United States Patent

Harwick et al.

[15] **3,650,216**

[45] **Mar. 21, 1972**

[54] **RAILWAY CAR SPEED CONTROL TRANSPORTATION SYSTEM**

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[73] Assignee: **Rex Chainbelt Inc.,** Milwaukee, Wis.

[22] Filed: **Aug. 11, 1969**

[21] Appl. No.: **849,083**

[52] **U.S. Cl.**..............................**104/166,** 104/88, 104/130, 104/147 R, 104/152, 104/167, 104/168, 105/26 R, 105/30, 198/110, 246/182 R

[51] **Int. Cl.**..................**B61b 13/12,** B61c 11/00, B61c 13/00

[58] **Field of Search**..................104/147, 149, 152, 165, 166, 104/167, 168, 88, 130, 147 R; 105/26, 29, 26 R, 30; 246/18 Z, 18 R; 198/110

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Assistant Examiner—Howard Beltran
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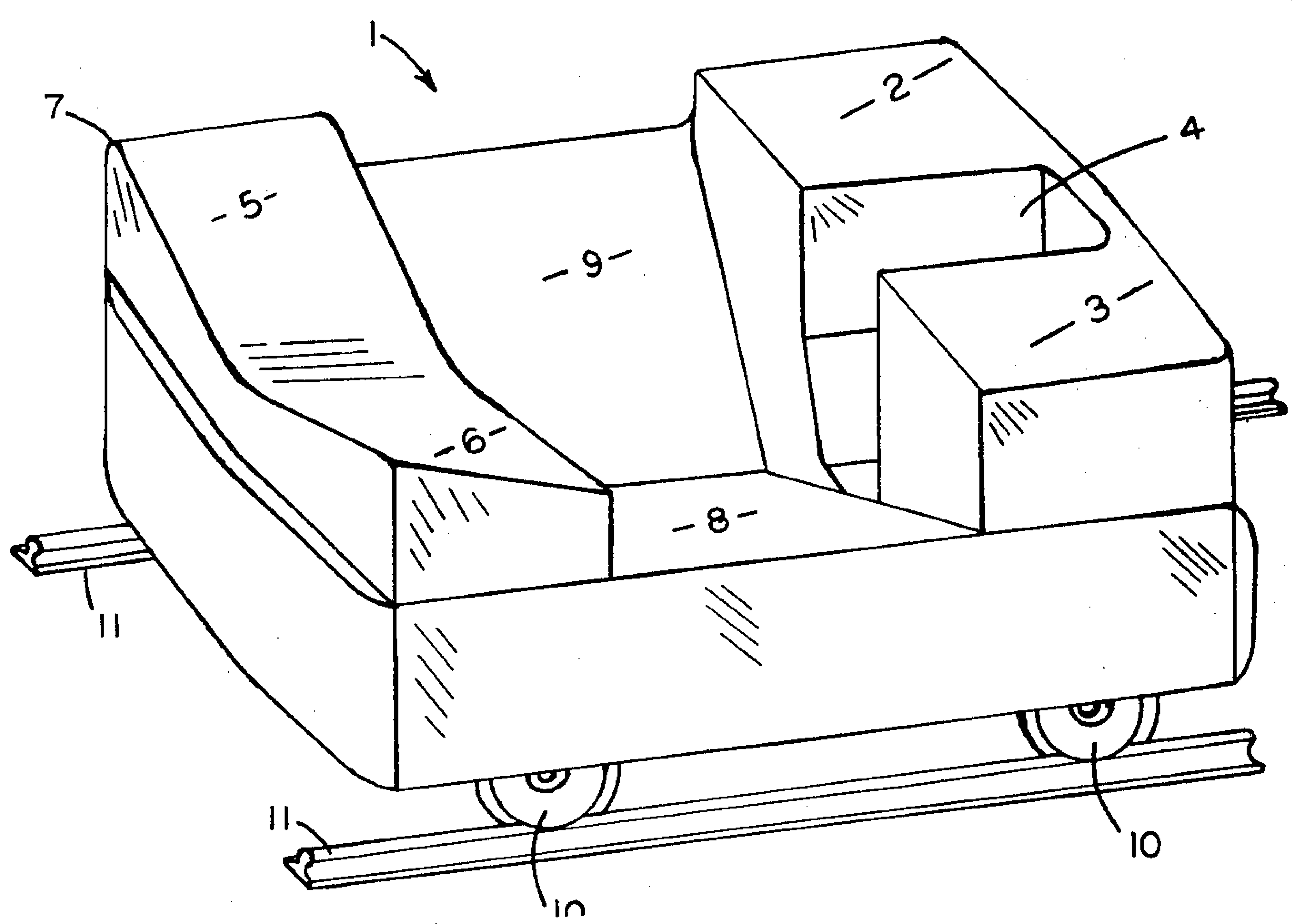
[57] **ABSTRACT**

Individual cars of an operator-less railway transportation system are driven along a pathway by cooperation of a motor driven drive tube in each car that cooperates with angularly positioned reaction wheels spaced along the pathway. Controls are included for varying, in response to external signals, the angular position of selected reaction wheel assemblies to bring a car smoothly to a stop at a predetermined point, to bring a car past a particular point at a predetermined speed at a predetermined time, to insert a car from a side path into a gap in traffic on a main path, or to selectively delay cars to create gaps in the traffic to accept cars from a branch path.

