

May 3, 1966

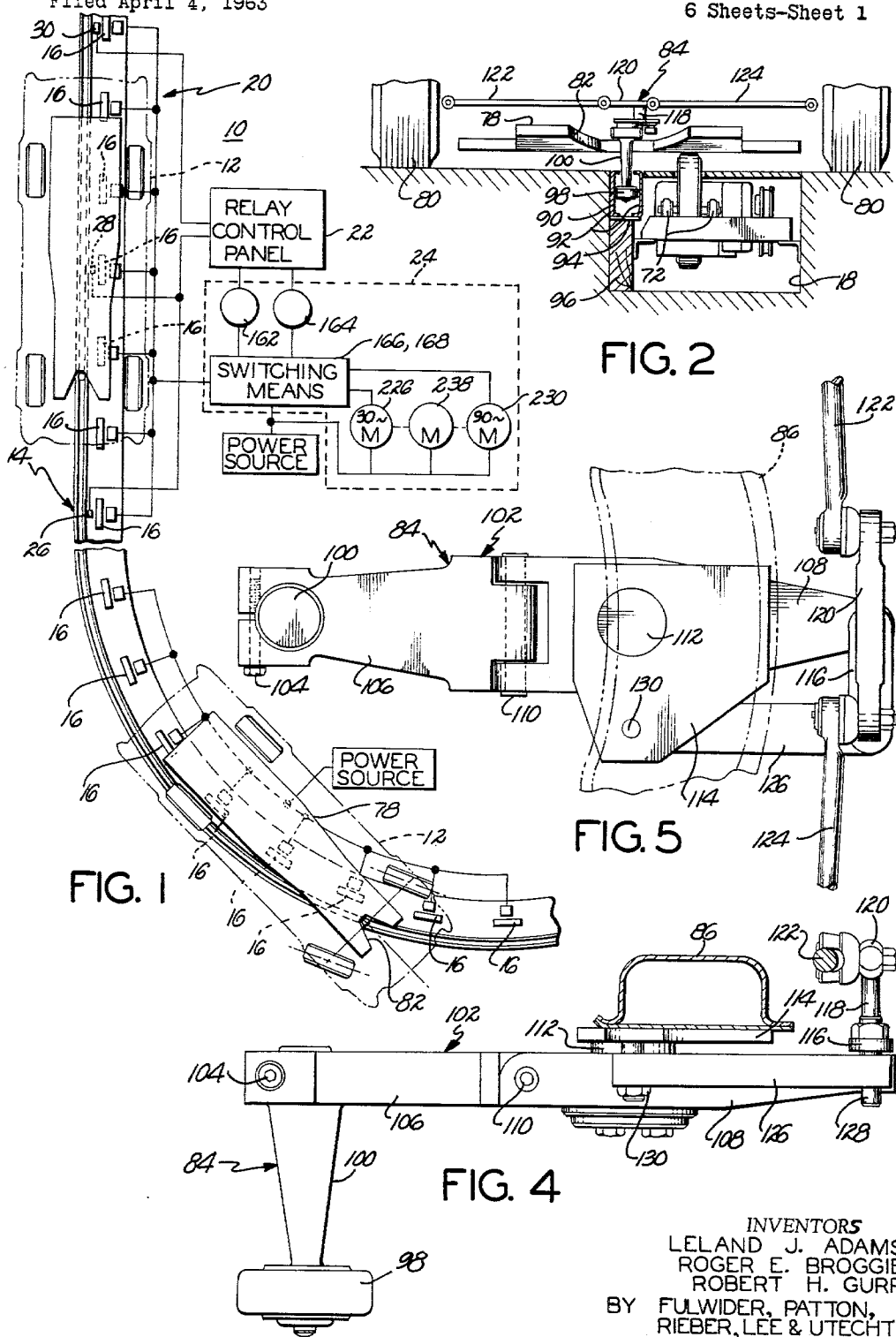
L. J. ADAMS ETAL

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ARTICLE HANDLING MEANS

Filed April 4, 1963

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ARTICLE HANDLING MEANS

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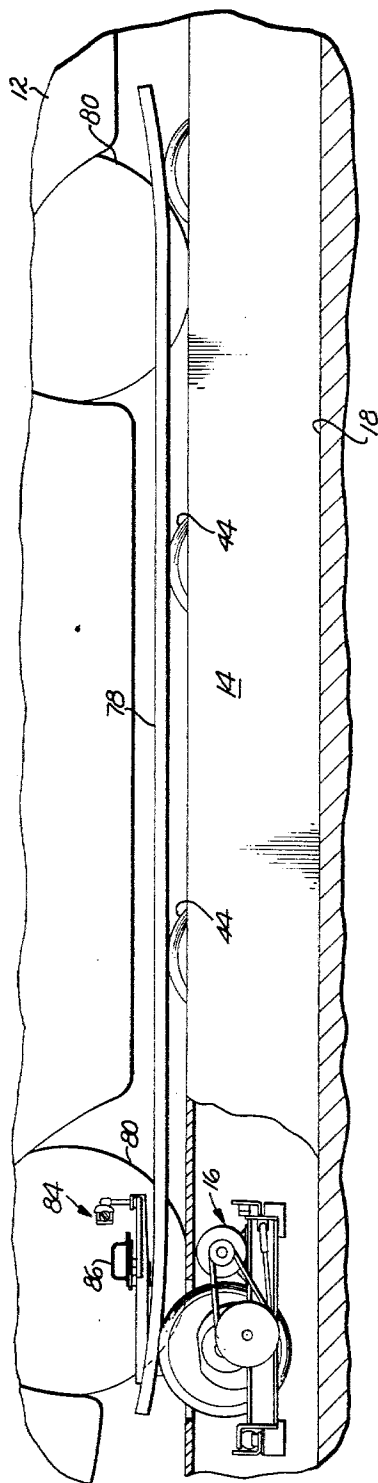


FIG. 3

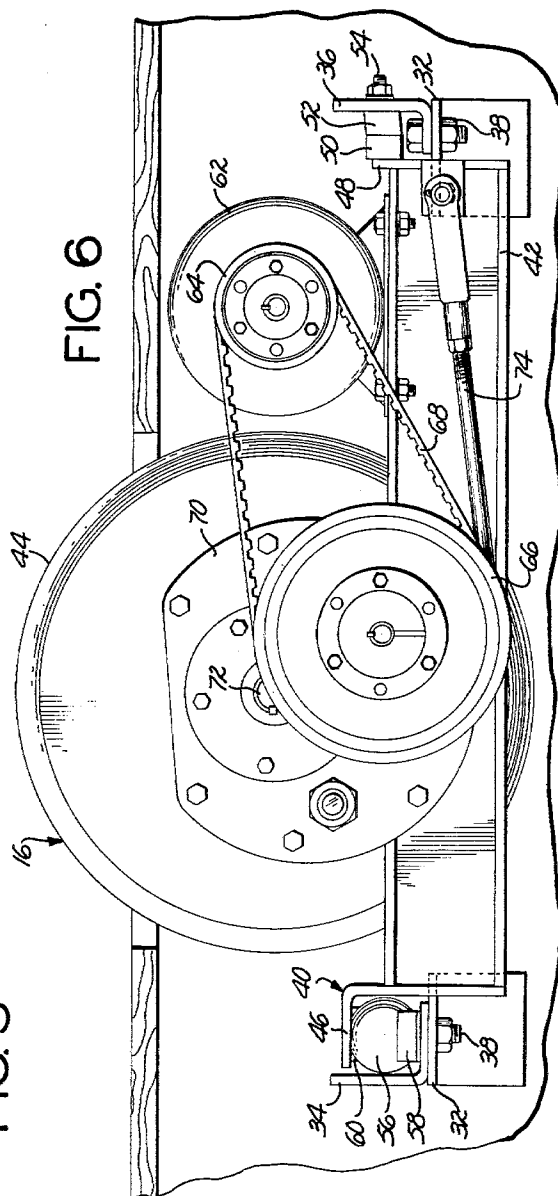


FIG. 6

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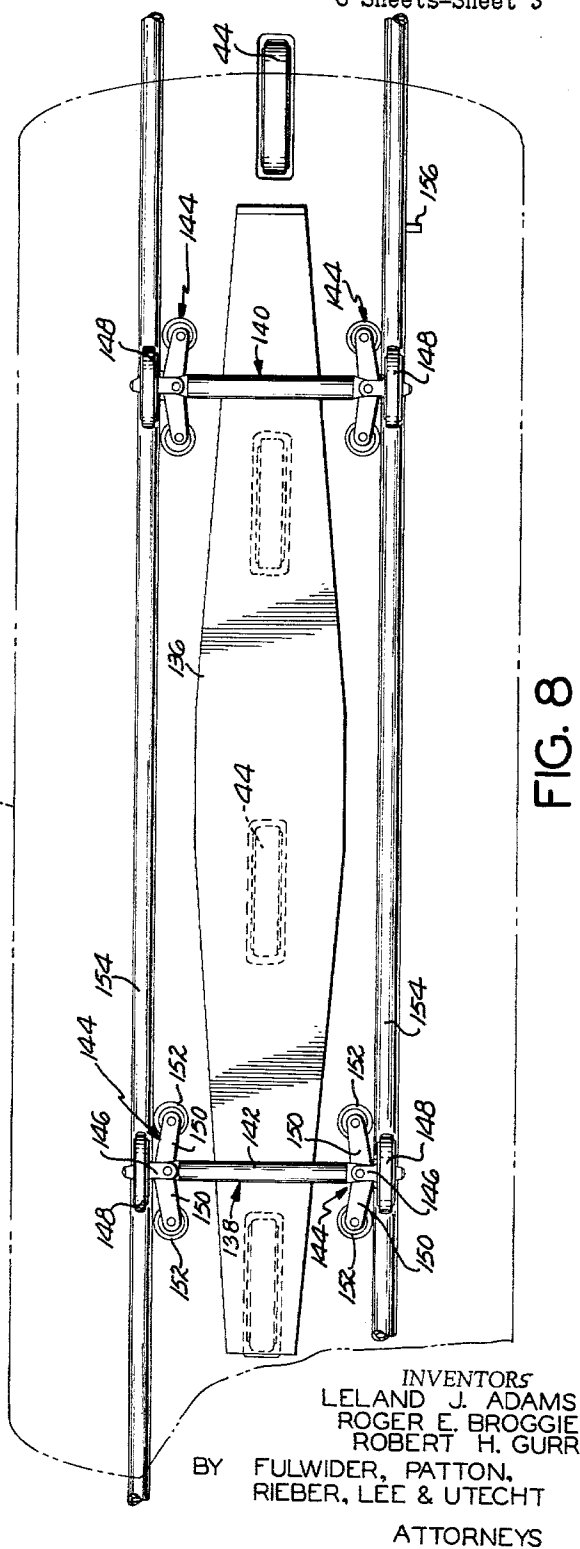
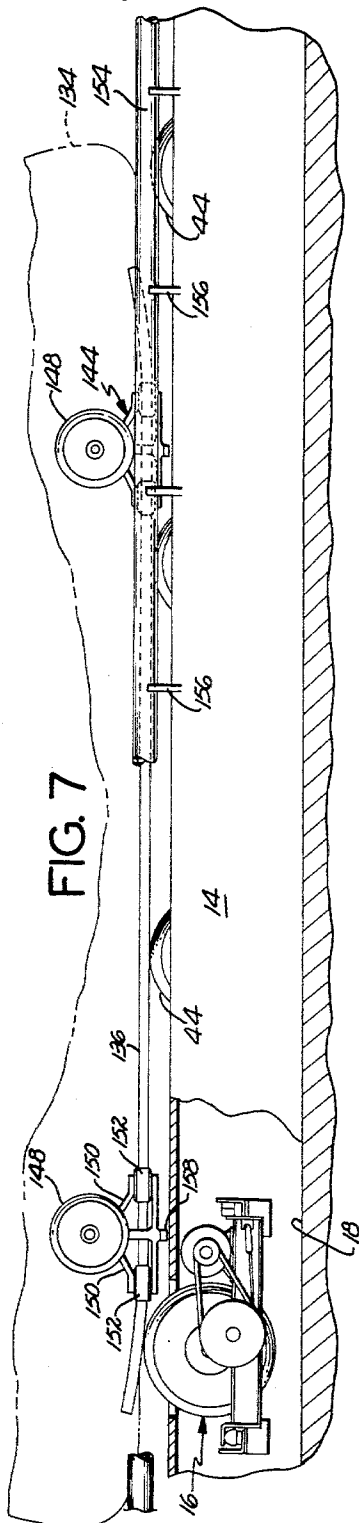
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ARTICLE HANDLING MEANS

