$$
$$= \quad // \quad + (\bar{H}_3\bar{D}_3)(\overline{H_3D_3})C_2$$
$$= \quad // \quad + (H_3 + D_3)(\bar{H}_3 + \bar{D}_3)C_2$$
$$= \quad // \quad + (H_3\bar{D}_3 + D_3\bar{H}_3)C_2$$
$$= \bar{D}_3(\bar{H}_3C_2 + H_3C_2) + D_3(H_3\bar{C}_2 + \bar{H}_3C_2)C$$



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Fig. 3A-(1)

SECTION (i-i)

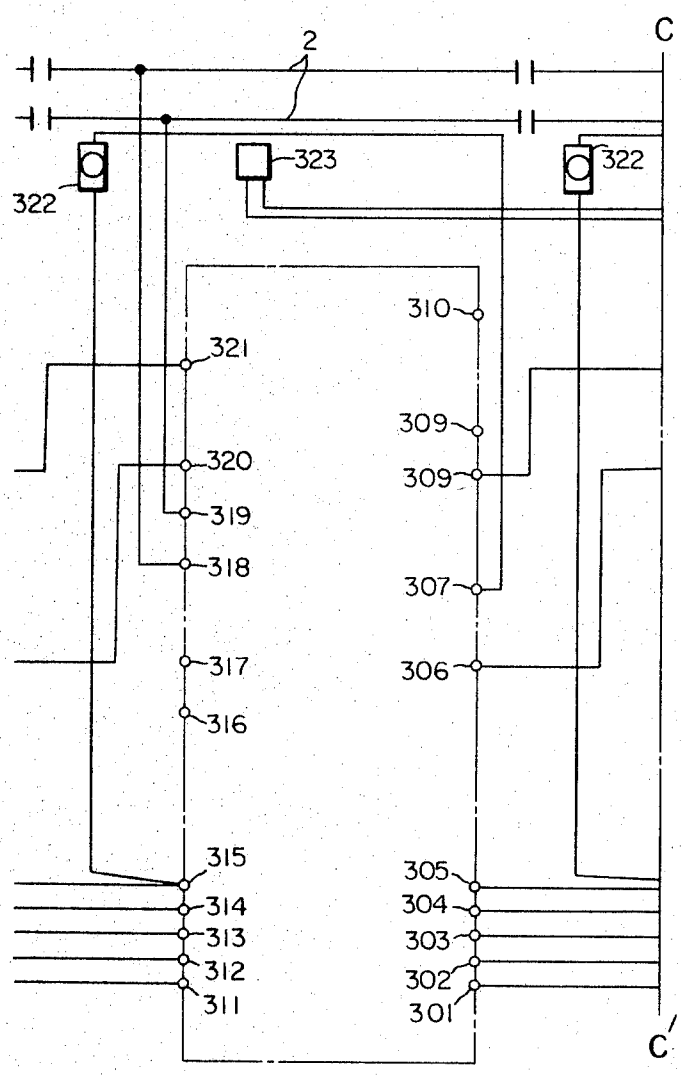


Fig.3A-(1)	Fig.3A-(2)	Fig.3A-(3)

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Fig. 3A-(2)

SECTION (i)