12 Claims, 17 Drawing Figures



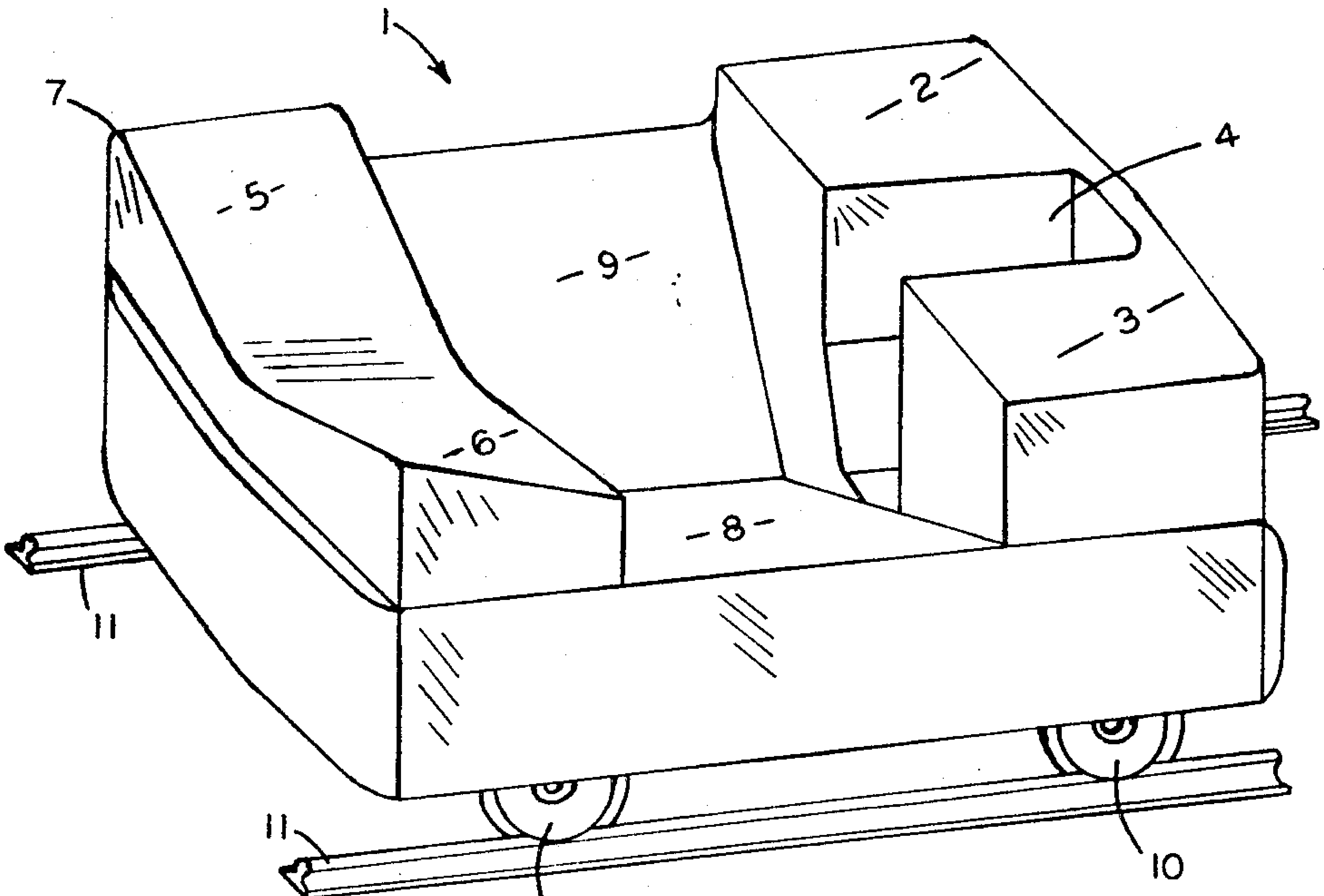


FIG. 1

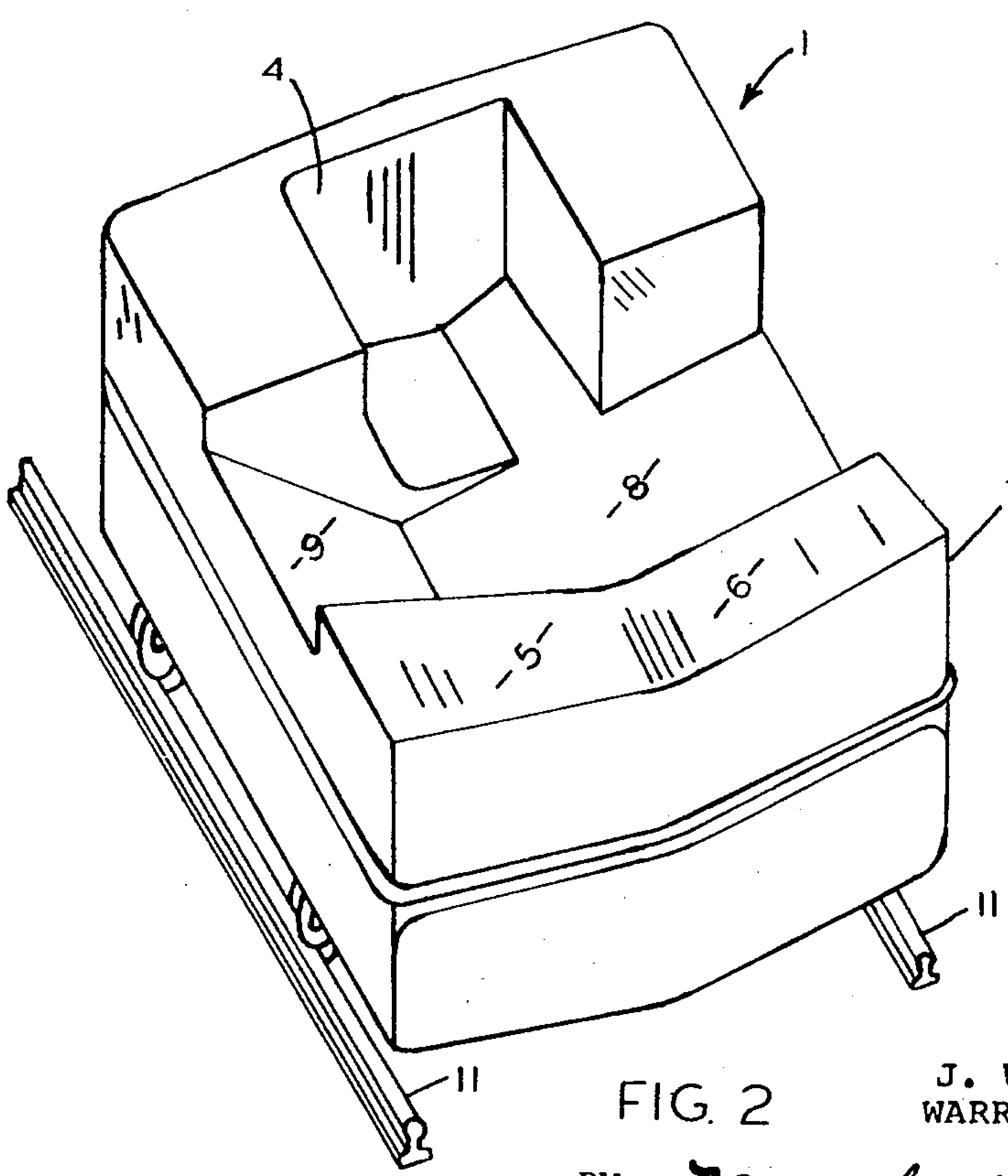


FIG. 2

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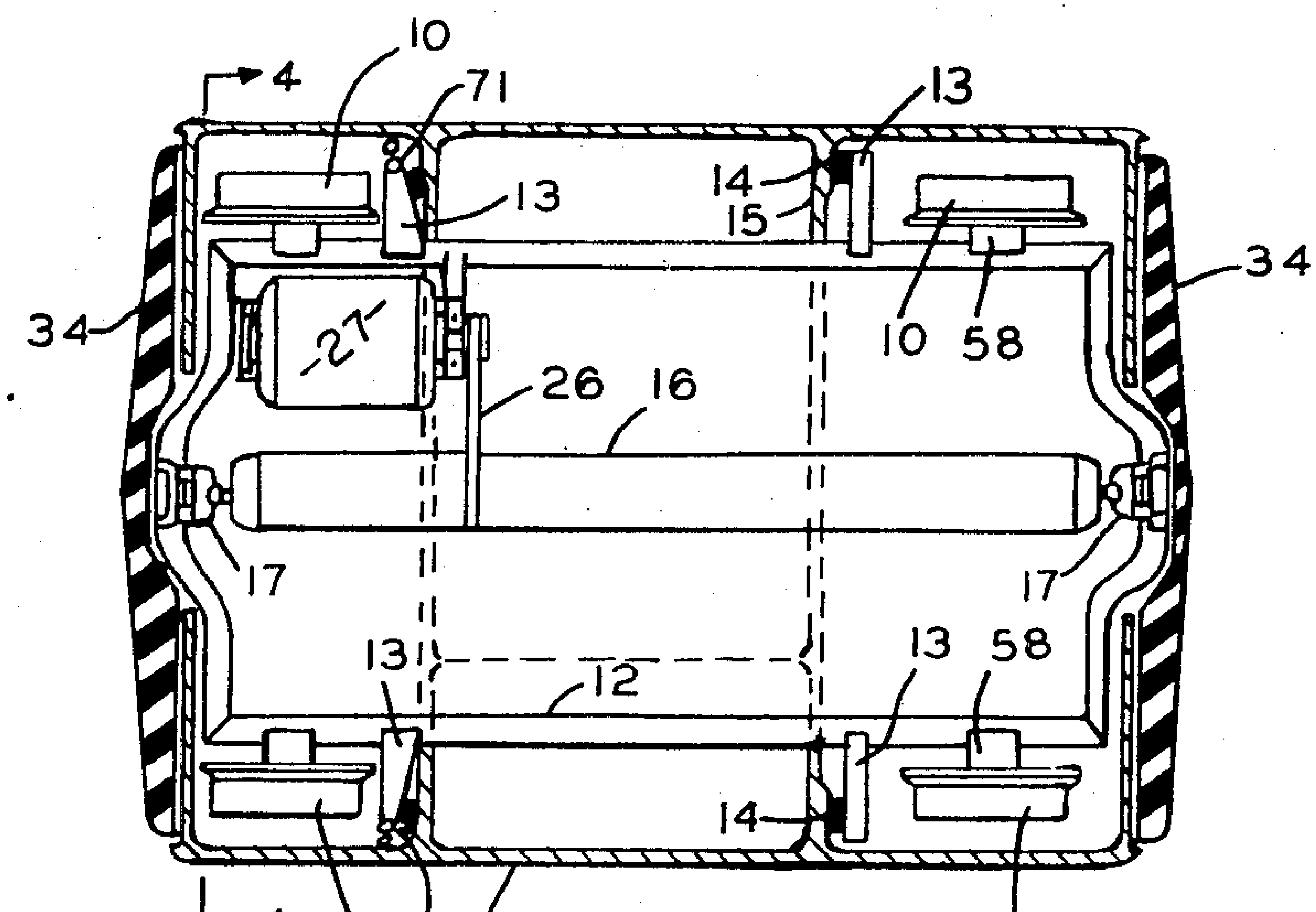