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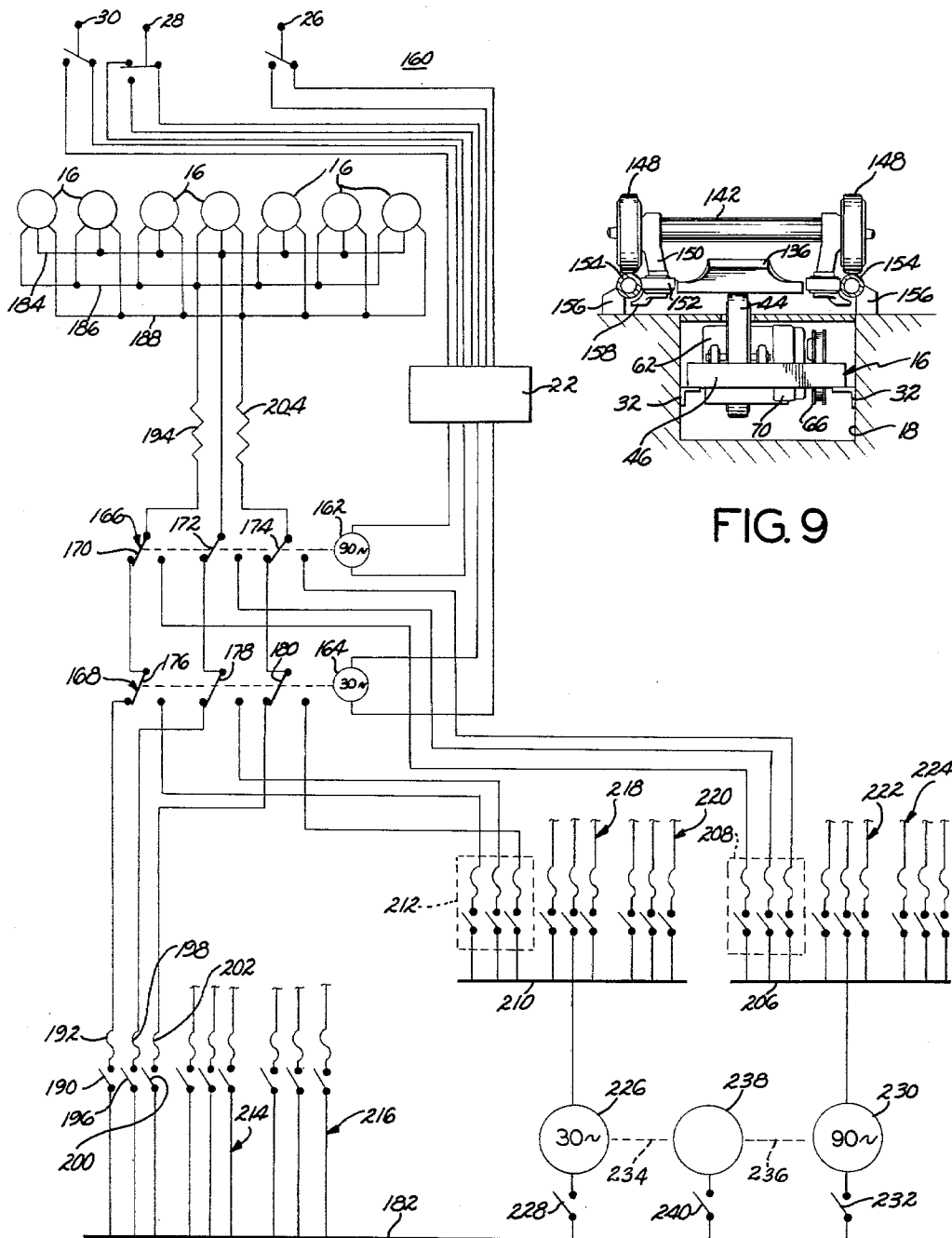
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ARTICLE HANDLING MEANS

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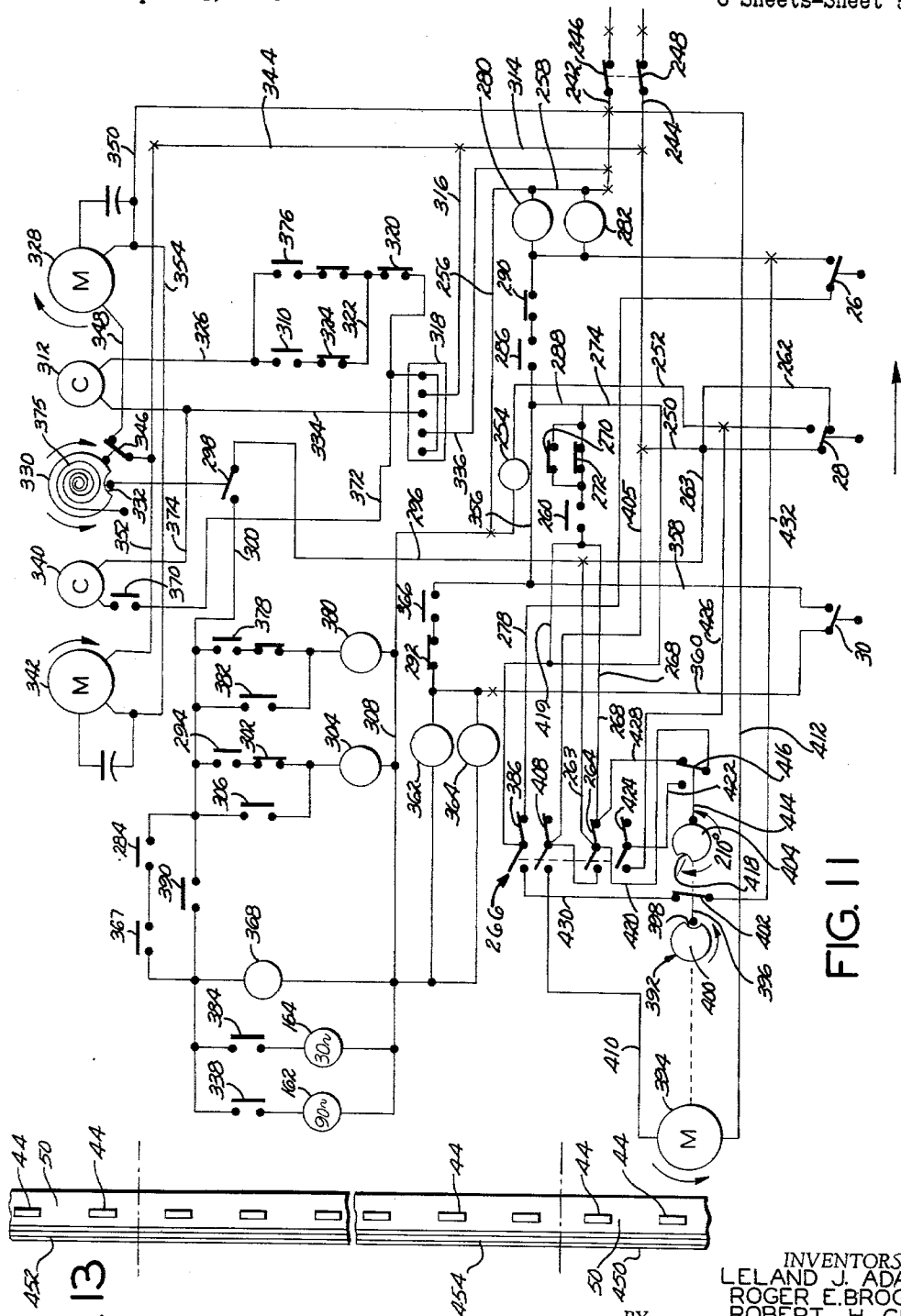


FIG. 11

FIG. 13

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ARTICLE HANDLING MEANS

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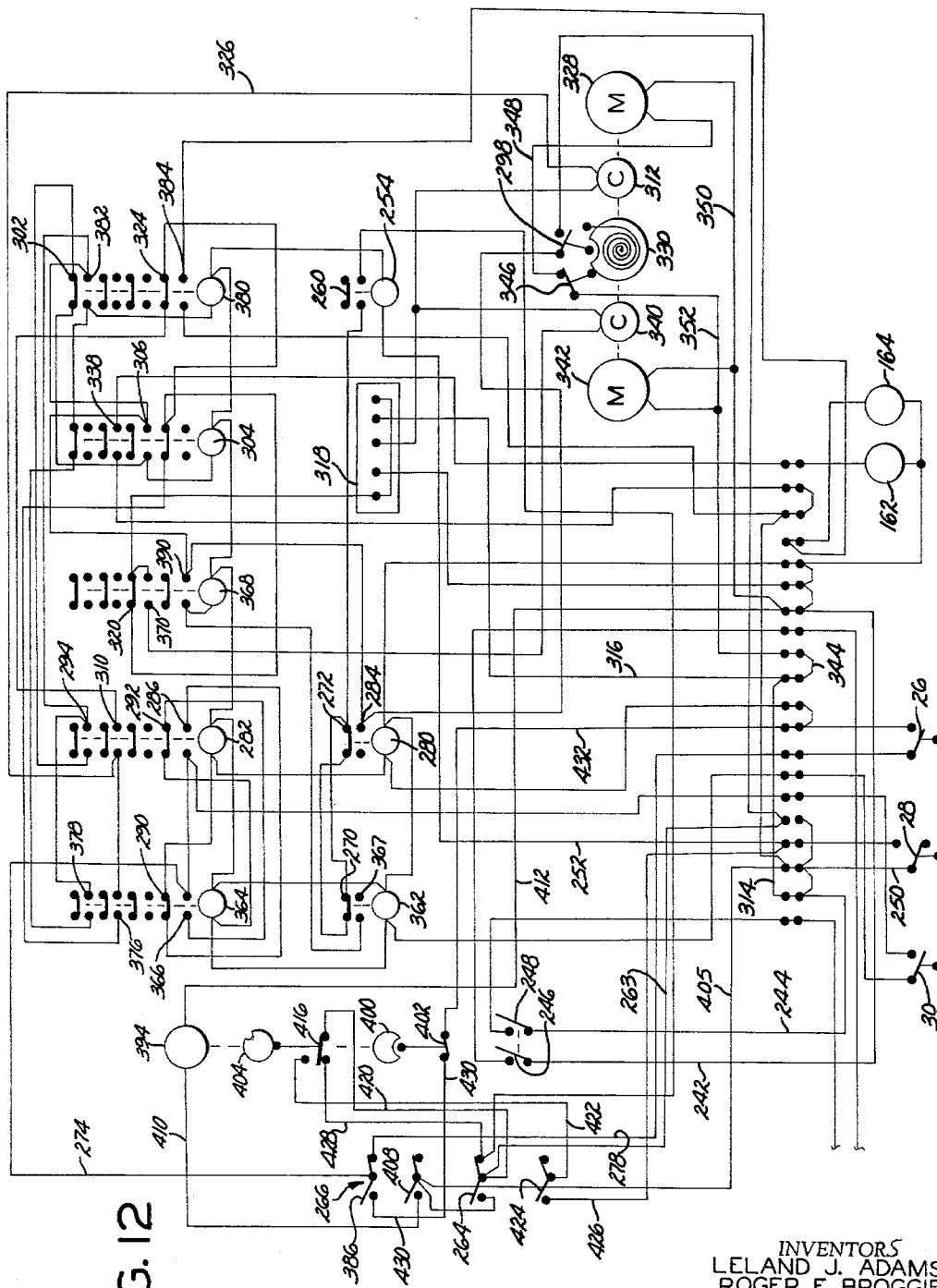


FIG. 12

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ARTICLE HANDLING MEANS

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16 Claims. (Cl. 104-149)

The present invention relates to article handling means, and more particularly to article handling means adapted for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles.