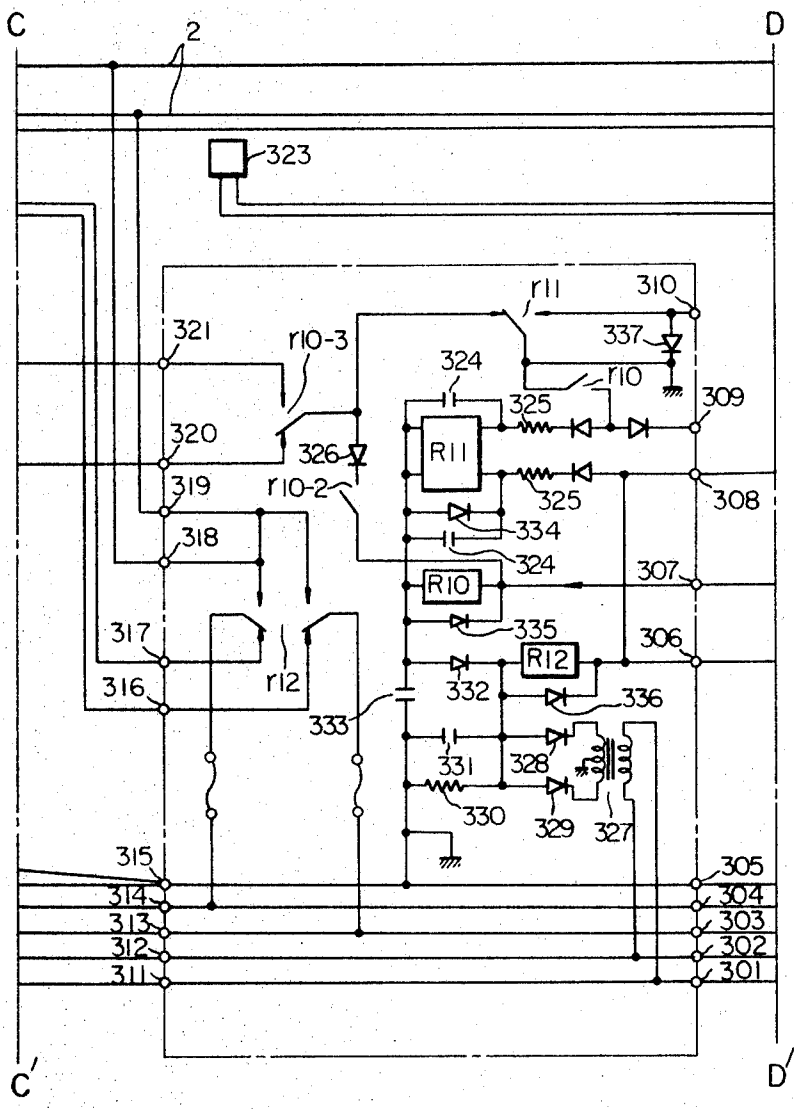


Fig.3A-(1)	Fig.3A-(2)	Fig.3A-(3)

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Fig. 3A-(3)

SECTION (i+1)