FIG. 3

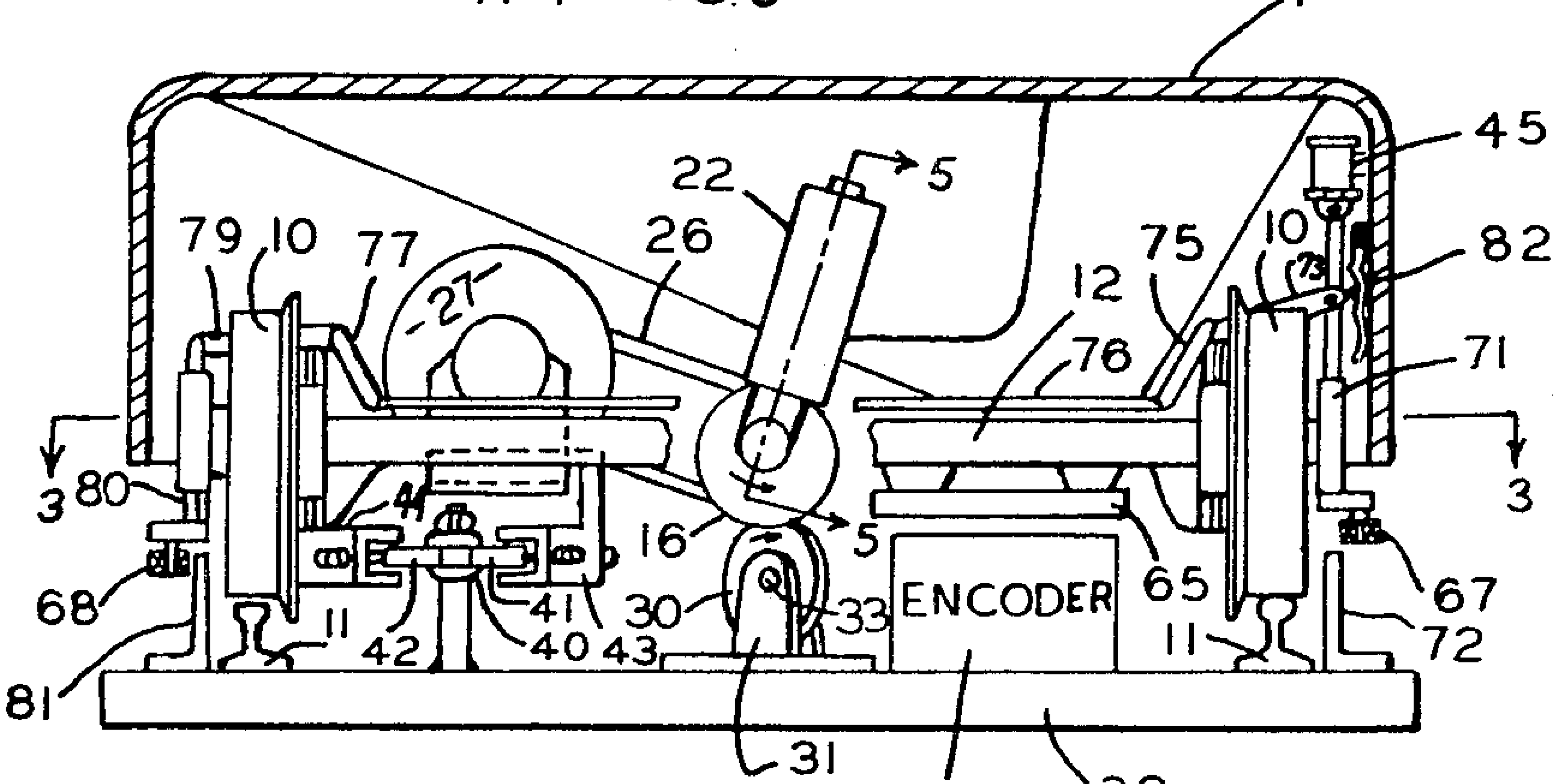

FIG. 4

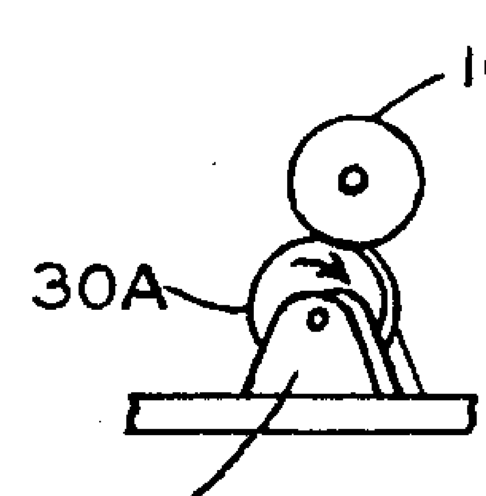

FIG. 4A

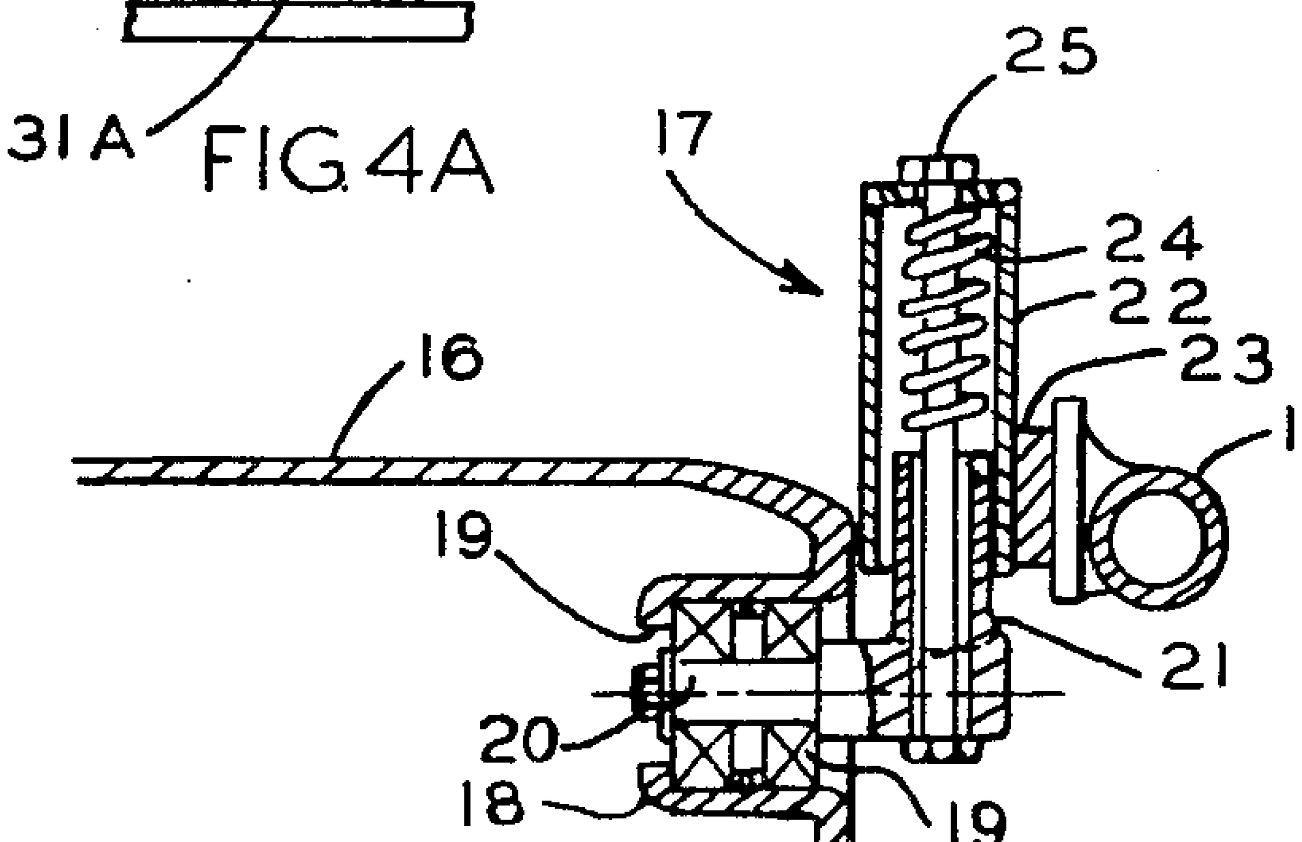

FIG. 5

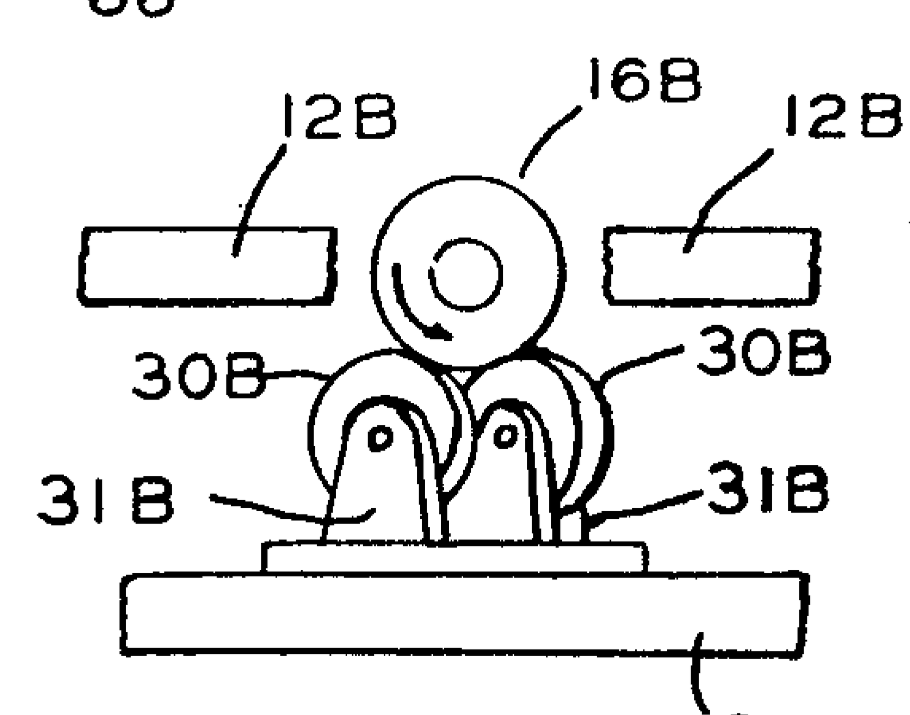

FIG. 6

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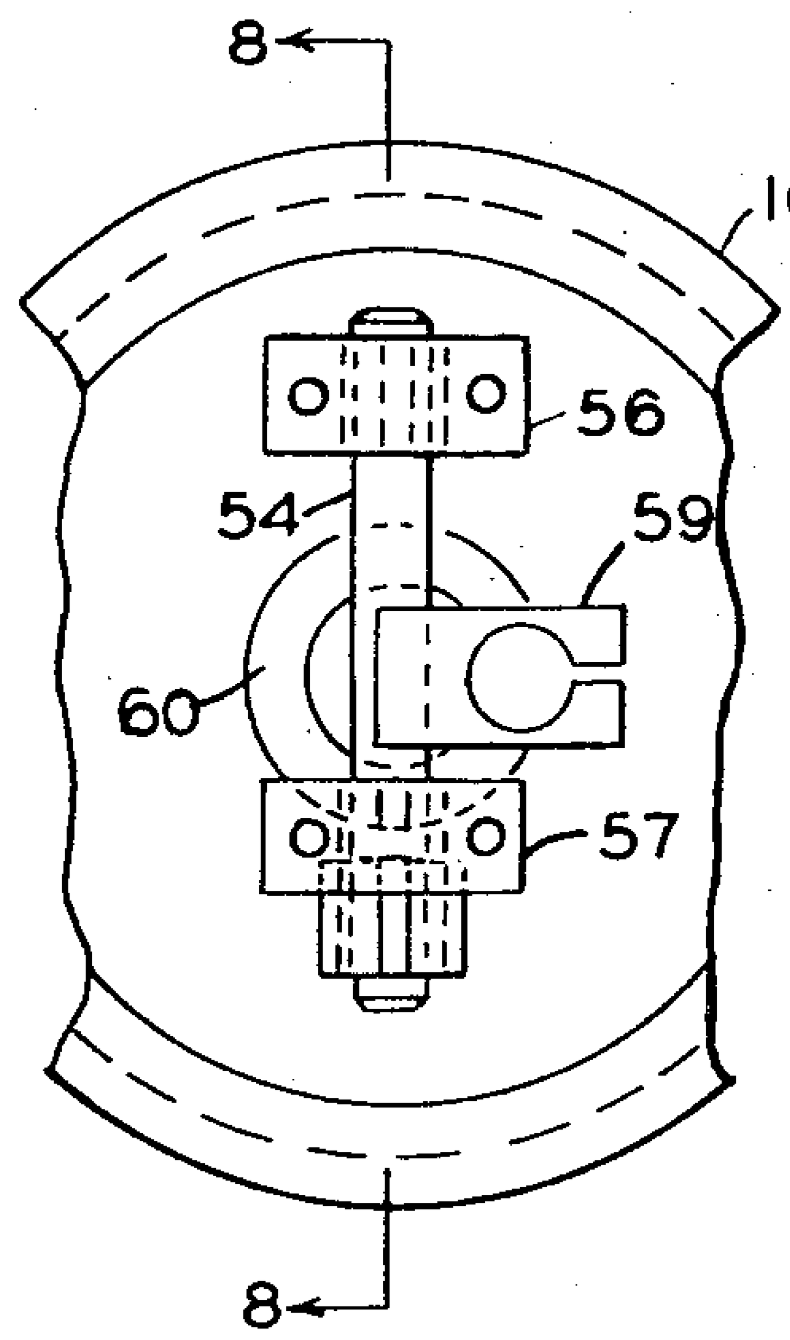