Although the present article handling means is particularly adapted for transporting and guiding unpowered vehicles along a fixed track in predetermined spaced relationship, the invention has broader application in its adaptability for properly spacing a moving plurality of articles, whether such articles be self-propelled or externally driven. Moreover, although the positioning or spacing means of the invention effects such spacing by controlling an external driving apparatus engageable with the vehicles, it is also adapted to effect such spacing by controlling a drive apparatus carried by the vehicle. However, the invention will be particularly described primarily in connection with vehicles externally driven along a fixed track, the control of self-powered vehicles or articles being an obvious variation which will be apparent to those skilled in the art.

According to the present invention, passengers are transported in modified automobiles along a track passing through an exhibit area or the like. Upwards of seventy automobiles are accommodated on the track, which has a perimeter in excess of 2000 feet. The automobiles are driverless, and automatically and continuously moved along the track, up moderate grades, around curves, and past a loading and unloading station where the passengers enter and leave the moving vehicles by means of a moving sidewalk. The sidewalk is driven at the same speed as the vehicles so that the vehicles are motionless relative to the passengers.

The outward appearance of the automobiles is identical to that of conventional automobiles, although they are preferably stripped of engines, manual braking mechanisms, transmissions and radiators. Each is provided with a steering pin which is coupled to the automobile steering mechanism and depends below the chassis for slidable retention in a channel of the track to steer or guide the associated automobile during its forward passage along the track.

In another embodiment of the present article handling means the steering pin arrangement is omitted and the vehicles are constructed with four support wheels which ride upon a pair of spaced apart rails extending coextensive with the track. The forward and rearward support wheels are coupled together, respectively, and guide wheels attached to each of the support wheels ride upon the sides of the rails to impart the configuration of the track to the vehicle and steer it around curves and the like.

In both embodiments each vehicle is propelled along the track by engagement between an elongated platen, which is secured to the underside of the vehicle chassis, and a plurality of rotating drive wheels protruding above the track, the platen serving as a bearing surface for the drive wheels. Each drive wheel forms a part of a separate propulsion unit located within a trench of the track and including a drive motor and a gear reduction box. The plurality of propulsion units are regularly spaced along the complete length of the track with the propulsion units on the steeper grades preferably located closer together.

2

The track includes at least one elongated respacing zone within which the positions of the moving vehicles are adjusted. Vehicle position adjustment is essential since the weight, turning radius, and dimensions of the various vehicles are usually different, resulting in differential speeds which must be compensated for to prevent undesirable bumping and collisions between adjacent vehicles.

Two different control embodiments are herein disclosed for properly spacing the vehicles. Either may be used, as desired, since both have successfully accomplished the desired vehicle repositionment, or both may be incorporated in the same system and used alternatively, as will be seen. Regardless of which of the two means is utilized, each utilizes multiple propulsion units arranged along the length of the respacing zone, the motors of these units being varied in speed upwardly or downwardly by varying the frequency of the alternating current applied to the motors. Frequency adjustment is accomplished by correction means constituted by a pair of motor driven, wound rotor motors which are operable to provide lower cycle and higher cycle outputs, respectively, such as 30 cycle or 90 cycle outputs for example. One or the other of these outputs is applied to the respacing propulsion units by control means which are in electrical circuit with the propulsion units and which are actuated by sensors or switches operated by vehicles passing through the respacing zone.

One control means embodiment employs a switch at each extremity of the respacing zone, the leading or down-track one of these switches being actuated by a leading vehicle simultaneously with the actuation of the following switch by the following vehicle when the two vehicles are properly spaced apart. If the following vehicle is too far behind the leading vehicle, the following switch will be actuated subsequent to actuation of the leading switch, causing the control means to operate the correction means to apply a 90 cycle output to the respacing propulsion units for speeding up the following vehicle as it passes through the respacing zone. Conversely, should the following switch be actuated by the following vehicle prior to actuation of the leading switch by the leading vehicles, the control means causes the correction means to apply a 30 cycle output to the respacing propulsion units for slowing the following vehicle during its travel through the respacing zone.

A third switch intermediate the above-described pair of switches may be employed when the plurality of vehicles passing around the track are to be separated into spaced apart groups, the third switch being operative to sense the extraordinary spacing between the groups and prevent the first vehicle of the following group from being speeded up by the system, thereby confining vehicle acceleration to those vehicles following the leading vehicle of a group.

The other control means embodiment retains the aforementioned following switch, but replaces the leading switch with a switch which is momentarily closed by a timer at predetermined, regularly spaced intervals corresponding with the time intervals between passing, properly spaced vehicles. In the event that the following switch is actuated prior to expiration of the predetermined time interval established by the timed switch, the correction means is operated to apply a 30 cycle output to the respacing propulsion units. However, should the following switch be actuated subsequent to expiration of the predetermined time interval, the correction means is operated to apply a 90 cycle output to the respacing propulsion units.

Although the correction means herein described is physically connected by electrical leads to the respacing

propulsion units for altering the frequency of the current applied to such units, the correction means of the present invention may also take other forms, such as an electrically operable carburetor and brake arrangement associated with the engine and wheels of a conventional automobile, and actuated by the above-described control means from a remote location. Coupling of the output of the control means to such a correction means would not then of course be by physical connection, but would be through a communications system such as a radio transmitter-receiver arrangement or the like. Such coupling systems for controlling remote slave units are well known in the art, and various methods therefor will immediately suggest themselves to those skilled in the art. With such a remote control arrangement, the present control means is utilizable to properly position vehicles on a highway, or control the interval of entry of vehicles into a traffic problem area, such as a tunnel or the like. The present invention is also adapted to properly space articles traveling on a conveyor belt, or on analogous forms of material handling systems.

Accordingly, it is an object of the present invention to provide article handling means for establishing a predetermined spaced relationship between individual articles of a plurality of articles moving over a prescribed course, such as a track, highway, conveyor line or the like, in a trouble-free, dependable manner with relatively quiet, smooth, and precise operation of the article handling means components.

It is another object of the invention to provide article handling means of the aforementioned character wherein the articles handled are vehicles propelled by external drive units which incorporate tired drive wheels engageable with a platen carried by each vehicle. An important aspect of this arrangement is the ease with which conventional automobiles can be converted for propulsion by the present system. Such automobiles need only be equipped with elongated platens secured to the undersides of the automobiles for engagement by the tired wheels of the propulsion units.

Another object of the invention is the provision of article handling means of the aforementioned character for propelling vehicles along a track by virtue of engagement between the system propulsion units' tired drive wheels and the vehicle platens, and wherein such engagement is cushioned and smoothed by a pivotable, resilient mounting of the propulsion units to adjacent track structure.

A further object of the invention is the provision of article handling means of the aforementioned character for propelling vehicles along a track of irregular configuration and varying grade, and wherein each vehicle is smoothly and accurately guided by engagement of a channel of the track by a steering pin which depends from the vehicle and operates steering rods extending transversely of and connected to the front wheels thereof. In this regard, another object of the invention is to smoothly and accurately guide a vehicle along a track by engagement between wheels of the vehicle and rails extending parallel to and coextensive with the track, and wherein oppositely disposed or confronting pairs of such wheels are coupled together and controlled by guide wheels running along the sides of the rails.

An additional object of the invention is to provide article handling means of the aforementioned character for propelling vehicles along a track without the use of conveyor chains or the like coupled to the vehicles, and wherein the propulsion units engage vehicle mounted platens whereby the means for propelling the vehicles is unobtrusive and in large part concealed from view.

Another object of the invention is the provision of article handling means of the aforementioned character which are adapted to quickly and accurately sense and adjust any incorrect spacing between adjacent articles, and wherein

the sensing and control means is relatively inexpensive, easy to maintain, reliable, and characterized by extended service life.

A further object of the invention is to provide article handling means of the aforementioned character wherein engagement between the articles handled and the external means for propelling the same is resilient, impositive, and such as to afford smooth propulsion of the articles around curves and the like.

Another object of the invention is the provision of article handling means of the aforementioned character in which alternating current motors are utilized for moving the articles through a respacing zone, and in which correction means alter the speed of the motors, thereby altering the speed of the articles, through the utilization of variable frequency input to the motors, the correction means being responsive to sensor means operative to sense any discrepancy in spacing between the articles.

Another object of the invention is to provide article handling means of the aforementioned character in which the predetermined spacing between the articles may be altered merely by adjusting the positions of the switch means and employing a timer apparatus adapted to dictate the desired time intervals.

The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawings in which certain embodiments of the invention are illustrated by way of example. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only, and are not intended as a definition of the limits of the invention.

FIG. 1 is a diagrammatic view of a means for establishing a predetermined spaced relationship between individual automobiles according to the present invention, only a portion of the track being illustrated in phantom outline;

FIG. 2 is an elevational cross-sectional view illustrating a propulsion unit in a trench associated with the track, the drive wheel of the propulsion unit being in engagement with a platen attached to the underside of the automobile;

FIG. 3 is a side elevational view of the structure of FIG. 2, a portion thereof being illustrated in cross-section;

FIG. 4 is a detail view in side elevation of the guide means secured to the automobile for steering the same along the track;

FIG. 5 is a plan view of the guide means of FIG. 4;

FIG. 6 is a detail side elevational view of one of the propulsion units and the adjacent track structure;

FIG. 7 is a side elevational view, partially in cross-section, illustrating a slightly different form of vehicle traveling upon parallel rails adjacent the track;

FIG. 8 is an elevational view of the arrangement of FIG. 7;

FIG. 9 is a front elevational view, partially in cross-section, of the arrangement illustrated in FIG. 7;

FIG. 10 is a schematic wiring diagram of the present means for establishing a predetermined spaced relationship between individual articles, automobiles, or the like;

FIG. 11 is a schematic wiring diagram of the control means of the arrangement shown in FIG. 10;

FIG. 12 is a schematic wiring diagram essentially the same as that illustrated in FIG. 11, but showing the relays adjacent their associated switches; and

FIG. 13 is a diagrammatic representation of a section of the track, particularly illustrating the arrangement of sections of drive motors operating at different speeds and separated by an intermediate section of drive motors whose speeds are stepped.

Referring now to the drawings, and particularly to FIG. 1 thereof, there is illustrated means 10 for establishing a predetermined spaced relationship between individual

articles of a plurality of moving articles, such articles in FIG. 1 being constituted by automobiles, a pair of which are indicated at 12—12 in phantom outline. As previously indicated, a plurality of such automobiles 12 are propelled around a track 14 by propulsion means constituted by a plurality of propulsion units 16 located within an elongated trench 18, FIG. 2, which extends coextensive with the track 14.

Each automobile 12 is conventional in form, including the usual four wheels, body, and chassis, but if desired for reasons of ease of propulsion and prevention of manual braking by passengers, each automobile 12 may be stripped of its usual manual brakes. In addition, the steering gear thereof is preferably disconnected to render the steering wheel inoperative. Thus, each automobile 12 is in outward appearance the same as any automobile just off the assembly line.

The purpose of the present means 10 is to propel each automobile 12 along the track 14 to carry passengers therein through an exhibit area, for example, while yet relieving the passengers of any responsibility for the operation of the automobile 12. For brevity, only a pair of automobiles 12 are illustrated, but it will be understood that a great plurality of such automobiles 12 are propelled simultaneously along the track 14, sometimes one right behind the other, completely filling the track 14, and sometimes in groups separated by four, five or more car lengths.