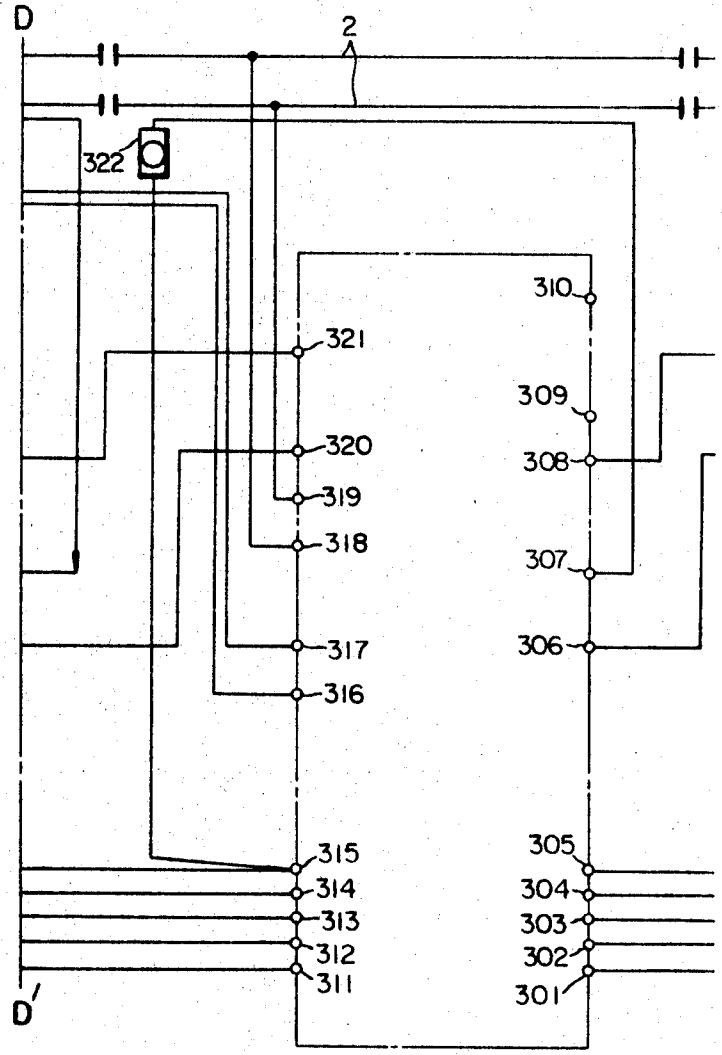


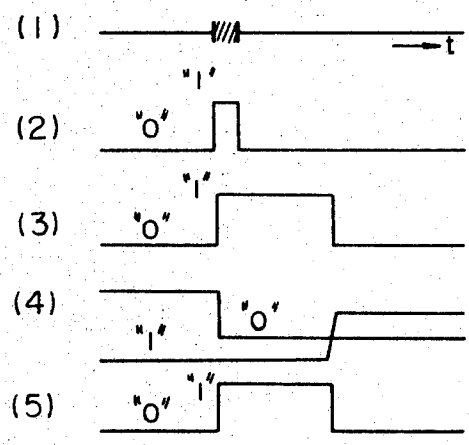
Fig.3A-(1)	Fig.3A-(2)	Fig.3A-(3)

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Fig. 3B



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TURNABLE DIRECTIONING APPARATUS IN AUTOMATIC CARRYING SYSTEM

RELATED APPLICATION

This application is a division of Ser. No. 769,320, filed Oct. 21, 1968, now U.S. Pat. No. 3,646,613.

FIELD OF THE INVENTION

This invention relates generally to a directioning apparatus used for changing the advancing direction of an electromotive carrying apparatus running on a rail provided with a power supply line contained therein.

DESCRIPTION OF THE PRIOR ART

In order to fully automatize a carrying system, it has been proposed to include rails provided with power supply lines therealong, such rails being equipped thereon with electromotive carrying apparatuses used for carrying loads, each having a collector slidingly in contact with such power supply lines, a motor, a controller, etc. therein, thereby allowing such electromotive carrying apparatuses to run on the rails by sending driving power and control signals from the power supply lines. In realizing such carrying system, it is desired that the direction in which an electromotive carrying apparatus is running can be changed as variously as possible so that loads can be adapted to various possible processes to undergo during transportation thereof.

There has been an increasing demand for a turnable directioning apparatus which may change automatically and smoothly the direction in which an electromotive carrying apparatus is running between a number of rails at a portion where such rails converge.

SUMMARY OF THE INVENTION

In accordance with the invention, there is provided a turnable directioning apparatus for use in an automatic carrying system including an electromotive carrying apparatus adapted to run on rails, said apparatus comprising a segment of rail mounted on a turnable member and positioned at a location at which the end portions of said rails converge, a direction finder for detecting the direction in which the carrying apparatus is approaching the turnable directioning apparatus, and means for determining the direction of rotation in which the turnable member must be turned in order to permit the member to take the shortest course to the position to be directed, said turnable member being turned under the control of said direction finder and said direction determining means so that the rail segment of the turnable member is automatically turned to a direction in line with the rail along which the carrying apparatus is approaching the turnable directioning apparatus.

The turnable directioning apparatus according to this invention will be effectively used to automatically convert the direction in which an electromotive carrying apparatus is running to an arbitrary one at a portion where a plurality of rails converge.

In an automatic carrying system to which this invention may be applied, a rail has a power supply line contained therein and is divided into several sections each provided with a power supply line, further such each section being provided with a section control circuit controlling the cut-off of power to its associated power supply line as desired.

The invention will be better understood by reference to the following description made in conjunction with the accompanying drawings in which:

FIGS. 1A to 1C are a plan view, a side view and a bottom plan view respectively, schematically illustrating the construction of a turnable directioning apparatus according to this invention;

FIG. 2A (1 and 2) is a block diagram of the control circuit of the turnable directioning apparatus;

FIG. 2B (1 and 2) shows one embodiment of the control circuit of the turnable directioning apparatus;

FIGS. 2C to 2G show data used in the direction finder of the turnable directioning apparatus and an embodiment of the direction finder;

FIG. 3A (1–3) is a block diagram of the electric circuit of a section control circuit controlling power supply to each section of rails;

FIG. 3B shows signal waveforms appearing at various points as seen in FIG. 3A.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The turnable directioning apparatus according to this invention is used at a portion where a plurality of rails converge, and in its construction, as shown FIGS. 1A to 3C, a section of rail **51** on which the electromotive carrying apparatus runs is provided integrally underneath a circular turnable table **502** supported close to the outer edge thereof by more than at least two pairs of rollers **503** provided diametrially oppositely underneath the circular turnable table **502,** thus allowing it to turn freely. A plurality of chain wheels **504** are provided externally in contact with the circular turnable table **502,** one of which is driven by a drive motor **506** through a belt **507,** thereby allowing the circular turnable table **502** to turn. Connecting fixed rails **508** are fitted to a frame **509** in various directions corresponding to the rail **51** mounted on the circular turnable table.