FIG. 7

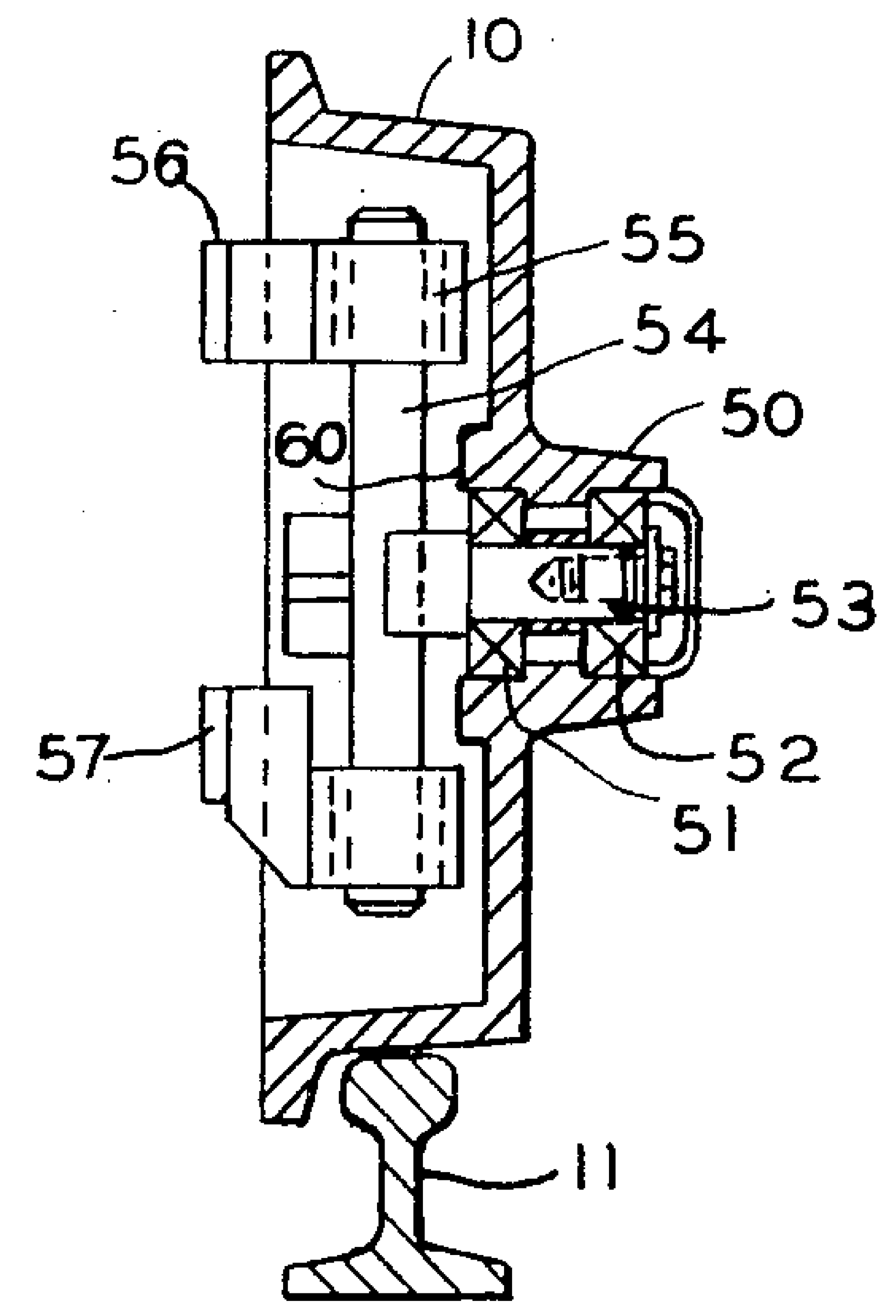

FIG. 8

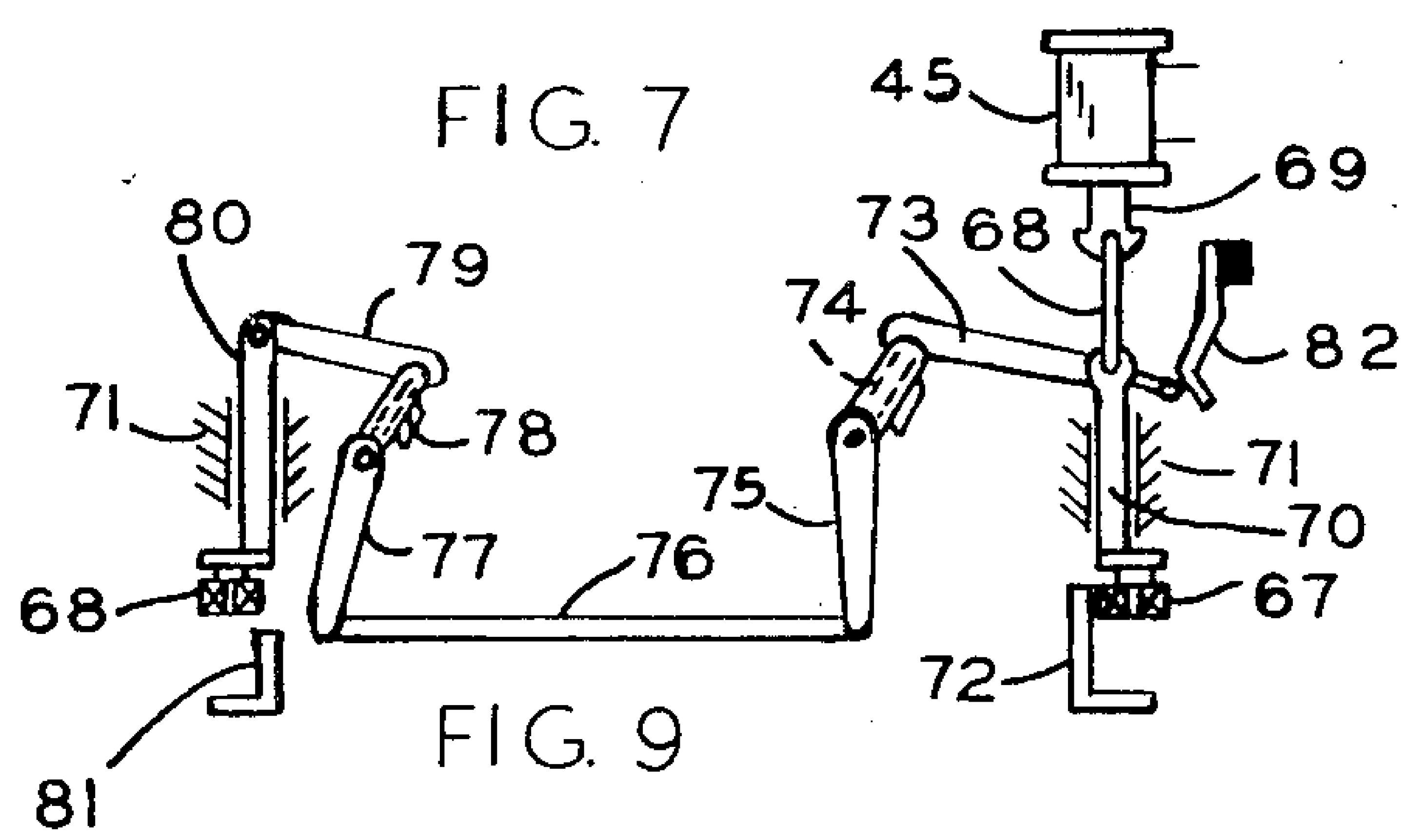

FIG. 9

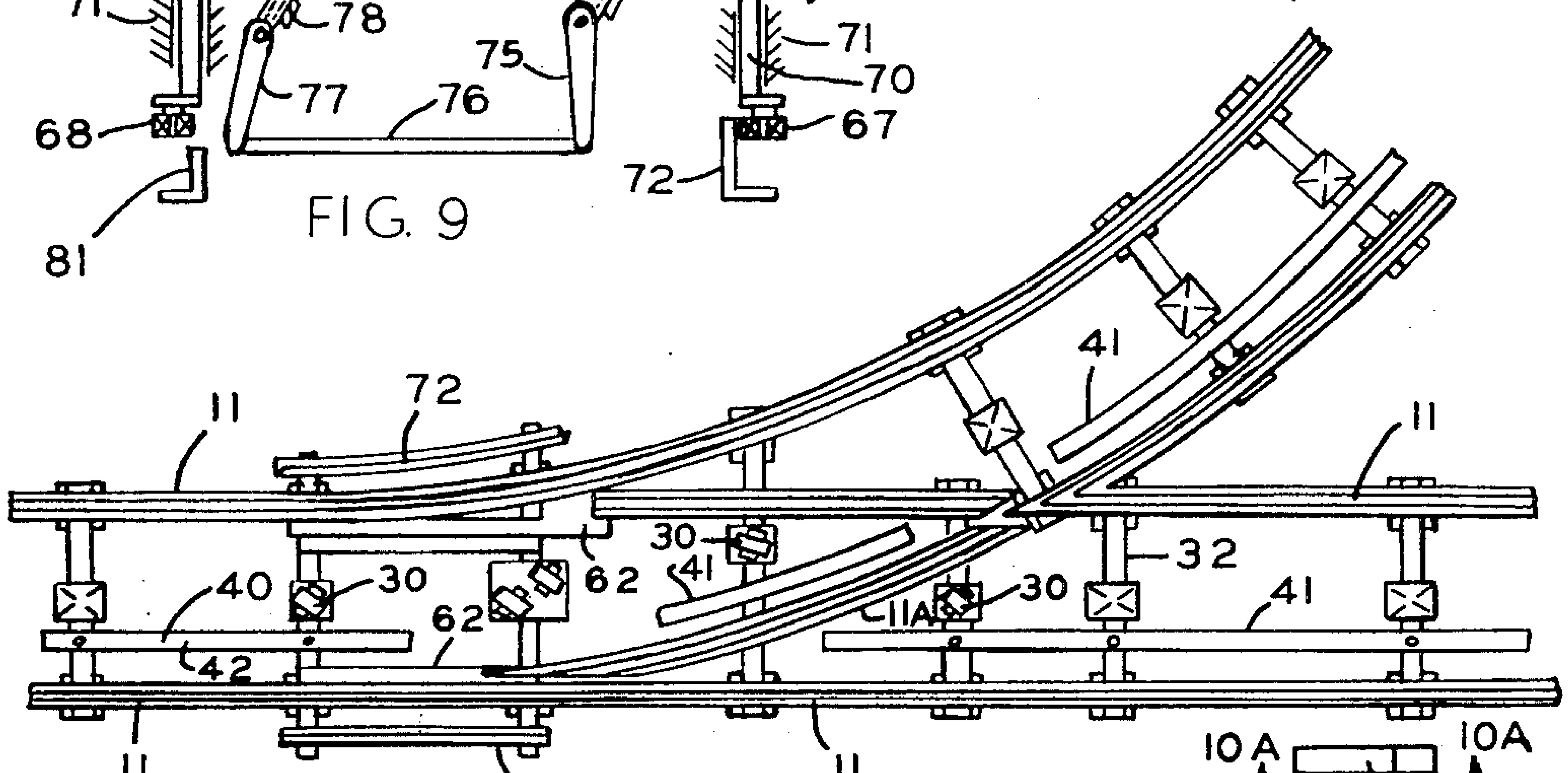