Depending upon the length of the track 14, a number of respacing zones 20 may be provided, but only one such zone 20 is illustrated in FIG. 1 for brevity. The propulsion units 16 in the respacing zone 20 are variable in speed to speed up or slow down the automobile 12 with which they are in engagement, and are herein referred to as respacing propulsion units. There are approximately seven such respacing propulsion units 16 in each respacing zone 20 so that at least three units will always be in driving engagement with the automobile 12. However, it will be apparent that the number and spacing of such propulsion unit 16 may be varied as desired, or as required by the particular application.

Each propulsion unit 16 in the respacing zone 20 is under the control of a control means 22 which is in electrical circuit with a correction means 24, the correction means 24 in turn being in electrical circuit with the propulsion units 16 to speed up or slow down the units 16 in accordance with the dictates of the control means 22, as well be more particularly described hereinafter.

The control means 22 includes three switches or sensors constituted by a leading switch 26, an interval switch 28, and a following switch 30. The sequence of actuation of the switches 26 and 30 is translated by the control means 22 into signals which actuate the correction means 24 to supply an increase or decrease in the speed of the propulsion units 16, while the interval switch 28 renders the control means 22, in effect, inoperative to actuate the correction means 24 in the event that the following switch 30 is not actuated for a considerable time interval. That is, where a number of the automobiles 12 pass seriatim past the switches 26 and 30, closely adjacent each other, and are thereafter followed at a considerable distance by another group of the automobiles 12, the non-actuation of the interval switch 28 during the prolonged time interval between the groups of automobiles causes inactivation of the control means 22. This prevents the leading automobile 12 of the following group of automobiles 12 from being immediately speeded up upon coming into the respacing zone 20. However, as soon as such leading automobile actuates the interval switch 28, the automobile behind it will be speeded up or slowed down, depending upon its spacing from the leading automobile, as sensed by the switches 26 and 30.

Thus, the leading automobile 12 is the reference automobile and the automobile 12 following is speeded up or slowed down to provide correct spacing. Thereafter, the following automobile becomes the leading or reference

automobile for the automobile following it. As will be seen, if the leading automobile 12 actuates or trips the leading switch 26 prior to actuation of the following switch 30 by the following automobile 12, the following automobile 12 is too far behind and is speeded up under the dictates of the control means 22. However, if the following automobile 12 trips the following switch 30 prior to actuation of the leading switch 26 by the leading automobile 12, the following automobile is too close and is subsequently slowed in accordance with the dictates of the control means 22.

Propulsion unit

The propulsion units 16 are located in the motor trench 18, and are spaced apart about the periphery of the track 14. Each propulsion unit 16 includes a supporting framework having two pairs of longitudinally spaced-apart angle brackets 32, the brackets 32 of each pair being secured to opposite sides of the motor trench 18 in confronting relationship, as best illustrated in FIGS. 2 and 6. The horizontal legs of these brackets 32 support a pair of elongated, longitudinally spaced-apart, transverse angles 34 and 36 which are secured in position by usual nut and bolt assemblies 38.

Each propulsion unit framework also includes a platform 40 having a pair of longitudinally extending structural channels 42, one of which is illustrated in FIG. 6, which are transversely spaced-apart to provide room for rotation of a rubber tired drive wheel 44 in a vertical plane between the channels 42. The forward or down-track extremities of the channels 42 are secured to a transverse structural angle 46 and the opposite extremities of the channels 42 are rigidly secured to a transverse plate 48 to which is affixed an elongated transversely extending bar 50, thereby forming a rectangular frame. The bar 50 is secured to the angle 36 by a plurality of transversely spaced-apart flexible bolt mountings 52 made of resilient material such as neoprene rubber, the mountings 52 in turn being secured to the bar 50 by a corresponding plurality of nut and bolt assemblies 54. Resilient bolt mountings such as the mountings 52 are well known in the art for providing a resilient but secure support between adjacent members to prevent shock. However, the mountings 52 could take the form of a resilient metal or plastic hinge, if desired.

In the present instance the mountings 52 resiliently support the platform 40 for limited pivotal movement thereof relative to the channel 36 which, as previously indicated, is fixed to the track walls by the angles 32.

The horizontally oriented legs of the confronting angles 34 and 36 are disposed in confronting relationship, and are spaced apart by a pair of resilient balls 56, made of rubber or the like, which are held in position by a pair of longitudinally arranged stub angles 58 welded to the angle 34 and a pair of stub angles 60 welded to the angle 46. A metal coil spring, hydraulic or pneumatic cylinder, or any similar resilient means could be used in place of the balls 56, if desired.

The angles 58 and 60 are offset relative to each other to bear against opposite sides of the balls 56 to prevent transverse movement thereof, the transverse angles 34 and 46 preventing movement of the balls 56 in a longitudinal direction.

With this arrangement, the platform 40 is pivotable about the resilient bolt mountings 52, and the balls 56 are compressed to resiliently accommodate such movement. This yieldability of the platform 40, particularly to downward forces, permits a firm, resilient engagement between the associated drive wheel 44 and the automobile 12. In contrast, an inflexible engagement is undesirable in that irregularities in the automobile surface engaged by the various drive wheels 44 would prevent simultaneous engagement of the automobile 12 by all of the drive wheels 44 in position for such engagement. Moreover, a resilient arrangement substantially prevents any jolting engagement of the automobile 12 by the drive wheels 44 so that the

passengers have no awareness of the means by which their automobile is being driven, and move about the track in quiet comfort. Such distraction-free propulsion of the automobiles 12 is an important and salient feature of the prevent invention to permit the passengers to give their undivided attention to the exhibit areas through which they are traveling, as well as the quality and attractiveness of the automobile itself.

Each platform 40 rigidly mounts an electric drive motor 62 atop the upper surfaces of a pair of longitudinal channels 42 for driving a gear reduction unit 70, the drive motor 62 and the unit 70 being connected by a drive pulley 64 mounted to the motor 62, a pulley 66 mounted to the unit 70, and a drive belt 68 connected between the pulleys 64 and 66. The pulley 66 is of a larger diameter than the pulley 64 to provide some speed reduction, but the main speed reduction takes place in the gear reduction unit 70, whose output is transmitted to the drive wheel 44 by a shaft 72. The drive wheel 44 is supported for rotation by a pair of pillow or bearing blocks 72 which are rigidly bolted to the longitudinal channel 42 in spaced-apart relationship.

A turnbuckle rod 74 is rigidly secured at its forward extremity to the housing of the gear reduction unit 70, and secured at its opposite end to the transverse plate 48 by means of a mounting tab 76 welded to the transverse plate 48.

Platen

Each automobile 12 mounts an elongated platen 78, which may be made of any suitable material such as plywood or a sandwich arrangement of thin structural aluminum or the like, secured by any suitable means to the underside of the automobile chassis. The platen 78 is approximately 12 feet in length to accommodate engagement thereof by at least three propulsion units 16, but it will be apparent that the particular size of the platen 78 is not critical so long as effective driving engagement is provided between the automobile 12 and the drive wheels 44.

Each platen 78 extends longitudinally between the automobile wheels 80, and is cut away at its forward extremity, as at 82, to provide space for movement of the steering means for the automobile 12, as will be described. In addition, the forward and rearward extremities of the platen 78 are preferably inclined slightly upwardly from a horizontal plane to enable gradual engagement and disengagement thereof with the drive wheels 44. More particularly, upon engagement between the toe or upwardly curved forward extremity of the platen 78 and the periphery of the adjacent drive wheel 44, the drive wheel 44 is urged downwardly under the weight of the automobile 12, deforming the resilient mountings 50 and balls 56 and thereby effecting a resilient and gradually more direct association which continues throughout the interval of passage of the platen 78 past the drive wheels 44. Disengagement therebetween is equally gradual because of the relative divergence between the rearward extremity of the platen 78 and the associated drive wheel 44.

The smoothness of engagement between the automobile 12 and the propulsion units 16 provides a distraction-free ride which is in sharp contrast to the jolting and jerky propulsion effected by prior art systems such as the well known continuous chain or continuous link mechanisms. Heretofore, the propulsion of unpowered vehicles through display areas and the like has been accompanied by distracting bumps and relatively sudden accelerations and decelerations such that the passengers were uncomfortably aware of the presence of some laboring artificial mechanism, and thus destroying their impressions of easily transition from one exhibit area to another. This defect was particularly obvious where changes in track direction occurred. In this regard it is noted that the longitudinal axis of the platens 78 and the vertical plane of rotation

of the various drive wheels 44 need not be exactly aligned for smooth propulsion. Along straight stretches of the track 14 there is exact alignment, but at turns in the track 14 the drive wheels 44 engage the platen 78 at an angle, and only a vector of the propulsive force is effective to drive the wheels 44. However, the impositive nature of the engagement between the wheels 44 and the platen 78 allows a desirable relative sideways tilting movement of the wheels 44 provided by the resilient mounting so that undesirable jerkiness, wheel sideslip and the like are completely eliminated.

Steering apparatus

A steering apparatus 84, as best illustrated in FIGS. 2, 4 and 5, is rigidly mounted to a transverse chassis section 86 of the automobile chassis adjacent the front wheels 80 thereof, and is engageable with an elongated channel 90 of the track 14 to guide the automobile 12 along the track 14. The channel 90 is formed by a pair of channel sections 92 which are maintained in a predetermined spaced-apart relationship by a baseplate 94 to which their lower portions are fastened. The baseplate 94 is secured atop a longitudinally extending support member 96 disposed within the motor trench 18, which member 96 also affords a mounting surface for the adjacent angle brackets 32 of the propulsion unit 16.

The upper portions of the channel sections 92 extend toward each other to define a throat section which is narrower than the channel 90 formed by the vertical portions of the channel sections 92, and a rotatable roller 98 of the steering apparatus is disposed within the channel 90 for rotation in a horizontal plane. The roller 98 cannot be separated from the channel 90 because of the narrower throat section formed between the upper extremities of the channel sections 92, but disengagement sections are provided at intervals along the channel 90 to permit separation when desired. Such disengagement sections (not shown) are provided by cutting away the upper extremities of the confronting channel sections 92 to provide a space sufficiently great to permit the roller 98 to be upwardly withdrawn therefrom.

The roller 98 rotates whenever it is in engagement with one or the other of the adjacent vertical walls of the channel sections 92, and is rotatably carried at the lower end of an elongated, vertically disposed steering pin 100 rigidly secured at its upper extremity to the forward end of an elongated articulated linkage 102. The linkage 102 is pivotable about a vertical axis in response to side movements of the steering pin 100 and includes an opening at its forward extremity for receiving the upper end of the steering pin 100, being bifurcated adjacent the opening and provided with a bolt 104 threaded through the adjacent portions of the bifurcation to urge such portions together for firmly holding the steering pin 100 in position.

The linkage 102 is constituted by a forward link 106 and a rearward link 108 which are pivotable relative to each other about a hinge pin 110. The adjacent extremities of the links 106 and 108 are characterized by a hinge knuckle arrangement pivotally secured together by the hinge pin 110, the adjacent extremities of the links 106 and 108 being vertical except for the upper forward edge of the rearward link 108. This edge is arcuate or curved to permit upward pivotal movement of the link 106 relative to the link 108. However, downward pivotal movement of the link 106 out of the plane of the link 108 is prevented by engagement between the adjacent straight lower vertical portions of the links 106 and 108. Thus, the link 106 is upwardly pivotable to accommodate slight irregularities in the channel 90 during forward travel of the automobile 12, and is also upwardly pivotable out of the channel 90, at one of the previously described track disengagement sections, to effect disengagement between the channel 90 and the steering pin 100 when the automobile 12 is to be moved off the track 14.

The rearward link 108 of the steering apparatus is sup-

ported for pivotal movement about a vertical axis by a vertically disposed stub shaft 112 which is rigidly secured to a horizontally oriented mounting plate 114 which is fastened to the underside of the transverse chassis section 86 of the automobile 12. With this arrangement, sideways movement of the roller 98 as it travels along the channel 90 is translated into a partial rotation of the rearward link 108 about the sub shaft 112.