The rail **51** mounted on the circular turnable table **502,** that is, a rotary rail, is provided at opposite ends thereof with stoppers to prevent the electromotive carrying apparatus entering into position on the rail from running out thereof during turning of the rotary rail. These stoppers are controlled for their in-and-out operation by a turnable directioning control circuit as described hereinafter.

Each of a plurality of rails converging toward the turnable directioning apparatus is preferably divided into sections each having a power supply line sectionably energized, or at least is designed to constitute one section, such each section being provided with a section control circuit controlling the cut-off of power to the power supply line thereof as desired.

Therefore, referring now to FIGS. 3A and 3B, the construction and energization of such section control circuit will be described prior to the explanation of the turnable directioning circuit.

In FIG. 3A, although one section control circuit comprises a portion designated as the section (i), for example, for convenience of explanation, the construction and operation of the section control circuit will be described in a state that the section (i+1) and the section (i−1) each having a section control circuit of the same construction as that of the section (i) are connected immediately before and after it.

A terminal **320** of the section control circuit of the section (i) is connected to a terminal **306** of the section

control circuit of the section (i-1) to which in turn a relay R12 of the section control circuit of the section (i-1) is connected. The connection between the section control circuits of the section (i) and the section (i+1) is the same as that between the section (i-1) and the section (i).

A moveable contact r11 of a relay R11 is closed at its left side as seen in FIG. 3A. When the electromotive carrying apparatus enters into the section (i), a detector 322 of the section (i) detects the entrance of the electromotive carrying apparatus into the section (i), and sends a detected signal to a relay R10. The relay R10 is energized to close its moveable contact r10-1 and the upper side of the relay R11 is grounded, whereby its moveable contact r11 is closed to its right side in FIG. 3A. The terminal 320 of the section control circuit of the section (i) is, until the relay R10 is energized, grounded through the lower side contact of its moveable contact *r*10-3 and the left side contact of the moveable contact *r*11 of the relay R11. Thus, since the relay R12 of the section (i−1) is energized with its one end grounded, its moveable contact r12 is closed at the side (upper side) opposite to that shown in FIG. 3A with respect to the corresponding moveable contact r12 of the section (i), the driving power being fed to the power supply line 2 from power supply terminals 303 and 304. When the relay R10 is energized as described above, its moveable contact *r*10-3 is closed at the side (upper side) opposite to that shown in the drawing and its moveable contact *r*11 is also closed at its right side. Thus, the relay R12 of the section (i−1) is disconnected from the ground and the contact *r*12 is switched to the position (lower) as shown in the drawing, thereby the power supply to the power supply line of the section (i−1) being cut off.

A capacitor 324 and a resistor 325 are connected to the relay R11 and the energization thereof is delayed a period determined by the time constant of the capacitance and the resistance after the energization of the relay R10. This delay time may be adjusted by changing either the capacitance of the capacitor 324 or the resistance of the resistor 325. However, the change of the resistance of the resistor 325 will result in the change of the current flowing through the relay R11, thus the capacitance of the capacitor 324 being preferably changed. By providing a delay between the energization of the relay R10 and that of the relay 11, even if the moveable contact *r*10-3 is closed at the side (upper side) opposite to that shown in FIG. 3A, the moveable contact r11 is kept to be closed at its left side as shown in FIG. 3A and a terminal 321 of the section (i) is grounded, thus the current flowing through the lower side of the relay R11 of the section (i−1), and its moveable contact r11 being kept to be closed at its left side as shown in FIG. 3A.

In FIG. 3B are shown the timing relationship of the main waveforms in the section control circuit. The waveform (1) represents a detecting time of the detector 322, the waveform (2) represents a detected signal at the terminal 307, the waveform (3) represents that at the terminal 309, the waveform (4) represents examples of the potential change at the terminal 320 (negative going) and the state of transition of the moveable contact r11 (positive going) and the waveform (5) represents that at the terminal 321.