FIG.10

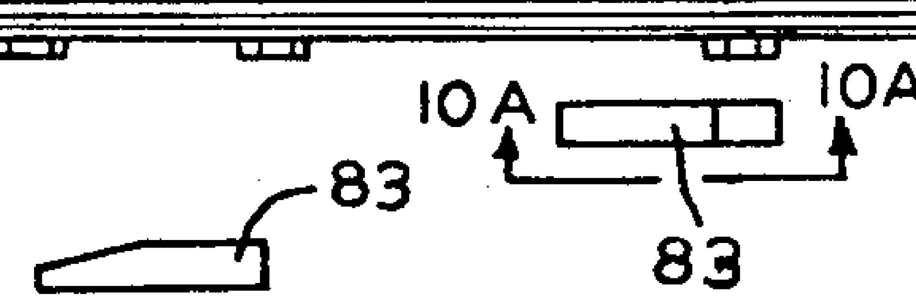

FIG. 10A

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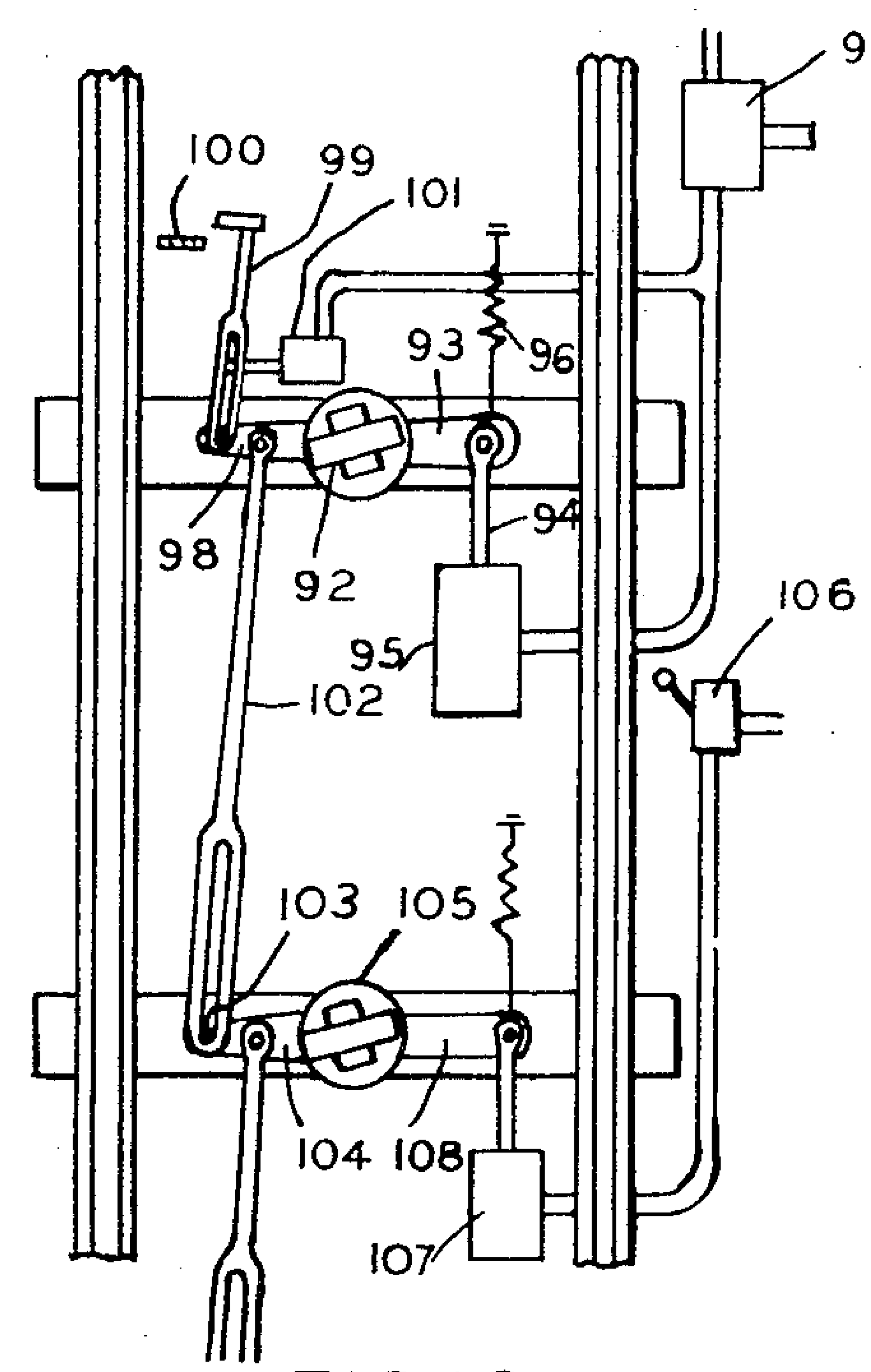