The pivotal motion of the link 108 is imparted to the automobile 12 by an elongated, transversely connecting link 116 which is pivotally connected at its extremities, respectively, to the rearward extremity of the rearward link 108 and to a vertically disposed tie member 118 whose upper extremity is welded to an elongated transversely disposed intermediate link 120.

The opposite extremities of the intermediate link 120 are pivotally secured to a pair of elongated side links 122 and 124 whose opposite extremities are secured in any suitable fashion (not shown) to the usual steering arms which are connected to the automobile front wheels 80. Such usual steering arms are the same steering arms to which the conventional steering mechanism of an automobile is connected to cause the automobile wheels 80 to turn for steering purposes. The up and down springing action of the front wheels 80 is accommodated by the pivotal connection between the adjacent extremities of the intermediate link 120 and the side links 122 and 124.

An elongated stabilizing link 126 is pivotally connected at its rearward extremity to a depending portion 128 of the tie member 118, and is pivotally connected at its forward extremity to the mounting plate 114 by a stud-nut assembly 130. With this arrangement, the mounting plate 114, the links 108 and 126, and the intermediate link 116 constitute the sides of a parallelogram, with the stabilizing link 126 preventing undesirable longitudinal deflection of the transverse linkage constituted by the intermediate link 120 and the side links 122 and 124.

Pivotal movement of the linkage 102 and the associated steering pin 100 relative to the adjacent platen 78 of the automobile 12 is permitted by the provision of cutout section 82 in the forward extremity of the platen 78. Thus, the steering apparatus just described is adapted to smoothly guide the automobile 12 over the predetermined course of the track 14, while yet accommodating any slight irregularities existing in the channel 90, as well as accommodating the usual vertical springing action of the automobile wheels 80. An alternate arrangement is to eliminate the links 116 and 126 and instead employ a side link connected directly from the rear of the link 108 to the conventional steering linkage of the automobile.

Steering apparatus—Another embodiment

In certain applications it is desirable to provide for steering of the rear wheels of a four-wheeled vehicle, as well as the steering of the two front wheels, and a vehicle or car 134 steered in this manner is illustrated in FIGS. 7 and 8 together with the associated apparatus for effecting such steering. More particularly, an elongated platen 136 is secured to the underside of the chassis of the car 134 for engagement with the wheels 44 of the propulsion units 16 for driving the car 134 along the track 14.

The steering mechanism is constituted by identical forward and rearward steering portions 138 and 140, respectively, which are each constituted by an elongated transverse axle 142 fixed to the car chassis (not shown) in any suitable fashion. The opposite ends of each of the axles 142 pivotally mount a pair of wheel assemblies or mounts 144 which each includes a laterally extending arm 146 for rotatably mounting a support wheel 148, and also includes a pair of oppositely extending, longitudinally oriented arms 150 which each mount a guide wheel 152. The arms 150 are arranged substantially parallel with a pair of elongated, spaced-apart rails 154 extending along the track 14, the rails being secured to the track 14 by

any suitable means, such as by a plurality of vertical members 156 schematically shown in FIG. 7.

The pair of rails 154 are coextensive with the track 14, following each conformation thereof, and the four support wheels 148 of the car 134 ride upon these rails to support the car 134 above ground level. The wheels 148 are steered along the rails 154 by the guide wheels 152 which ride along the inner peripheries of the pair of rails 154 and pivot the wheel mounts 144 in conformity with the curvature of the rails 154. That is, pivotal movement of the arms 150 of the wheels 152 about the extremities of the axles 142 is transmitted to the arms 146 supporting the wheels 148 to pivot the wheels 148 and thereby steer the car 134 at both its forward and rearward ends. Each of the wheel mounts 144 also includes a depending shoe 158, as best seen in FIG. 9, which extends beneath the rails 154 to prevent the car 134 from moving upwardly and jumping the rails 154.

Respacing apparatus

Referring now to FIG. 10, there is illustrated a respacing apparatus 160 located in each respacing zone 20, and which includes the previously indicated control means 22, the correction means 24, and the switches 26, 28 and 30. One of the respacing apparatuses 160 is located in each of the respacing zones 20, but for the purpose of brevity only one of the respacing apparatuses 160 is herein described and illustrated. However, the electrical leads for two other such respacing apparatuses are illustrated in FIGS. 10 and 12 to show how simply additional apparatuses 160 may be added when needed.

The respacing means of the invention includes, generally, the switches 26, 28 and 30 connected by suitable leads to the control means 22, a pair of usual and conventional holding coils 162 and 164 in electrical circuit with the control means 22 and alternately energizable by the control means 22 to close, respectively, a pair of relays 166 and 168. The relay 166 includes three ganged switches 170, 172 and 174, and the relay 168 includes three ganged switches 176, 178 and 180. The switches of the relays 166 and 168, in the positions thereof illustrated in FIG. 10, connect three-phase alternating current of 60 cycle frequency from a 60 cycle bus 182 to three bus bars 184, 186 and 188 in electrical circuit with the three-phase alternating current drive motors constituting the propulsion units 16. That is, the switches 170 and 176 connect the 60 cycle bus to 182 to the bus bar 186 through a start switch 190, through a conventional overload fuse 192, and through a usual self-saturating reactor 194. Switches 172 and 178 connect the 60 cycle bus 182 to the bus bar 184 through a start switch 196, and through an overload fuse 198. Similarly, the switches 174 and 180 connect the 60 cycle bus 182 to the bus bar 188 through a start switch 200, through a fuse 202, and through a usual self-saturating reactor 204.

In the just described positions of the switches of the relays 166 and 168, the propulsion units 16 are powered by three-phase 60 cycle alternating current tapped from the bus 182. However, energization of coil 162 is operative to power the respacing propulsion units 16 with 90 cycle alternating current to increase their speed of rotation, while energization of coil 164 is operative to drive the propulsion units 16 with 30 cycle alternating current to decrease their speed of rotation. Thus, the control means 22 is effective to energize one or the other of the coils 162 and 164, in accordance with the sequence of operation of the leading switch 26 and the following switch 30, to thereby alter the speed of the respacing propulsion units 16.

More particularly, upon energization of the coil 162, the switches 170, 172 and 174 are moved to their opposite positions to provide power to the motor buses 184, 186 and 188 from a 90 cycle bus 206, through a fused master switch arrangement 208 identical to that described in connection with the 60 cycle bus 182.

Similarly, energization of the coil 164 is operative to move the switches 176, 178 and 180 to their opposite positions to provide power to the motor bus bars 184, 186 and 188 from a 30 cycle bus bar 210, through a fused master switch arrangement 212 identical to the fused master switch arrangement described in connection with the 60 cycle bus bar 182.

The leads generally indicated at 214 and 216 illustrate the means by which power for two other respacing apparatuses 160 may be drawn from the 60 cycle bus 182; the leads generally indicated at 218 and 220 illustrate the means by which such apparatuses 160 are provided with 30 cycle alternating currents; and the leads indicated at 222 and 224 illustrate the means by which such other apparatuses 160 may be provided with 90 cycle alternating current from the bus 206. It will be apparent that any number of respacing apparatuses 160 may be thus powered by the buses 182, 210 and 206.

The 30 cycle alternating current at bus 210 is provided by a four-pole wound rotor motor 226 connected between the 60 cycle bus 182 and the 30 cycle bus 210 through a start switch 228. The 90 cycle alternating current is provided by a four-pole wound rotor motor 230 connected between the 90 cycle bus 206 and the 60 cycle bus 182 through a start switch 232. The motor 226 is forwardly rotated and the motor 230 is reversely rotated by mechanical connections, indicated generally at 234 and 236, respectively, to any suitable drive motor, such as an induction motor 238 powered through a start switch 240 from the 60 cycle bus 182. With this arrangement, the one motor-generator set, constituted by the motors 226, 238, and 230, is adapted to provide power to all of the respacing apparatuses 160 which are utilized in the present means 10 for establishing the predetermined spaced relationship between the individual automobiles 12.

Control means

Referring now to FIG. 11, the control means 22 for selectively energizing one or the other of the coils 162 and 164, in response to the sequence of operation of the leading switch 26 and the following switch 30, is illustrated in detail. However, for clarity of description the relays have been separated from their associated switches, thereby better showing the separate circuits affected by such relays, it being noted that FIG. 12 is a showing of the same circuit as that of FIG. 11, but with the relays and their switches associated in conventional array.

The control means 22 derives its power from any suitable source of 115 volt, 60 cycle alternating current through a pair of leads 242 and 244 connected through ganged start switches 246 and 248, respectively, to the power source. Closure of the start switches 246 and 248 applies power to the correction means 24, provided that the interval switch 28 is in its closed or actuated position. However, the switch 28 is normally open, as illustrated in FIG. 11, and is moved to its closed position only when an automobile 12 engages the switch 28. For this purpose, the switches 26, 28 and 30 are disposed in the respacing zone 20 adjacent the channel 90 for actuation by the steering pin 100 as the automobile 12 travels down the track 14 through the respacing zone 20. The leading switch 26 is located so that the leading automobile 12 actuates it just after the automobile 12 leaves the respacing zone 20. The following switch 30 is located one car length within the respacing zone 20 so that the following automobile 12 trips it just after it has completely entered the respacing zone 20, the switches being spaced apart approximately 27 feet, with the interval switch 28 about 7 feet forward of the following switch 30. These distances are merely exemplary, being those adapted for use in spacing apart automobiles 12 approximately 9 seconds apart when the automobiles are moving at a rate of 3 feet per second, that is, approximately 27 feet apart. The leading switch 26 is approximately one car length beyond the respacing zone 20, the respacing zone itself being approxi-

mately 27 feet long. In this regard it should be noted that the particular form of switch is not critical, and switches 26, 28, and 30 may be usual microswitches, as described, of photoelectrically operated types, or magnetically operated types, or any other type switch for sensing the presence of the automobile 12, as desired.

Assuming a group of automobiles 12 are approaching the respacing zone 20, the leading automobile 12 actuates the following switch 30 with no effect on the control means 22, as will be seen, when the interval switch 28 is in its normally open position. However, as the leading automobile 12 proceeds through the respacing zone 20, the interval switch 28 is engaged and moved to its closed position, passing power from the lead 244 through a lead 250 to one side of the interval switch 28, thence through the switch 28, through a lead 252, through a time delay relay 254, through another lead 256, a lead 258, and on to the power source through the lead 242. This circuit energizes the time delay relay 254, thereby readying the correction means 24 for actuation of either the coil 162 or the coil 164, as will be seen.

The time delay relay 254 is of conventional construction, and various types of such time delay relays are available on the market, the particular relay 254 preferably being of the pneumatic time delay type adjusted to provide a delay of approximately 60 seconds before its associated switch is permitted to move back to its normal position. The time delay relay 254 is utilized because the interval switch 28 is only momentarily actuated and would otherwise cut off power to the correction means 24 after passage of the automobile 12. However, the sustained closure of the relay 254 permits a switch 260 associated therewith to be maintained in its closed position during the 60 second interval to provide power to the correction means 24. More particularly, the switch 260 is located in a circuit effective to energize one or the other of the holding coils 162 or 164, depending upon which of the switches 26 or 30 is first actuated.

Following automobile too far behind

Assuming that the leading automobile 12 actuates the leading switch 26 to a closed position prior to actuation of the following switch 30 by the following automobile 12, it will be apparent that the following automobile is moving too slowly, that is, located at too great an interval from the leading automobile, and therefore must be speeded up. Accordingly, upon actuation of the leading switch 26 to its closed position, a circuit is completed from the source lead 244, through the lead 250, through a lead 263, through a switch 264 which forms a part of a ganged selection switch 266, through a lead 268, through the closed switch 260 associated with the time delay relay 254, through a parallel circuit including a pair of normally closed switches 270 and 272, through a lead 274, through another switch 386 of the selection switch 266, through a lead 278, through the closed leading switch 26, through a parallel circuit including a pair of time delay relays 280 and 282, and thence back to the power source through the lead 242.