When the electromotive carrying apparatus runs from the section (i) into the section (i+1), the power to the supply line of the section (i) is cut off by virtue of the operation of the section control circuit of the section (i+1), a signal similar to the signal of the waveform (5) as shown in FIG. 3B, is sent to the terminal 308 of the section (i) from the terminal 321 of the section control circuit of the section (i+1), the lower side of the relay R11 of the section (i) is grounded, its movable contact r11 is closed at its left side, the relay R12 is grounded from the terminal 320 through the terminal 306 of the section control circuit of the section (i−1) to allow the relay R12 to operate and the moveable contact *r*12 of the section (i−1) to be switched to the upper side position, thereby feeding power to the supply line of the section.

While the carrying apparatus is running within the range detectable by the detector 322 and the relay R10 of the section control circuit is energized, a ground level signal appears at the terminal 309. This ground signal may be used as a signal indicating that they carrying apparatus has entered into the section in question. Also, while the moveable contact r11 of the relay R11 is closed at its right side, a ground level signal appears at the terminal 310. This ground signal may be used as a signal indicating that they carrying apparatus is present in the section.

When the period during which the detector 322 detects the carrying apparatus running at a high speed by energizing the relay R10 is shorter than the delay time of the relay R11, it may happen that the power to the power supply line in the immediately succeeding section will not be cut off after the carrying apparatus has entered into the present section. In order to prevent this, a contact *r*10-2 of the relay R10 and a diode 326 are provided so as to self-hold the relay R10. More particularly, the diode 326 prevents the terminal 320 from being grounded by the moveable contact *r*10-2 even after the moveable contact r11 has been switched to close at its right side in FIG. 3A

Further, the diode 326 cuts off the current flowing through the winding of the relay R10 so that it prevents its surge from affecting the moveable contact *r*11.

A D.C. power supply is provided including a power transformer 327, rectifying diodes 328 and 329, a resistor 330 and a smoothing capacitor 331 so as to supply the power to energize each of relays for operation. A power supply for the relays R10 and R11 is composed of a capacitor 333 having one end grounded and the other end connected to said D.C. power supply through a diode 332. The capacitance of the capacitor 333 is preferably selected so that the electric charge on it is sufficient to energize the relays R10 and R11. Now, let us suppose that either the regulated power supply alone (at terminals 301 and 302) or both the regulated power supply and the main power supply (at terminals 303 and 304) fail. It may happen that the carrying apparatus running in the section (i−1) cannot stop simultaneously with the occurrence of the failure, so that because of its running inertia it runs into the section (i), thereby causing the detector to be operated. In this case, the electric charge of the capacitor 333 is not discharged through the winding of the relay R12 due to the presence of the diode 332, even though the regulated power supply of the section control circuit of the section (i) fails. Therefore, when the detector 322 is activated, the electric charge of the capacitor 333 energizes the relays R10 and r11 so that the terminal 320 of the section (i) is disconnected from the ground.

Thus, since the moveable contact r12 of the section ($i-1$) is switched to its lower position and the power to the power supply line of the succeeding section ($i-1$) is cut off, the relay R12 of the section ($i-1$) is not energized unless the relay R11 of the section (i) is energized, even if the power is supplied again, and consequently the power is kept not to be supplied to the power supply line. The capacitance of the capacitor 333 is sufficient to energize the relays R10 and R11 at least once. Therefore, the power to the power supply line of the succeeding section is assuredly cut off for at least one time of operation of the detector even after the failure of the power supply.

When the power is not supplied to the power supply line in the section control circuit of the section (i), the moveable contact r12 of the relay R12 is closed at its lower position so that the power is supplied to terminals 316 and 317 of the section (i). Therefore, if a low speed instruction device 323 for the carrying apparatus is provided at the entrance whereat it runs into the section ($i-1$), and if such instruction device 323 is connected to the terminals 316 and 317, the low speed instruction device 323 can be used to reduce the speed of the succeeding electromotive carrying apparatus soon after it has entered into the section ($i-1$) so that it may be stopped smoothly with less shock when it has entered into the section (i) in which the power to the power supply line is interrupted.