FIG. 12

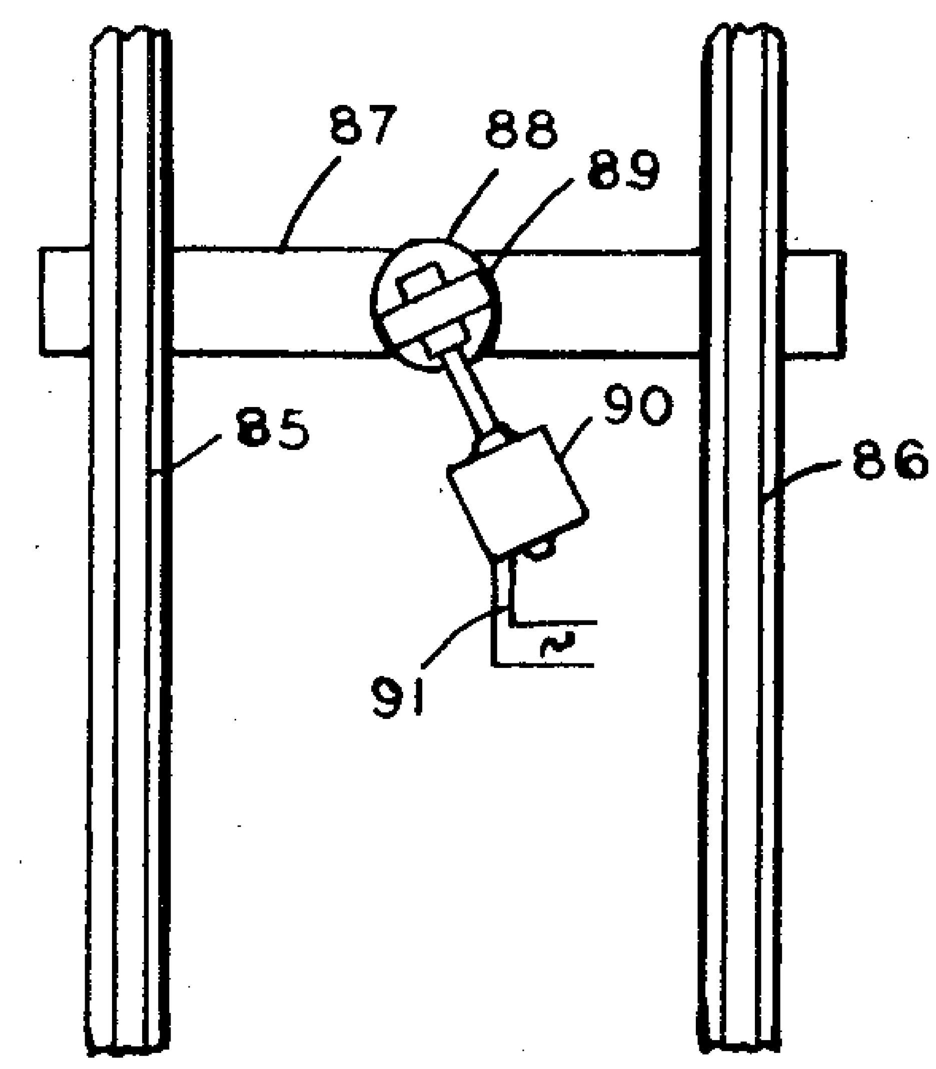

FIG. 11

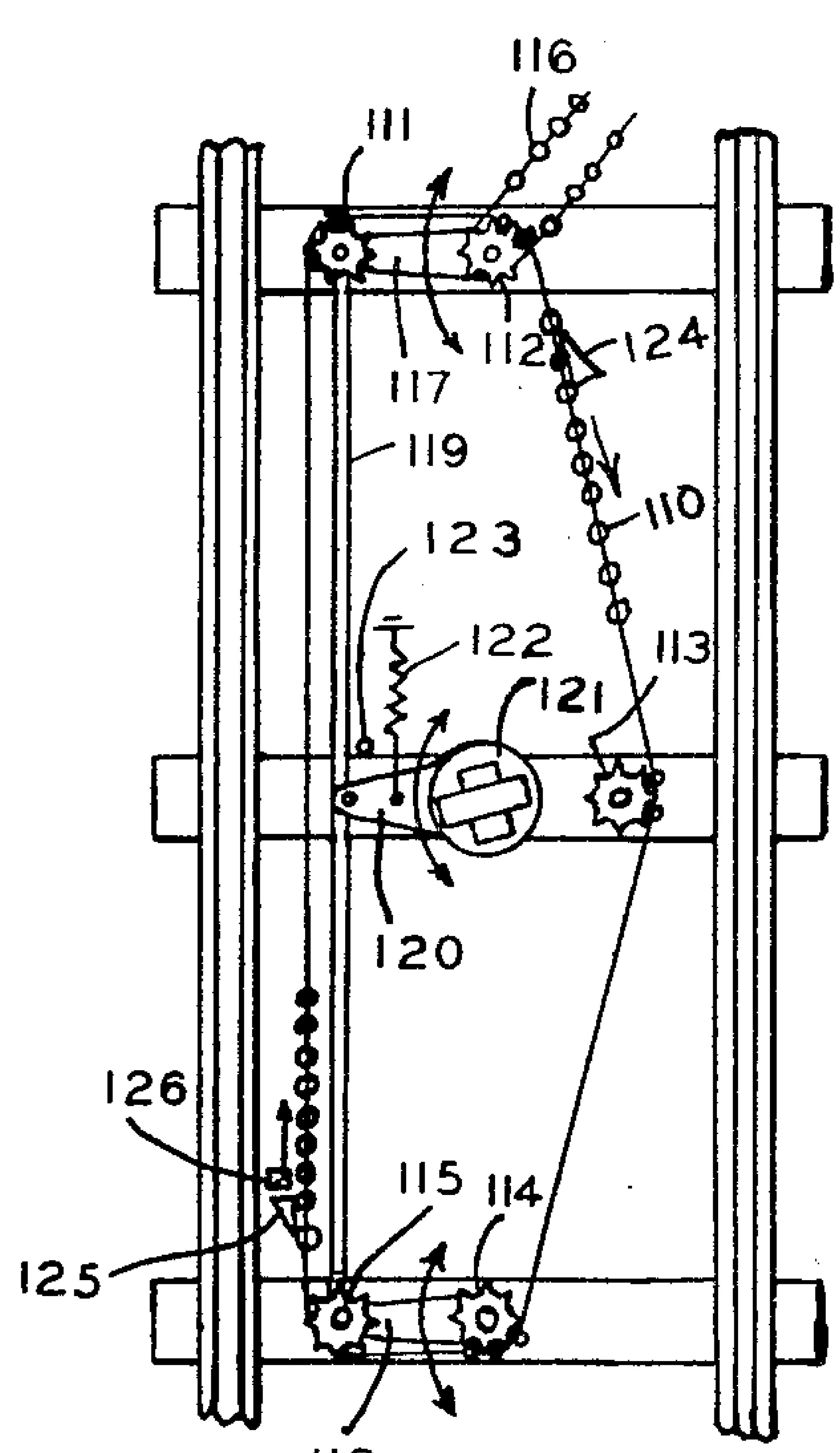

FIG. 13

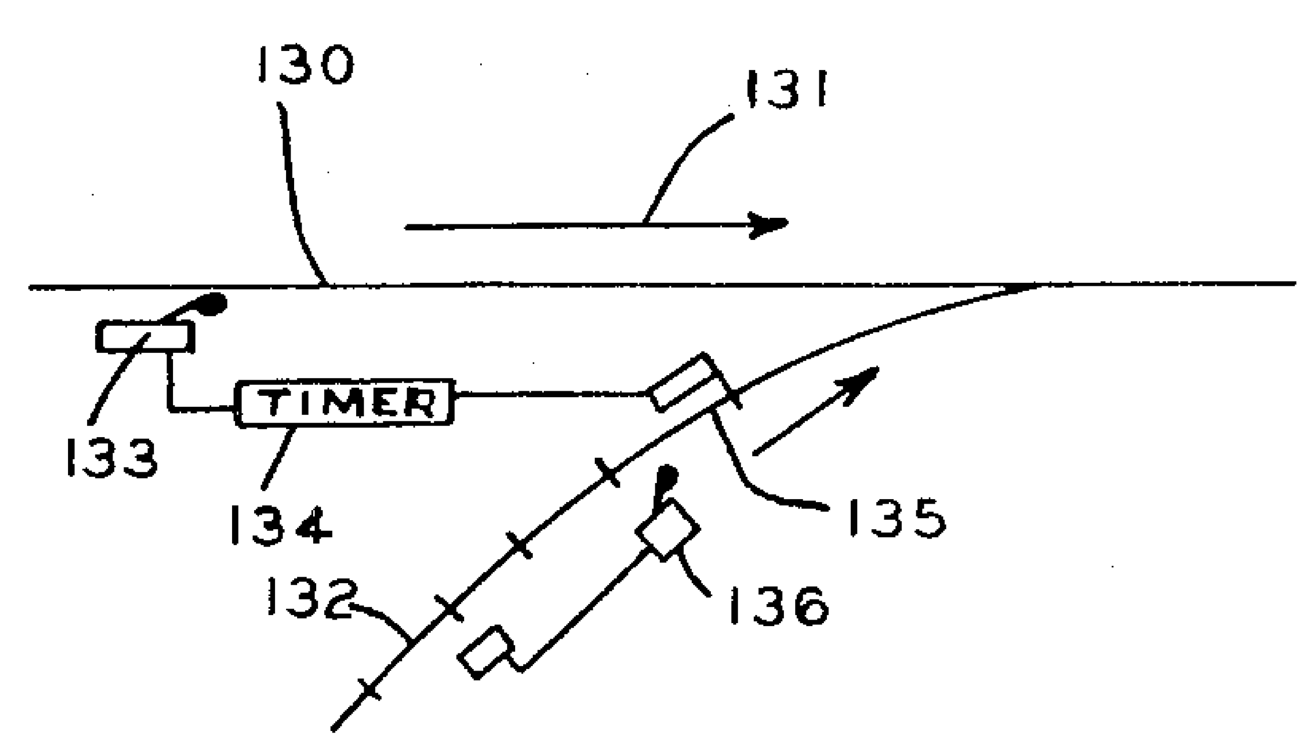

FIG. 14

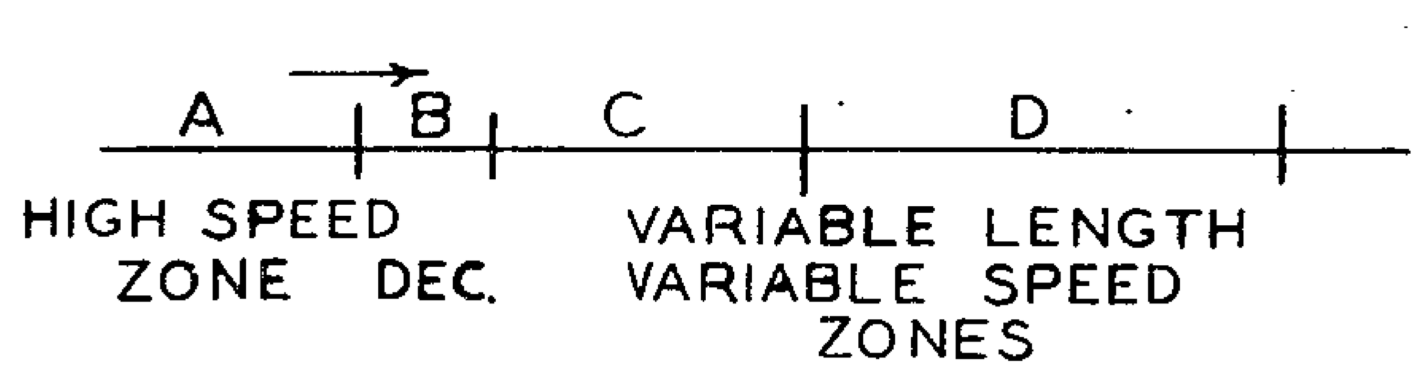

FIG. 15

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RAILWAY CAR SPEED CONTROL TRANSPORTATION SYSTEM

SUMMARY OF THE INVENTION

To meet the demands of some transportation systems it is necessary to use a large number of small cars or carriers rather than a few large carriers or trucks. For example, in handling passenger luggage in an airport it is desirable to be able to directly and promptly transport each piece of luggage to its destination without waiting for a larger load or using a carrier that must stop at each of a number of stations along its route. Small individually driven and directed cars offer the greatest flexibility in transporting such luggage between selected stations of the systems.

One of the requirements in such a system is the accurate control of the car speed over various portions of its travel and accurate, shock free positioning of the car for various operations such as loading, unloading, elevating or synchronizing the car movement with that of other cars when moving from a branch track or pathway onto a heavily traveled main line, track or pathway. To coordinate the movements of a number of cars it is desirable that all of the control including car speed be trackside.