The described energization of the time delay relay 280 and the relay 282 effects closure or energization of other circuits of the control means 22, as will next be described.

More particularly, energization of time delay relay 280 closes the normally open switch 284 in a circuit subsequently effective to energize the 90 cycle coil 162, as will be seen, and also opens the normally closed switch 272. The time delay relay 280 is of the same type as the delay relay 284, but is adjusted so that its associated switches are actuated for approximately one-half second.

Energization of relay 282 closes a normally open switch 286 to provide power in certain circuits of the control means 22 subsequent to closure of the momentarily opened leading switch 26. This circuit is provided by the lead 244, the lead 250, the lead 263, the switch 264 of the

selection switch 266, the lead 268, the now closed switch 286 associated with the relay 282 and the time delay relay 280, and the power lead 242 to the power source.

Energization of relay 282 also opens a normally closed switch 292 in a circuit effective to operate the 30 cycle coil 164, the opening of this circuit preventing energization of the coil 164.

Energization of relay 282 also closes a normally open switch 294 in a circuit which readies for operation the circuit of the 90 cycle coil 162. More particularly, this circuit is connected in parallel with the just described circuit which was energized by closure of the switch 286, and is provided with power through the lead 263 connected to the center pole of the switch 264 of the selection switch 266. The circuit associated with the lead 263 is constituted by a lead 296, a cam switch 298, a lead 300, and that side of a parallel circuit which includes the switches 294 and a switch 302. The switch 294 is normally open, but is now closed by reason of the energization of the relay 282. From the switch 294 the circuit proceeds through a relay 304 whose consequent energization closes an associated switch 306 in the other branch of the parallel circuit which included the switches 294 and 302. Thus, when relay 304 is energized, closure of the switch 306 continues to provide power through the relay 304 in spite of the subsequent opening of either of the switches 294 and 302.

The circuit from the relay 304 continues through a lead 308, through the lead 256, and back to the power source through the leads 258 and 242. However, since the circuit just described includes the normally open cam switch 298, the means or circuit effective to close this switch will next be described.

More particularly, energization of the relay 282 also closes a normally open switch 310 located in a circuit effective to energize a conventional electric clutch 312, which circuit is constituted by the power lead 244, a lead 314, a lead 316, a pair of tied terminals of a conventional rectifier 318 for converting the alternating current of the power source into direct current for actuation of the clutch 321, a normally closed switch 320, a lead 322, and that side of a parallel circuit which includes a normally closed switch 324 and the normally open but now closed switch 310 associated with the relay 282. The circuit continues through a lead 326 to the clutch 312, which is energized to effect a mechanical, driving connection between a clockwise rotating clock motor 328 and a rotatable cam 330 having a peripheral detent 332. As illustrated in FIG. 11, the cam switch 298 is in its normally open position when its associated switch arm is located in the detent 332, the switch 298 being moved to its closed position when the cam 330 rotates and forces the switch arm of the switch 298 out of the detent 332 onto the outer periphery of the cam 330. Thus, upon energization of the relay 282 and consequently the elastic clutch 312, cam 330 immediately rotates. Accordingly, energization of the circuit which includes the clutch 312 and of the circuit which includes the relay 304 is substantially simultaneous.

The circuit of the clutch 312 is completed through a lead 334, through another pair of tied terminals of the rectifier 318, through a lead 336, and thence back to the power source through the power lead 242.

Summarizing the effects of the energization of relay 282, the clutch 312 is energized to commence counter-clockwise rotation of the cam 330; a power circuit is established so that closure of the leading switch 26 after the automobile 12 has passed does not cut off power to the control means 22; the possibility of energization of the circuit of the 30 cycle coil 164 is eliminated; and consequent energization of the relay 304 closes a normally open switch 338 in the circuit of the 90 cycle coil 162 to ready the coil 162 for operation of the respacing propulsion units 16 on 90 cycle power.

The clutch 312 and the clock motor 328 have their

counterparts in an oppositely located clutch 340 and a clock motor 342 engageable with the opposite face of the cam 330 and operative to rotate the cam 330 in a counter-clockwise direction. Although the clock motors 328 and 342 are normally energized, they are ineffective to rotate the cam 330 until one or the other of the electric clutches 312 or 340 are energized.

The motors 328 and 342 are operated in parallel, the branch of the circuit for the motor 342 including a lead 344 connected to the power lead 244, a normally closed cam switch 346 whose actuating arm rides upon the periphery of the cam 330, a lead 348 connected to the clock motor 328, and the lead 350 which is connected to the power lead 242 to complete the circuit. The branch of the parallel circuit for the motor 342 is provided by a lead 352 connected to the lead 344, the motor 342, and a return lead 354 connected to the lead 350 to complete the circuit to the power lead 242.

With this arrangement, actuation of the leading switch 26 causes the clock motor 328 to rotate the cam 330 in a clockwise direction for an interval of time which is terminated by actuation of the following switch 30 by the following automobile 12. More particularly, upon actuation and closure of the normally open following switch 30 by the following automobile 12, a circuit is completed which is constituted by a lead 356 connected to the now energized lead 288, a lead 358, the switch 30, a lead 360, a time delay relay 362 and a relay 364 connected in parallel, the leads 308, 256, and 258, and the power lead 242.

Energization of the relay 364 opens the normally closed switch 290 connected therewith, cutting off power to the time delay relay 280 and the relay 282. The de-energization of the relay 282 has the immediate effect of opening the switch 310 to cut off the power to the clutch 312.

Energization of the time delay relay 362 closes an associated normally open switch 366 to provide power through the circuit of the time delay relay 362 and the relay 364, independently of the following switch 30, so that after the short interval of closure of the following switch 30, power still exists in the circuit of the relays 362 and 364. Energization of time delay relay 362, which is set for approximately one-half second delay, also closes an associated, normally open switch 367 to establish a circuit through a relay 368, the switch 367, the switch 284 which is in a closed position by reason of the continuing action of the time delay relay 280, through the switch 306 whose closure was effected at the time that the leading switch 26 was actuated, through the relay 304, and back to the power source through the leads 308, 256, 258 and 242.

The energization of relay 368 effects closure of an associated, normally open switch 370 which energizes the clutch 340 through a circuit provided by the lead 314, the lead 316, a lead 372, the closed switch 370, the clutch 340, a lead 374, the lead 334, the lead 336, and the power lead 242. Energization of the electric clutch 340 effects a mechanical connection between the clock motor 342 and the cam 330 so that the cam 330 is then rotated in a counter-clockwise direction until the detent 332 engages the switch arm of the switch 298 to open the switch 298, as will be described, it being noted that in the absence of engagement of the cam 330 by either of the clutches 312 or 340, the cam 330 is biased back to its normal position illustrated in FIG. 11 by a spiral spring 375.

Simultaneously with the above, energization of the relay 304 closes the associated, normally open switch 338 to effect a completed circuit through the 90 cycle holding coil 162, which, as previously indicated, is effective to apply 90 cycle alternating current to the respacing propulsion units 16, as more particularly illustrated in FIG. 10.

Application of 90 cycle alternating current to the respacing propulsion units 16 is effective to speed up the following automobile 12 for a length of time determined by the duration of travel of the switch arm of the switch 298 before it falls into the detent 332 of the cam 330. The speed of rotation of the clock motor 342 is half that

of the clock motor 328, the motor 328 rotating at 28 r.p.m. while the clock motor 342 operates at a speed of 14 r.p.m., whereby the corrective action, be it speeding up or slowing down the following automobile 12, is carried on for a period of time twice that of the interval between actuation of the leading switch 26 by the leading automobile 12 and the actuation of the following switch 30 by the following automobile 12.

When the switch arm of the cam switch 298 drops into the detent 332, the circuit to the 90 cycle holding coil 162 is cut off, de-energizing the relay 368, and opening the switch 370 to open the circuit to the clutch 340. Power to the control means 22 is thus cut off, and means 22 is in effect inoperative until the following automobile 12 engages the interval switch 28 to ready the system for another corrective cycle of operation.

Operation of the control means 22 is essentially similar when the following switch 30 is actuated by the following automobile 12 prior to actuation of the leading switch 26 by the leading automobile 12, indicating that the following automobile 12 is too close to the leading automobile and must be slowed. A brief description of this operation follows.

Following automobile too far ahead

Assuming that the following switch 30 is actuated by the following vehicle or automobile 12 prior to actuation of the leading switch 26 by the leading automobile 12, the interval switch 28 is first opened by engagement with the leading automobile 12, establishing the previously described circuit through time delay relay 254 which results in closure of the switch 260 which is associated with the time delay relay 254.

Subsequent actuation of the following switch 30 by the following automobile 12 then establishes a circuit from the power lead 244, through the leads 250 and 263, the switch 264 of the selector switch 266, the closed switch 260 associated with the time delay relay 254, the normally closed switch 272, the following switch 30, the time delay relay 362 and the relay 364, and through the power lead 242 to the power source.

Energization of the relay 362 closes its associated, normally open switch 376 to establish a circuit to the clutch 312, which effects a mechanical interconnection between the clock motor 328 and the cam 330 to initiate clockwise rotation of the cam 330, as previously described. In addition, rotation of the cam 330 closes the cam switch 298, and energization of the relay 364 closes an associated, normally open switch 378 to establish a circuit through a relay 380, which relay 380 closes its associated switch 382 in parallel with the switch 378 so that the relay 380 remains energized subsequent to opening of the switch 378 when the following switch 30 closes. That is, the relay 380 "seals itself" into the power circuit.

Energization of the relay 380 also closes an associated, normally open switch 384 in the circuit of the 30 cycle holding coil 164, readying that circuit for operation.

Energization of the time delay relay 362 also closes its associated, normally open switch 366 so that power continues to flow through the relays 362 and 364, by-passing the following switch 30, subsequent to opening of the following switch 30 when the following automobile 12 disengages the following switch 30.

Next, the leading automobile 12 actuates the leading switch 26, and a circuit is established through time delay relay 280 and relay 282 which, as will be seen, cuts off power from the time delay relay 362 and the relay 364 and also establishes a circuit to energize the clutch 340. More particularly, the circuit through the time delay relay 280 and the relay 282 is afforded by the power lead 244, the lead 250, the lead 263, the switch 264 of the selector switch 266, the lead 268, the switch 260 which is now closed by reason of the continuing operation of the time delay relay 254, the normally closed switch 272, the lead 274, another switch 386 of the selector switch 266,

the lead 278, the closed leading switch 26, the relays 280 and 282, and the power lead 242.

Energization of the relay 282 opens its associated, normally closed switch 292, breaking the circuit through the relay 362 and 364.

Energization of the time delay relay 280 closes its associated switch 284, which establishes the circuit through the relay 368 which, when energized, closes its associated switch 390 in parallel with the switches 367 and 284, sealing the relay 368 into the powered circuit. In addition, energization of the relay 368 opens its associated, normally closed switch 320, cutting off power from the clutch 312 and stopping clockwise rotation of the cam 330. Simultaneously, the normally open switch 370 also associated with the relay 368 is closed, establishing a circuit from the power source to the clutch 340, and effecting a mechanical interconnection between the motor 342 and the cam 330 to rotate the cam 330 in a counter-clockwise direction.

When the circuit of the relay 368 is energized, the 30 cycle hold-in coil 164 is also energized by reason of its parallel connection with the relay 368, the switch 384 in the circuit of the hold-in coil 164 being at this time closed by reason of the continuing energization of the associated relay 380. In addition, the continuing energization of the relay 380 establishes a circuit providing power to the 90 cycle hold-in coil 164 subsequent to opening of the leading switch 26 after the automobile 12 passes therepast. More particularly, this circuit is provided by the power lead 244, the lead 250, the lead 263, the lead 296, the cam switch 298, the closed switch 382, the relay 380, the leads 256 and 258, and the power lead 242.