In FIG. 3A, diodes 334, 335, 336 and 337 are used as surge absorbers.

Referring now to FIGS. 2A to 2G, a turnable directioning control circuit of the turnable directioning apparatus will be described.

Referring particularly to FIG. 2A, a block diagram of the turnable directioning control circuit is shown. Assume that there are eight directions in which the electromotive carrying apparatus can enter into and come out of the turnable directioning apparatus, then there will be eight section control circuits (as described previously referring to FIG. 2A) in total which must be controlled. Accordingly, the eight section control circuits are connected to the turnable directioning control circuit. Switches TS 13 through TS 20 are used for switching the entrance and exit for the electromotive carrying apparatus in each rail with which each section is associated.

Gate circuits 511 allow the turnable directioning control circuit to supply a signal to only the section control circuit of the rail of the section with which the rail of the turnable directioning control apparatus is engaged. This gate circuit 511 may be a relay circuit for applying a position signal produced from a position detector 517 to detect the position of the rail directed to turn as will be described hereinafter, through a relay circuit 518 and a decoder 519 as will be described hereinafter to the gate 511, thereby connecting only the section control circuit of the rail of the section among the eight rails mentioned above, with which the rail of the turnable directioning apparatus is engaged to this turnable directioning control circuit.

Selector circuits 520 are used for selecting any one of the electromotive carrying apparatuses when they enter simultaneously into the turnable directioning apparatus.

A rail positioner 512 is used for returning the rotary rail (the rail of the turnable directioning apparatus) to a predetermined position, when there is no electromotive carrying apparatus which is going to enter into the rail of the turnable directioning apparatus.

A directioning instruction device 521 is used for instructing the rail of the turnable directioning apparatus to be positioned as desired through a push button, for example.

A relay circuit 518 is a relay to switch the rail of the turnable directioning apparatus to the side of the directioning instruction device by a turning instruction after the rail has been moved to an angular position in accordance with the approach of the electromotive carrying apparatus or the setting thereof at a predetermined position.

An encoder 513 converts a signal indicating from which direction the electromotive carrying apparatus is approaching the turnable directioning apparatus, or a directioning instruction signal into a code which will be described hereinafter.

A position detector 517 detects the present position of the rail in the turnable directioning apparatus to energize a corresponding relay of a relay circuit 518 disposed immediately in succession, and a decoder 519 feeds the gate circuit 511 of the section control circuit of the rail of the section which is aligned with the rail of the turnable directioning apparatus with a signal indicating the present position, and also feeds it to a coincident circuit 514 as will be described hereinafter.

The coincident circuit 514 detects the difference between a signal indicating the direction from which the electromotive carrying apparatus is approaching, or a directioning instruction signal produced from the encoder mentioned above and a signal indicating the present position of the rail of the turnable directioning apparatus so that if there is a difference therebetween, it will energize a direction finder 515. The direction finder 515, when energized, finds the shortest course within 180° to turn the rail of the turnable directioning apparatus in a direction of the rail on which the electromotive carrying apparatus is coming or of that indicated by the directioning instruction. Thus, a motor M3 is actuated by the direction finder 515 through a reversible switch 516 for driving the rail of the turnable directioning apparatus.

A stopper control circuit 522 controls the operation of the stoppers 523 mounted at both ends of the rail so that when the electromotive carrying apparatus is on the rail of the turnable directioning apparatus, it is prevented from running out of the rail due to turning thereof.

A detector 526 detects that the electromotive carrying apparatus has reached the center of the rail of the turnable directioning apparatus and cuts off the power to the supply line 525 so that it may be stopped within the rail.

A phase inverter 524 functions to invert the phase of the power to the power supply line of the rail of the turnable directioning apparatus, and in practice it is operated when the electromotive carrying apparatus is required to run out of the turnable directioning apparatus at the entrance at which the electromotive carrying apparatus has entered thereinto.

Referring now to FIG. 2B, a wiring diagram of the turnable directioning control circuit is shown.