These requirements are met in a drive tube and reaction wheel propulsion system by controlling the angular position of each of the reaction wheels which are spaced along the track and which cooperate with a constant speed rotating drive tube, mounted on and extending lengthwise along the under side of the car. Preferably the drive tube is driven by an electric motor energized through a brush contacting a third rail. In those portions of the system where all of the cars travel at a fixed speed the reaction wheels are journaled in fixed supports. On those portions where a car or a number of cars must be started and stopped or the speed varied, as at a loading or unloading station, or on an approach to a main line where the car must await a break in the main line traffic flow, the reaction wheels are journaled on pivoted supports that can be moved to any position between a no drive position (reaction wheel axis parallel to the drive tube axis) and a full speed drive position.

This arrangement, while it depends on friction between the drive tube and reaction wheel, acts like a positive infinitely variable drive to accelerate the car if it tends to run slower or to decelerate or brake the car if it tends to run faster than the selected speed.

The previously proposed systems using a series of drive tubes journaled in the trackway or overhead to cooperate with reaction wheels journaled in the vehicles such as shown in U.S. Pat. Nos. 402,933 and 402,934 to W. L. Judson or in U.S. Pat. No. 3,164,104 to W. A. Hunt do not afford the simplicity and reliability of control from trackside that is obtained by locating the drive tube in the car and the reaction wheels in the trackway.

In the previous arrangements failure of a drive motor incapacitates the corresponding section of track thus blocking all the cars. Whereas in the new system failure of a car carried drive motor incapacitates that particular car which may easily be removed from the system without affecting any other car.

Only those parts of the new system actually in use are running. In contrast, in the previous systems all of the drive tubes along a track must be running regardless of the number of cars actually in operation.

A luggage carrier system embodying the invention is illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a perspective view of a car as viewed from the right rear.

FIG. 2 is a perspective view of a car as viewed from the left rear.

FIG. 3 is a plan view of the frame of the car as seen from the line 3—3 of FIG. 4 to show the drive system in the car.

FIG. 4 is a transverse elevation of the frame of the car and track as seen from the line 4—4 of FIG. 3.

FIG. 4*a* is a fragmentary view showing an alternative alignment of a reaction wheel with respect to the drive tube.

FIG. 5 is a sectional view of one end of the drive tube and its support taken along the line 5—5 of FIG. 4.

FIG. 6 is a fragmentary view of an optional arrangement of a drive tube cooperating with a pair of reaction wheels to provide guidance for the car.

FIG. 7 is an elevation of one of the running wheels of the car showing its pivotal mounting.

FIG. 8 is a vertical section of the running wheel and its mounting taken along the line 8—8 of FIG. 7.

FIG. 9 is a diagrammatic view of car switch cam follower mechanism carried in the car.

FIG. 10 is a plan view of a section of track including a switch and cam that cooperates with the switching cam follower mechanism shown in FIG. 9.

FIG. 10*a* is a side view of an elevating cam positioned along the track resetting the cam follower on the car as seen from the line 10A—10A of FIG. 10.

FIG. 11 is a fragmentary plan view of a section of track and a power driven reaction wheel.

FIG. 12 is a plan view of a section of track showing pivotally mounted reaction wheels including means for positioning a car.

FIG. 13 is a plan view of a section of track including means for controlling the advance of a car according to a prescribed speed and timing.

FIG. 14 is a diagrammatic view of a merging switch illustrating one use for the car speed and positioning control shown in FIG. 12.

FIG. 15 is a diagrammatic view of a section of track in which speed control is used to collect the cars into groups.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As an example, the novel propulsion system is shown as used to drive individual cars of a luggage transporting system such as may be used in an airport. An individual car is shown in FIGS. 1 and 2. As shown, the car comprises a body 1 that is uniquely shaped to receive the ordinary types of luggage commonly encountered. In order to accommodate duffel bags and golf club bags and similar elongated cylindrical pieces of luggage the forward end of the car, the right end as seen in FIG. 1, is formed with a pair of upstanding hollow boxlike portions 2 and 3 closed at the top and sides and cooperating to form therebetween a recess 4 adapted to receive one end of a duffel bag or similar article. The other end of the duffel bag is carried in a cradle or valley formed by sloping top portions 5 and 6 of a boxlike section 7 extending transversely across the rear of the car. Ordinary suitcases and similar articles are carried in the middle of the car, such articles resting on an inclined surface 8 extending downwardly from the left side of the car at an angle of approximately 20° to 25°. A steeply inclined surface 9 extending downwardly from the left-hand side of the car meets this surface 8 at substantially a right angle to thus form a generally V-bottomed receptacle for suitcases. The rear end wall of the boxlike portions 2 and 3 toward the front of the car and the front vertical wall of the rear boxlike section 7 form vertical fore and aft boundaries for the suitcase receiving portion of the car.

In use, luggage may be loaded from either side of the car. If loaded from the right-hand side the luggage is placed on the gently sloping inclined surface 8 and allowed to slide down until it comes to rest against the steep surface 9. Duffel bags and similar articles are loaded by placing one end in the recess 4 and the other end in the cradle formed by the inclined surfaces 5 and 6. If luggage is to be loaded from the left side of the car, it is lifted over the high side of the surface 9 so that the end of the suitcase rests against the surface 9 and it is then lowered until it comes to rest on the surface 8.

Luggage is automatically discharged from the car at appropriate positions by tilting at least the body of the car to the right about a longitudinal axis through an angle of approximately 65 to 70 degrees so that the luggage slides off the inclined surface 8 onto a receiving conveyor. Duffel bags and golf club bags are oriented during the discharge operation since the rear end of such bags slides off the surface 6 before the other end can pull free from the recess 4. Thus such elongated articles are discharged lengthwise onto the receiving surface.

Preferably the car is carried on flanged wheels 10 adapted to run on rails 11.

The chassis of the car is shown in FIGS. 3 and 4. Referring to FIG. 3 the chassis itself includes a generally rectangular frame 12 which may be built of tubing or rolled sections. The wheels 10 are individually mounted from the frame 12. To support the body 1 the frame 12 has outriggers 13 provided with shear blocks 14 that are connected to ribs 15 of the car body. The shear blocks 14 serve to isolate the body of the car from the vibrations generated by contact between the wheels 10 and rails 11.

The frame also carries a longitudinally extending rotatable drive tube 16 that is resiliently supported from the frame 12 by resilient mounting means 17 attached to the end sections of the frame 12. As may be seen more clearly in FIG. 5 the drive tube 16 is tapered at each end, the end further being formed with a reentrant portion 18 adapted to receive the outer races of a pair of ball bearings 19. The inner races of the ball bearings 19 are carried on a stub shaft 20 projecting horizontally from the lower end of a cylindrical member 21 that extends upwardly in telescoping relation with a tube 22. The tube 22 is mounted with shear blocks 23 to the end member of the frame 12. A compression spring 24 compressed between the closed upper end of the tube 22 and the upper end of the cylindrical member 21 urges the member 21 and consequently the drive tube 16 downwardly to a limit imposed by a bolt 25 extending from the upper end of the tube 22 downwardly through the cylindrical member 21. The drive tube 16 is driven through a belt 26 from a drive motor 27 mounted in the frame 12 of the car. While not shown in detail the belt 26 may be an ordinary V belt or a toothed timing belt. The corresponding groove in the drive tube 16 is of such a depth that the exterior of the belt is substantially flush with or slightly recessed below the external surface of the drive tube 16.

FIG. 4 shows the general arrangement of the parts of the chassis and drive particularly as to their vertical relationship. It may be noted that the tube mounting 17 for the drive tube 16 is inclined from a vertical line so as to be generally normal to the line of centers of the drive tube 16 and the motor 27. This inclination is selected so that the belt can remain substantially constant as the cylindrical member 21 slides up and down the tube 22 to accommodate variations in height of various reaction wheels, such as the wheel 30, spaced along the track. Each of the wheels 30 is journaled in a small stand 31 erected from a crosstie 32 carrying the rails 11.

While not shown in detail, each of the reaction wheels is preferably a small rubber tired wheel carried on radial thrust bearings from a stationary axle 33 mounted in the stand 31. The allowable travel of the cylindrical member 21 in the sleeve 22 is such that as the rotating drive tube 16 approaches one of the reaction wheels 30 the tapered forward end engages and rotates the reaction wheel as it climbs onto the wheel compressing the spring 24 in what ever amount is required.

The springs 24, one at each end of the drive tube, push the tube down onto the reaction wheels with sufficient force so that the frictional contact between the wheel and the drive tube provides sufficient force to drive the car.

The speed at which a car passes one of the reaction wheels is determined by the speed of rotation of the drive tube 16, which is normally held fixed since it is driven by the constant speed motor 27, and the angle between the axis of the drive tube and the axis of rotation of the reaction wheel, as measured in a horizontal plane, i.e., the angle between the horizontal projections of the two axes. This angle may vary from zero, the condition when the axes are parallel, which provides for zero speed to an angle of about 45° to 50° in which case the speed of the car along the tracks is equal to or greater than the peripheral speed of the drive tube 16.

In FIG. 4 the center of the reaction wheel 30 is shown as being vertically beneath the center of the drive tube 16. In many instances, particularly when the reaction wheels are oriented for high speed travel, it is desirable to offset the reaction wheels toward the descending side of the drive tube. This orientation is shown in FIG. 4*a*, in which a counterclockwise rotating drive tube 16A cooperates with a reaction wheel 30A so positioned that a vertical line through the reaction wheel passes between the descending side of the drive tube and its axis of rotation. In this orientation the line of force between the tube and wheel is inclined so that the horizontal component of the force urging tube against to the wheel offsets the tangential force between the tube and wheel as the tube drives the wheel. Preferably the stand 31A is set on a wedge or tipped so that a line normal to the axis of the drive tube and the axis of rotation of the reaction wheel passes through the center of the reaction wheel.