As previously described, the energization of the 30 cycle hold-in coil 164 is operative to apply 30 cycle alternating current to the respacing propulsion units 16 to slow the automobile 12 in the respacing zone 20. This slowing of the automobile is terminated when the cam 330 rotates counter-clockwise sufficiently to permit the switch arm of the cam switch 298 to drop into the detent 332, opening the power circuit to the 30 cycle hold-in coil 164.

Automobiles properly spaced

If the automobiles 12 are properly spaced apart, it will be apparent that the leading automobile 12 will actuate the leading switch 26 simultaneously with actuation of the following switch 30 by the following automobile 12. When this occurs, neither of the hold-in coil 162 or 164 is energized and consequently no speeding up or slowing down of the automobile 12 in the respacing zone 20 will occur. More particularly, it will be recalled that energization of either the coil 162 or the coil 164 required the preliminary establishment of a circuit through the parallel connected switches 270 or 272. However, when both the leading switch 26 and the following switch 30 are simultaneously actuated, the associated relays 280 and 362, respectively, are also simultaneously energized, and this simultaneous energization causes their associated, normally closed switches 270 and 272 to both open, cutting off any possible circuit through them. Consequently, no power is applied to either of the hold-in coils 162 or 164.

Alternate control means

According to the present invention, there is provided another means for establishing the proper spaced relationship between adjacent automobiles 12. In effect, this system replaces or eliminates the leading switch 26, and substitutes switch means 392 operated by a timer motor 394 so as to close momentarily every 9 seconds. Thus, if the following switch 30 is not actuated at exactly 9 second intervals by the passing automobiles 12, correction of the spacing of the automobile 12 in the respacing zone will occur. The alternate control means is primarily intended for use in properly spacing automobiles 12 which are not separated by wide gaps into groups of automobiles.

More particularly, assuming that the alternate control means or internal circuit is to be utilized, the selection switch 266 is manually thrown to its opposite position in which its associated switch arms disengage the switch contacts with which they are in engagement in FIG. 11, and engage the opposite switch contacts. The selection switch 266 is manually thrown when the leading automobile 12 initially actuates the following switch 30, at which time a switch arm 396 rests in a detent 398 of a cam 400. In this position the switch 402 associated with the switch arm 396 is located in its normally closed position, as illustrated in FIG. 11.

The cam 400 and another cam 404 are mechanically coupled to the motor 394 so as to rotate with the armature of the motor 394, and the motor 394 is adjusted to rotate once every 9 seconds.

The motor 394 is energized upon operation of the selection switch 266 by a circuit constituted by the power lead 244, a lead 405, a switch 408, a lead 410, through the motor 394, a lead 412, and the power lead 242. Since the motor 394 and its associated cams 400 and 404 rotate once every 9 seconds, and the required interval between the cars is a 9-second interval, there will be applied a corrective speed adjustment to the respacing propulsion units 16, as will be seen, in the event that the following switch 30 is not actuated by the following automobile 12 precisely when the switch arm 396 again drops into the detent 398 subsequent to a complete counter-clockwise revolution of the cam 400.

When the leading automobile 12 actuates the following switch 30, none of the critical relays in the various circuits are energized because the switch 260 is open. It will be recalled that in the other control system previously described the switch 260 was opened when the interval switch 28 was actuated by the leading automobile 12. Similarly, the leading automobile 12 can effect closure of the switch 260 by actuation of the interval switch 28, but the internal system now being described is operative without the utilization of any interval switch, the function of the interval switch 28 being taken over by the cam 404. That is, after the leading automobile 12 has passed the following switch 30, the cam 404 will rotate in a counter-clockwise direction through 210° in approximately 5 seconds, at which time a switch arm 414 of a switch 416 will drop into a detent 418 of the cam 404 to close a circuit through the time delay relay 254.

More particularly, this latter circuit is constituted by the power lead 214, the lead 263, the switch 264, a lead 420, the switch arm 416, a lead 422, a switch 424, a lead 426, the lead 252, the time delay relay 254, and the leads 256, 258, and 242. The control means circuit is now ready for operation, by reason of the closure of the switch 260 associated with the time delay relay 254, for speeding up or slowing down the following automobile 12, depending upon whether the switch arm 396 falls into its detent 398 before or after actuation of the following switch 30 by the following automobile 12.

Assuming that the switch arm 296 drops into its detent 398 prior to actuation of the following switch 30 by the following automobile 12, in which case the following automobile 12 must be speeded up, closure of the switch 402 completes a circuit through the time delay relay 280 and the relay 282.

More particularly, this circuit is established by the power lead 244, the lead 250, the lead 263, the lead 420, the switch 416, a lead 428, the lead 268, the now closed switch 260, one or the other of the parallel connected switches 270 and 272, the lead 274, the switch 386, a lead 430, the cam switch 402, a lead 432, the time delay relay 280 and the relay 282, and the power lead 242.

Energization of relay 282, as was true in the case of the first described control means embodiment, energizes the clutch 312 to commence clockwise rotation of the

cam 330. As will be seen, subsequent actuation of the following switch 30 by the following automobile 12 will effect energization of the 90 cycle holding coil 162 to speed up the following automobile 12, as previously described.

More particularly, when the following automobile 12 actuates the following switch 30, the time delay relay 362 and the relay 364 are energized by a circuit constituted by the power lead 244, the lead 263, the switch 264, the lead 420, the switch 416, the lead 428, the lead 268, the closed switch 260, the switch 270, the lead 288, the lead 356, the lead 358, the now closed following switch 30, the lead 360, the time delay relay 362 and the relay 364, the lead 308, the lead 256, the lead 256, the lead 258, and back to the power source through the power lead 242. As previously described, energization of the time delay relay 362 opens the normally closed switch 290 connected therewith, cutting off power to the time delay relay 280 and the relay 282. The de-energization of the relay 282 has the immediate effect of opening the switch 310 to cut off the power to the clutch 312.

In addition, as previously described, energization of relay 368 effects closure of the switch 370 to energize the clutch 340, rotating the cam 330 in a counter-clockwise direction until the detent 332 engages the switch arm of the switch 298 to open the switch 298. In addition, the 90 cycle holding coil 162 is energized to speed up the following automobile 12.

Similarly, should the following switch 30 be actuated prior to entry of the switch arm 396 into the detent 398, the time delay relay 362 and the relay 364 would be first energized, readying the circuit for a slowing down of the following automobile 12. That is, energization of the relay 362 effects clockwise rotation of the cam 330, and subsequent closing of the switch 402 energizes the time delay relay 280 and relay 282 which cuts off power from the time delay relay 362 and the relay 364, as previously described. In addition, the clutch 340 is energized to rotate the cam 330 in a counter-clockwise direction, and the 30 cycle holding coil 164 is energized to effect a slowing down of the following automobile 12.

Should the switch arm 396 fall into its detent 398 simultaneously with actuation of the following switch 30 by the following automobile 12, there will be no corrective action applied to the automobile 12 since both switches 270 and 272 will be opened, cutting off any possible circuit through them which would energize either of the holding coils 162 or 164.

In the utilization of the present system it will be apparent that the employment of 30 cycle and 90 cycle current to effect the corrective slowing and speeding up of the automobiles 12 is not critical, and if it is desired to further reduce the effect on the passengers of any corrective speed adjustment, the corrective current could be any other lower or higher cycle, such as 20 cycle and 80 cycle current, in which case the motor 342 would be made one-third the r.p.m. of the motor 330 rather than half.

When the present system is shut down, the automobiles 12 are braked so as to maintain their relative positions upon the track 14 by any suitable means, such as by a conventional Prony brake arrangement (not shown), the straps of the brakes being arranged for frictional engagement adjacent the tired drive wheels 44 of propulsion units 16. The braking system is preferably automatically actuated whenever the electrical power to the present means 10 is shut off. In addition, there is preferably employed in each automobile 12 a "hill holding" feature, as is well known in the art, to keep the automobile 12 from coasting backwardly on upgrades. Such a hill holding apparatus aids the braking effect of the air brakes associated with the automobiles 12.

FIG. 13 is a diagrammatic representation of a section of the track 14, and is exemplary of an arrangement by

which each of the automobiles 12 are speeded or slowed a predetermined amount, the particular showing being one in which the automobiles 12 are accelerated from a lower to a higher speed. More particularly, the section of track 14 illustrated includes a slow speed track zone 450, a high speed track zone 452, and an intermediate speed gradient zone 454. The track zones 450 and 452 each include a great plurality of propulsion units 16, such as for example 50 units 16 in each of the zones, it being noted that in FIG. 13 only the drive wheels 44 of the units 16 are illustrated for simplicity.

Assuming that the drive wheels 44 of the slow speed track zone 450 are adjusted to drive the automobiles 12 thereover at a speed of approximately 3 feet per second, and the drive wheels 44 of the high speed track zone 452 adjusted to drive the automobiles 12 at a rate of 6 feet per second, it is desired to accelerate the automobiles 12 across the speed gradient zone 454 in a smooth and gradual manner to minimize the sensation of speed increase for passengers in the automobiles 12.

Accordingly, the speed gradient zone 454 is provided with a plurality of the propulsion units 16, the drive wheels 44 thereof being illustrated in FIG. 13, with perhaps 20 of such units 16 being utilized between the slow and high speed zones 450 and 452. Each of the propulsion units 16 in the speed gradient zone 454 is driven so as to rotate their associated drive wheel 44 at different speeds, the speeds of the drive wheels 44 increasing from the slow speed track zone 450 to the high speed track zone 452 in increments of 5% of the speed difference between the zones 450 and 452.

Each of the electric drive motors 62 utilized in the propulsion units 16 in the present means 10 is preferably a four pole induction motor of the squirrel-cage type rotating at approximately 1750 r.p.m. The rotational speed of the drive wheels 44 is determined by the gear reduction unit 70 associated with the drive motor 62, as previously described, and the units 70 throughout the speed gradient zone 454 are operative, through appropriate gearing, to provide the desired 5% speed increase from one drive wheel to the next, as will be obvious to those skilled in the art. Other non-synchronous motors could be utilized, but the induction motors 62 are preferred because they are relatively inexpensive, which is important in the present application because of the comparatively large number of motors utilized.

As is well known, induction motors characteristically rotate at a relatively constant rate, but momentarily slow when they are loaded down, as by engagement of their associated drive wheel 44 by an automobile 12. Thus, it is an important feature of the present invention that the induction motors utilized for the propulsion units 16 are adapted to gradually accelerate or decelerate the automobile 12 in engagement with the drive wheels 44, not only by reason of the differential rates of rotation of the drive wheels 44 throughout the speed gradient zone 454, but also by reason of the inherent ability of each of the drive motors 62 to individually adjust its rate of rotation as the drive wheel 44 thereof engages the automobile 12.

The utilization of non-synchronous motors which have a capacity to speed up or slow down under load, that is adjust their r.p.m. to the load, provides important advantages over the types of prime movers found in prior art conveyor systems. More particularly, in previous conveyor systems great care was exercised to provide an effective slippage means or device between the conveyor prime mover and the articles being conveyed so that discrepancies between the relative speeds of the conveyor and the articles to be conveyed could be taken up or smoothed out by the slippage device. For example, fluid couplings are often used between the prime mover and the conveyor elements for this purpose. In contrast, the present utilization of non-synchronous motors completely obviates any necessity for employing slippage devices, since the motors themselves are both the prime movers

and the slippage devices. The motors are inherently capable of adjusting their speeds to compensate for discrepancies between the relative speeds of the wheels 44 and the automobiles 12 being conveyed. In addition, since the plurality of non-synchronous drive motors is each independently operative to rotate its associated drive wheel 44, the overall system has the further advantage of being operable even in the event that one of the motors should fail.

From the foregoing description it will be apparent that there has been provided an article handling means uniquely adapted for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles. In addition, there has been described a steering apparatus for association with a vehicle steered at its front end only, and a steering apparatus for steering all the wheels of a vehicle. Moreover, the propulsion units described have a desired gradual engagement and disengagement with the vehicles driven so as to minimize and substantially eliminate any shock or discomfort to the passengers in the vehicles.