When the electromotive carrying apparatus approaches the turnable directioning apparatus, any of relays R31 through R38 of the selector circuit 520 corresponding to the section now carrying the electromo-

tive carrying apparatus is energized through a relay R48 to close their corresponding moveable contacts r31 through r38 and r48, and thus the succeeding electromotive carrying apparatus from any direction will wait until the electromotive carrying apparatus completes its turning operation. In order to turn the rail of the turnable directioning apparatus in a direction corresponding to the rail of the section that the electromotive carrying apparatus is approaching, any of the relays R51 through R58 corresponding thereto is energized to close any of their moveable contacts r51 through r58, and then a code corresponding to that rail (as will be described hereinafter) is produced by the encoder 513 comprising relays R61 through R68, and thereafter it is sent to the coincident circuit 514. On the other hand, a signal from the position detector 517 (comprising limit switches LS1 through LS3) which detects the present position of the rail of the turnable directioning apparatus energizes through relays R81 through R83 by means of the circuit of their moveable contacts r81 through r83 any pair of relays R71 through R78 corresponding to the present position of the rail and is applied to the coincident circuit 514 so that the turnable directioning apparatus may be turned in a direction with which the rail of the section that the electromotive carrying apparatus is approaching is aligned as will be described hereinafter.

When there is no electromotive carrying apparatus approaching from any direction, the relays R51 through R58 corresponding to the direction which has been switched by the rail positioner 512 constituted by a rotary switch RS1 are energized, and thereafter the rail of the turnable directioning apparatus is turned to its corresponding position in the same manner as described previously in the case when the electromotive supplying apparatus is approaching. When the electromotive carrying apparatus is approaching, the contact r48 in the selector 520 is in the circuit of the rotary switch RS1, so that it cuts off the circuit, thereby being controlled by the selector 520 as was described previously, In this case, it is necessary that a switch TS21 has been switched to receive a signal giving an instruction to the rotary rail.

The position signal indicative of the position of the rotary rail from the position detector 517 energizes through the relay circuit 518 the decoder constituted by the relays R71 through R78 as described previously, one pair of moveable contacts r71 through r78 corresponding thereto are provided in the gate circuit 511 so that only when the rotary rail corresponds with the direction indicated by the position signal, the signal from the corresponding section is applied, and when the rotary rail corresponds with the rail of the section that the electromotive carrying apparatus approaches, connection with the section control circuits disposed immediately before and after that section are made, thus allowing delivery of the control signal.

When the rotary rail is turned to reach the rail of the section that the electromotive carrying apparatus is approaching, the direction finder 515 operates to find the shortest course to turn the rotary rail within 180° as will be described hereinafter. When both rails are aligned with each other, if there is no electromotive carrying apparatus in the preceding section, the power is supplied to the power supply lines of the connecting fixed rail of the turnable directioning apparatus and the rotary rail to cause the electromotive carrying apparatus to enter into the rotary rail, and then the stopper control circuit 522 constituted by a relay R98 is energized to close its moveable contact r98 so that solenoids S1 and S2 may be operated to cause the stoppers to be positioned at both ends of the rotary rail in the same manner as in the case of the section control circuit. The phase of the power to the power supply line in the rotary rail must be inverted by the phase inverter 524 constituted by relays R96 and R97 depending on the direction in which the electromotive carrying apparatus must be moved.

When the electromotive carrying apparatus reaches the center of the rotary rail, the detector 526 detects it and cuts off the power to the supply line in the rotary rail, thereby stopping it therewithin.

Then, a moveable contact r87 is switched to the side of the directioning instruction device so that any of the relays R51 through R58 are energized to close any of the moveable contacts r51 through 58, thus the coincidence in the coincident circuit 514 being lost so that the rotary rail may be turned in the same manner as in the case when the electromotive carrying apparatus approach the turnable directioning apparatus.

When the rotary rail is aligned with the rail instructed to be directed, the power is supplied to the line in the rail of the turnable directioning apparatus, and the electromotive carrying apparatus is started to run out to the rail of a predetermined section. After the electromotive carrying apparatus has run out, the turnable directioning apparatus returns to its original condition.

The directioning instruction device 521 may be a selector which will be described hereinafter.

Referring now to FIGS. 2C through 2F data and schematic diagrams concerning the direction finder are shown.

Referring particularly in FIG. 2C, the eight directions of the rail externally contacted with the turnable directioning apparatus may be represented by eight 3-digit binary codes. Such codes being designated, in a clockwise order, 001, 010, 011, 100, 101, 110 and 111 beginning with 000. A clockwise turning of the rail of the turnable directioning apparatus will be termed "forward turn," and a counterclockwise turning thereof will be termed "reverse turn" hereinafter. Further, the rail of the turnable directioning apparatus will be directional.

Referring to FIG. 2D, the table shows, that for each of all the possible positions of the rail of the turnable directioning apparatus, a binary code representing the present position of the rail plus the complement of a binary code representing the position to which it is to be turned, represents that position, sign (-) indicating that there is a carry made. The binary code 111 means that the present position of the rail is aligned with the position to which it is turned, so that turning is not necessary. The hatched area means that a reverse turn is preferably performed and the other area means that a forward turn is so done, both in order to take the shortest course to the position to be directed. From the table, it can be seen that the code having 1 as its most significant digit signifies that a forward turn should be performed and that having 0 as its most significant digit signifies that a reverse turn should be performed. Accordingly, a signal of forward turn or reverse turn can be determined by detecting whether the most significant digit of the code is 1 or 0, such code being the code representing the present position of the rotary rail

plus the complement of the code representing the position to which the rail must be turned.

Referring to FIG. 2E, a block diagram of the logic circuit for the detection described above is shown. When the relays R51 through R58 and R61 through R63 are used for converting a directioning instruction to a binary code by means of the encoder, the complement of the binary code representing the position to which the rotary rail is to be turned is obtained (the relays R61 through R63 are constituted by relays which are closed in a normal condition). The binary code representing the present position of the rail may be obtained from the position detector constituted by the limit switches LS1 through LS3. An addition of these codes can be performed for the intended purpose. In executing such addition, the most significant digit is only necessary, and the least significant digit and the second significant digit are not necessary except when a carry to the most significant digit is produced, thus since the operation on the least significant digits may have a significance only in the case when a carry is produced, a half circuit of a half adder, HA/2, that is, an AND circuit constituted by the R61 and R81 is sufficient. Similarly, with respect to the second digit, since it may have a significance only when there may be a carry from the least significant digit, a half circuit of a full adder, FA/2 is sufficient. With respect to the most significant digit, since both the sum and the carry from the second digit are of significance, a full adder, FA is required, but in this case the carry produced by the most significant digits is unnecessary.

Referring to FIG. 2F, a logic circuit and its operation are illustrated. This operation may be done by an arithmetic circuit shown in FIG. 2G, which comprises the relays R64 and R65. More particularly, this circuit can be connected to the motor M3 in such a manner that when the relay R65 is energized the rotary rail is turned forwardly, and when the relay R65 is deenergized the rotary rail is turned reversely.

The use of only one set of such turnable directioning apparatus may allow a branching operation in multiple directions, even when as many as six sets of two-direction branching apparatuses are required for the same operation.

What is claimed is:

1. A turnable directioning apparatus for use in an automatic carrying system in which eight fixed rails each provided with a power supply line therealong to run an electromotive carrying apparatus on the rail are arranged so that their ends converge at a common location, such locating being provided with a turnable member on which one section of a rail having a power supply line therealong is mounted, the consecutive angular positions of said eight fixed rails being represented by corresponding binary codes from 000 to 111, respectively, said turnable member being connected with a turning device for turning the same and with a present position indicating means for generating a signal representing the present angular position of its rail, said turnable directioning apparatus comprising:

means associated with said eight fixed rails and adapted to be actuated, when the electromotive carrying apparatus is running on one of said fixed rails, to generate a signal indicating on which rail the electromotive carrying apparatus is running;

a direction finder connected between said present position indicating means and said means for generating a signal indicating on which rail the electromotive carrying apparatus is running, said direction finder being adapted to determine whether the most significant digit of a sum obtained by adding a binary code representing the present angular position of the rail of said turnable member to the complement of a binary code representing the angular position to which said rail is to be turned is 1 or 0, said direction finder being also adapted to cause said turning device to turn said turnable member in a forward or reverse direction, depending on whether the most significant digit of said sum is 1 or 0, respectively, until the rail of said turnable member is aligned with the fixed rail along which the electromotive carrying apparatus is approaching said turnable member; and

a directioning instruction device for instructing an angular position to which the rail of said turnable member is to be directed, said directioning instruction device being adapted to be connected to said turning device after the electromotive carrying apparatus has entered into the rail of said turnable member for causing said turning device to turn the same to the direction so instructed.

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