Various modifications and changes may be made with regard to the foregoing detailed description without departing from the spirit of the invention or the scope of the following claims.

We claim:

1. Means for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles, said means comprising:

propulsion means for moving said articles through a respacing zone;

correction means responsive to a first electrical signal to speed said propulsion means and responsive to a second electrical signal to slow said propulsion means to thereby increase and decrease, respectively, the speed of movement of one of said articles in said respacing zone;

and control means in electrical circuit with said correction means, and including switch means actuable by said articles, said control means providing said first electrical signal when the distance between one of said articles in said respacing zone and an adjacent one of said articles is greater than a predetermined distance, said control means providing said second electrical signal when said distance is less than said predetermined distance.

2. Means for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles, said means comprising:

propulsion means for moving said articles through a respacing zone;

correction means responsive to a first electrical signal to speed said propulsion means and responsive to a second electrical signal to slow said propulsion means to thereby increase and decrease, respectively, the speed of movement of one of said articles in said respacing zone;

and control means in electrical circuit with said correction means, and including switch means located adjacent an extremity of said respacing zone and actuable by a leading article and a following article, said control means providing said first electrical signal when the time interval between actuation of said switch means by said leading article and said following article is longer than a predetermined time interval, said control means providing said second electrical signal when said time interval is shorter than said predetermined time interval.

3. Means for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles, said means comprising:

propulsion means for moving said articles through a respacing zone;

correction means operative to adjust the speed of said propulsion means to thereby adjust the speed of

movement of one of said articles in said respacing zone;

and control means in electrical circuit with said correction means, and including sensor means for detecting the spacing between said one of said articles and an adjacent article whereby said control means operates said correction means to increase the speed of said propulsion means when said spacing is greater than a predetermined spacing, and operates said correction means to decrease the speed of said propulsion means when said spacing is less than said predetermined spacing.

4. Means for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles, said means comprising:

propulsion means for moving said articles through a respacing zone;

first correction means operative to speed said propulsion means to thereby increase the speed of movement of one of said articles in said respacing zone;

second correction means operative to slow said propulsion means to thereby decrease the speed of movement of one of said articles in said respacing zone;

and control means in electrical circuit with said first and second correction means, and including switch means actuable by said articles whereby said control means operates said first correction means when the distance between one of said articles in said respacing zone and an adjacent one of said articles is greater than a predetermined distance, and operates said second correction means when said distance is less than said predetermined distance.

5. Means for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles, said means comprising:

alternating current motor means for moving said articles through a respacing zone;

correction means including current frequency varying means coupled to said motor means for adjusting the speed thereof to thereby adjust the speed of movement of one of said articles in said respacing zone;

and control means in electrical circuit with said correction means, and including means actuable by said articles for sensing the spacing between an adjacent pair of said articles, said control means actuating said correction means to increase the current frequency to said motor means when said spacing is greater than a predetermined spacing, said control means actuating said correction means to decrease the current frequency to said motor means when said spacing is less than said predetermined spacing.

6. Means for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles, said means comprising:

propulsion means for moving said articles through a respacing zone;

correction means responsive to a first electrical signal to speed said propulsion means and responsive to a second electrical signal to slow said propulsion means to thereby increase and decrease, respectively, the speed of movement of one of said articles in said respacing zone;

and control means in electrical circuit with said correction means, said control means including a first sensor located adjacent the entry extremity of said respacing zone and a second sensor located adjacent the exit extremity of said respacing zone, said control means providing said first electrical signal upon actuation of said first sensor by a following one of said articles subsequent to actuation of said second sensor by a leading one of said articles, said control means providing said second electrical signal upon actuation of said first sensor by said following article prior to actuation of said second sensor by said leading article.

7. Means for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles, said means comprising:

propulsion means for moving said articles through a respacing zone;

correction means responsive to a first electrical signal to speed said propulsion means and responsive to a second electrical signal to slow said propulsion means to thereby increase and decrease, respectively, the speed of movement of one of said articles in said respacing zone;

and control means in electrical circuit with said correction means, said control means including a sensor located adjacent the entry extremity of said respacing zone and timer switch means operative upon expiration of a predetermined time interval to electrically couple said control means and said correction means.

8. Means for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles, said means comprising:

propulsion means for moving said articles through a respacing zone;

correction means coupled to said propulsion means, and including a first electrical circuit energizable to operate said correction means to slow said propulsion means, and including a second electrical circuit energizable to operate said correction means to speed said propulsion means;

and control means electrically connected to said first and second circuits and including first relay means, a first sensor actuable to effect operation of said first relay means and located adjacent one extremity of said respacing zone, second relay means, a second sensor actuable to effect operation of said second relay means and located adjacent the opposite extremity of said respacing zone, switching means for energizing said first electrical circuit when said first relay means is operated before said second relay means, and for energizing said second electrical circuit when said second relay means is operated before said first relay means, and timing means coupled to said first and second circuits and said first and second sensors to maintain energization of the energized one of said first and second circuits for a period corresponding to the interval between actuation of said first and second sensors by a moving article.

9. Means for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles, said means comprising:

propulsion means for moving said articles through a respacing zone;

correction means coupled to said propulsion means, and including a first electrical circuit energizable to operate said correction means to slow said propulsion means, and including a second electrical circuit energizable to operate said correction means to speed said propulsion means;

and control means electrically connected to said first and second circuits and including first relay means, a first sensor actuable to effect operation of said first relay means and located adjacent the entry extremity of said respacing zone, second relay means, a second sensor actuable to effect operation of said second relay means and located adjacent the exit extremity of said respacing zone, switching means for energizing said first electrical circuit when said first relay means is operated before said second relay means, and for energizing said second electrical circuit when said second relay means is operated before said first relay means, an interval sensor between said first and second sensors and associated with said switching means to prevent energization of said first and second circuits when said interval sensor is not actuated for a predetermined time interval, and timing means coupled to said first and second circuits and said first and second sensors to maintain energization of the

23

energized one of said first and second circuits for a period corresponding to the interval between actuation of said first and second sensors by a moving article.

10. Means for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles, said means comprising:

propulsion means for moving said articles through a respacing zone;

correction means coupled to said propulsion means, and including a first electrical circuit energizable to operate said correction means to slow said propulsion means, and including a second electrical circuit energizable to operate said correction means to speed said propulsion means;

and control means electrically connected to said first and second circuits and including first relay means, a first sensor actuable to effect operation of said first relay means and located adjacent one extremity of said respacing zone, second relay means, a second sensor actuable to effect operation of said second relay means and located adjacent the opposite extremity of said respacing zone, a timing cam, first means operative to effect movement of said timing cam away from its normal position, second means operative to effect movement of said timing cam toward its normal position, and switching means for operating said first means when one of said first and second relay means is operated, and for rendering said first means inoperative and permitting operation of said second means when the other of said relay means is subsequently actuated, said switching means being operative to energize one of said first and second circuits upon operation of said second means, said switching means including a cam switch to de-energize said one of said first and second circuits when said timing cam is in said normal position.

11. Means for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles, said means comprising:

propulsion means for moving said articles through a respacing zone;

correction means coupled to said propulsion means, and including a first electrical circuit energizable to operate said correction means to slow said propulsion means, and including a second electrical circuit energizable to operate said correction means to speed said propulsion means;

and control means electrically connected to said first and second circuits and including first relay means, a sensor actuable to effect operation of said first relay means and located adjacent the entry extremity of said respacing zone, second relay means, a timer switch operable at predetermined, regular time intervals to effect automatic actuation of said second relay means, switching means for energizing said first electrical circuit when said first relay means is operated before said second relay means, and for energizing said second electrical circuit when said second relay means is operated before said first relay means, and timing means coupled to said first and second circuits, to said sensor, and to said timer switch to maintain energization of the energized one of said first and second circuits for a period corresponding to the interval between actuation of said sensor and operation of said timer switch.

12. Means for establishing a predetermined spaced relationship between individual articles of a plurality of moving articles, said means comprising:

propulsion means for moving said articles through a respacing zone;

correction means coupled to said propulsion means, and including a first electrical circuit energizable to operate said correction means to slow said propul-

24

sion means, and including a second electrical circuit energizable to operate said correction means to speed said propulsion means;

and control means electrically connected to said first and second circuits and including first relay means, a sensor actuable to effect operation of said first relay means and located adjacent the entry extremity of said respacing zone, second relay means, a timer switch operable at predetermined, regular time intervals to effect automatic actuation of said second relay means, a timing cam, first means operative to effect movement of said timing cam away from its normal position, second means operative to effect movement of said timing cam toward its normal position, and switching means for operating said first means when one of said first and second relay means is operated, and for rendering said first means inoperative and permitting operation of said second means when the other of said relay means is subsequently actuated, said switching means being operative to energize one of said first and second circuits upon operation of said second means, said switching means including a cam switch to de-energize said one of said first and second circuits when said timing cam is in said normal position.

13. In an article handling system, the combination of: an elongated track having a respacing zone;

a plurality of propulsion units spaced along said track and each including a drive wheel extending above said track;

a plurality of articles, each including an elongated platen on its underside for engagement with said drive wheels to drive said article along said track, and further including steering means engaged by said track for guiding said article along said track;

and respacing means in said respacing zone adapted to sense the interval between adjacent ones of said articles and speed up or slow down the following one of said adjacent articles when said interval is different from a predetermined interval.

14. In an article handling system, the combination of: an elongated track having a respacing zone;

a plurality of propulsion units spaced along said track and each including a drive wheel extending above said track;

a plurality of articles, each including an elongated platen on its underside for engagement with said drive wheels to drive said article along said track, and further including steering means engaged by said track for guiding said article along said track;

and respacing means in said respacing zone, said respacing means including propulsion means for moving said articles through said respacing zone, correction means responsive to a first electrical signal to speed said propulsion means and responsive to a second electrical signal to slow said propulsion means to thereby increase and decrease, respectively, the speed of movement of the following one of adjacent ones of said articles in said respacing zone, and control means in electrical circuit with said correction means, and including switch means actuable by said articles, said control means providing said first electrical signal when the distance between said adjacent articles is greater than a predetermined distance, said control means providing said second electrical signal when said distance is less than said predetermined distance.

15. In article handling means for altering the rate of travel of articles along a track, the combination of:

a first track zone including drive means adapted to engage articles for moving said articles at a first speed;

a second track zone including drive means adapted to engage said articles for moving said articles at a second rate of speed;

25

and a speed gradient track zone located intermediate said first and second track zones and including a plurality of drive wheels for moving said articles, said gradient track zone including electric motors for rotating said drive wheels at different speeds along the length of said speed gradient zone for gradually altering the rate of travel of said articles from said first track zone to said second track zone.

16. In article handling means for altering the rate of travel of articles along a track, the combination of:
- 10 a first track zone including drive means adapted to engage articles for moving said articles at a first speed;
 - 15 a second track zone including drive means adapted to engage said articles for moving said articles at a second rate of speed;
 - 20 and a speed gradient track zone located intermediate said first and second track zones and including a plurality of drive wheels for moving said articles, said gradient track zone including separate electric induction motors for said drive wheels and separate speed reduction means coupled between each said drive wheel and each said induction motor, said speed reduction means for said drive wheels being

26

operative to rotate said drive wheels at different speeds along the length of said gradient track zone for gradually altering the rate of travel of said articles from said first track zone to said second track zone.

References Cited by the Examiner

UNITED STATES PATENTS

430,587	6/1890	Merrill	104—129
867,765	10/1907	Strickler	104—246
1,463,137	7/1923	Makepeace	105—129
1,814,969	7/1931	Schmeck	104—248
2,499,060	2/1950	Goldberg	104—94
2,661,070	12/1953	Ferrill	104—151
2,743,678	5/1956	Hibbard	104—151
2,954,744	10/1960	Bonner	104—168
3,039,402	6/1962	Richardson	104—168
3,087,440	4/1963	Zarnstorff	104—152

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