While it is preferable to use flanged wheels 10 riding rails 11 there may be occasions when it is desirable for the car to operate on a flat surface without the guiding effect of the rails. In such a case, a dual reaction wheel assembly may be used as illustrated in FIG. 6. As shown, a second reaction wheel is provided to cooperate with a first reaction wheel the two wheels being offset from each other laterally of the direction of motion of the car as shown by the position of wheels 30B in FIG. 6. The wheels thus form a shallow V in which a drive tube 16B rests. By using stiff springs in the reaction tube mounting, such as the springs 24 in FIG. 5, it is possible to carry most of the weight of the car on the drive tube and thereby secure enough lateral stability so that the car follows the line of dual reaction wheels.

It may also be noted in the dual arrangement as well as the offset arrangement of FIG. 4A, that if the car encounters any resistance to its forward motion and the reaction wheels are oriented for a forward drive there is a reaction force action on the drive tube tending to move it to the left as shown in FIGS. 4, 4a and 6. This reaction force is opposed by force between the flange of the wheel 10 and the rails 11 and the horizontal component of force produced by the offset reaction wheel 30A or the left-hand reaction wheel 30B of FIG. 6.

This arrangement of the drive tube carried in the car and cooperating with reaction wheels positioned along the trackway is particularly advantageous for operatorless cars in that the speed may be easily and accurately controlled by means in each section of track and the same speed control is applied to each car passing that section of track.

Also as seen in FIG. 3 each end of the car is provided with a substantial rubber cushion or bumper 34 to absorb the shock as two cars may come into contact with each other in normal operation along the track.

Power for the motor 27, which preferably is a single phase electric motor to reduce the number of energized third rails, is supplied from a third rail assembly 40 supported from the ties 32 of the trackway. The third rail assembly 40 preferably includes a first section 41 that extends along a trackway to supply the power and a second section 42 that is used just ahead of each of the switch points. These third rails 41 and 42 are preferably of a more or less standard construction in which a U-shaped conductor, in cross section, is partially enclosed in a U-shaped plastic or nonmetallic cover serving as a shield or insulator to protect the energized conductor from accidental contact. A brush assembly 43 depending from the frame 12 of the car has an insulating U-shaped portion which fits generally over the outer insulating portion of the third rail 41 and includes a tongue or brush that is forced into contact with the energized third rail. Two of these brush assemblies 43 are provided, one at each end of the car and located generally in line with the wheels 10, to span the breaks or gaps in the third rail

41 required at track switches to provide clearance for the wheels **10** as they follow the switch track. Likewise locating the brushes generally in the transverse line with the wheels **10** maintains a relative constant spacing of the brushes and the third rail regardless of whether the car is operating on a straight track or on a sharp curve.

A second brush assembly **44** cooperating with a second third rail **42** provides electrical connection to a solenoid **45** mounted, by means not shown, in the upper left-hand corner of the car as seen at the right in FIG. **4**.

In order that the car may negotiate sharp curves on the track it is desirable that each of the wheels be mounted flexibly with respect to the car frame **12** so that it may pivot about a vertical axis. A suitable construction is shown in FIGS. **7** and **8**. As shown, each of the wheels **10** is provided with a hub section **50** fitted with ball bearings **51, 52** the inner races of which are mounted on a spindle **53**. The spindle **53** is welded or otherwise fastened to a king pin **54** the upper and lower ends of which are fitted with resilient bushings **55** pressed or formed in brackets **56** and **57** bolted to a mounting pad **58** as indicated in FIG. **3**. A brush holder **59** is also mounted on the king pin **54** to hold a brush assembly, the brush of which rides on a polished surface **60** of the wheel hub **50** to provide a return circuit for the motor **27** through the wheel **10** and the rail **11**.

Since the wheels **10** must follow the track **11** and be able to withstand considerable lateral force on the car, as when rapidly negotiating a sharp curve, without pivoting in response to that force, it is desirable that the axis of the king pin be precisely vertical, i.e., normal to the track. This is in contrast to ordinary construction in which the king pin in inclined slightly so that the axis of the pin intersects the road surface ahead of the center of pressure of the wheel whereby a caster effect is obtained.

To minimize the possibility of disruption of service in the system due to track switch malfunctions, a switching system using no moving parts in the track is employed. In this arrangement, at each switch, as shown in FIG. **10**, the approach rails, as in common railroad practice diverge, one rail following the straight line or through track the other following the siding. The remaining rails are arranged according to the usual practice except for the omission of the moving portions of the ordinary switch. This track arrangement is shown in FIG. **10**.

A car approaching from the left is, if it is to pass straight through, forced to its right by external means to be described, so that the flanges of its right-hand wheels pass through the gap between the bottom rail **11** and the corresponding switch rail **11A**. If the car is to follow the siding or branch line it is forced to the left as it approaches and enters the switching area so that its right-hand wheels follow the switch rail **11A**. Plates **62** are provided in the switching areas to support the flanges of the wheels **10** as the wheels cross the gaps in the track.

The switching of the car at each switch point is controlled automatically. When the car is loaded with luggage, address information is encoded in a magnet plate **65** mounted in the lower front left-hand side of the car as shown at the right in FIG. **4**. This magnetic address plate **65** incorporates a number of rods of high retentivity magnetic material that is magnetized in a particular pattern corresponding to the address to which the luggage on the car is to be delivered. This magnetizing is preferably done by a group of electromagnets mounted in the trackway at the loading station as is indicated by the rectangle **66** marked "ENCODER" in FIG. **4**. Just ahead of each switch point a reader is mounted in the trackway in a position corresponding to the encoder **66**. The reader comprises a plurality of reed switches, not shown, which through a decoding circuit closes a switch to energize the third rail **42** and solenoid **45** if the car is to follow the siding rather than the main track.

The cars, as shown, are normally conditioned to follow the left-hand branch at each switch. In the event that a car is to follow the right-hand branch the reed switches in the reading circuit close the circuits to energize the solenoid **45**. When it is energized it operates a linkage shown in FIG. **9** (see also FIG. **4**) to raise a cam roller **67** on a left-hand side of the car to the right as shown in FIG. **4** viewing the front end of the car) and lower a cam roller **68** at the right front corner of the car. As clearly shown in FIG. **9** the linkage from the solenoid **45** includes a tension link **68** connected between a plunger **69** of the solenoid **45** and a guide rod **70** vertically slidable in a tubular guide **71** on the frame **12** of the car. The cam follower roller **67** is mounted on the lower end of the guide rod **70** in position to cooperate with a left turn cam **72** mounted along the left-hand side of the trackway as indicated in FIG. **10**.

When the solenoid **45** is energized it not only raises the guide rod **70** but also acting through a linkage including a first arm **73**, pivot rod **74**, second arm **75**, drag link **76**, third arm **77**, pivot rod **78**, and fourth arm **79** lowers a second guide rod **80** which carries the cam roller **68** on its lower end. When the guide rod **80** is thus lowered the cam roller **68** is in position to engage a right turn cam **81** which in FIG. **10**, is the condition for the straight ahead travel of the car. A spring detent **82** cooperates with the end of the arm **73** to hold the linkage at one end or the other of its travel. Thus momentary energization of a solenoid is sufficient to switch the mechanism to the position shown in FIG. **4** for a right turn or travel to the right side of the switch.

After passing the switch the lowered cam roller **68** engages an elevating cam **83** which forces the cam roller **68** upwardly and acting through the linkage lowers the cam roller **67** and its guide rod **70** to their lower position past the detent **82**, so the car switching mechanism is returned to its normal position in which the car follows the left-hand branch of a switch.

While cams **72** and **81** are shown to cooperate with the cam followers **67** and **68**, the followers may be positioned to cooperate with the adjacent rails, provided the followers can be located closely adjacent the wheels and the curves in the track are not too sharp. Otherwise it is difficult to locate the cam follower so that it will work on both a curved rail and a straight rail.

The propulsion system in which the rotating drive tube is carried in the car and cooperates with reaction wheels located along the track allows additional power to be supplied directly to the reaction wheels. Such power is needed for climbing steep grades and at points where the car must be rapidly accelerated. One method of applying additional power is illustrated in FIG. **11**. As shown, a section of track including rails **85** and **86** are mounted on a cross tie **87** which supports a reaction wheel assembly **88** having a reaction wheel **89** that is driven by an electric motor **90** supplied with power through leads **91**. Although a direct drive is illustrated, a flexible shaft, universal joints or a belt drive may be included in the drive so that the motor **90** may be located below the plane of the rails **85,86** and the reaction wheel **89**.

As was mentioned in connection with FIGS. **4** and **5**, the speed and direction of the car past a particular reaction wheel is determined by the angle between the axis of rotation of the reaction wheel and the rotating drive tube in the car. If the speed of the car past a particular portion of track is to be the same for all cars at all times the brackets or stands carrying the reaction wheels may be fixed to the crossties at an angle selected according to the desired speed. However, in any complex transportation system it is necessary that the cars be stopped at certain stations such as loading or unloading stations or in storage areas, that the speed of the cars be selected according to the areas through which they are passing, and that the car be accelerated or decelerated as necessary to provide safe merging or switching of a car from a side track onto a main line when there is substantial traffic on the main line. Stopping of the car, reversing and speed changing is effected by pivoting the reaction wheel stands about vertical axes to positions corresponding to the desired speeds and directions of travel. This pivoting of the reaction wheels may be entirely in response to an external signal or it may be in response to the combination of an external signal and a feedback signal corresponding to the position of the car. Several such systems are schematically illustrated in FIGS. 12 and 13.

Referring particularly to FIG. 12 a pivoted reaction wheel assembly 92 is provided with a first arm 93 that is connected through a link 94 to an air cylinder or similar linear motor device 95. The arm 93 is normally pulled to the high speed position by a spring 96 and is drawn to its low speed position by the linear motor 95 in response to an external signal applied through a control device 97. The control device 97 may be responsive to signals in the nature of railroad block signals in the event large spacing is required between cars, or it may be any type of a stop signal for a loading or unloading station or, in fact, any signal that requires a reduced speed of operation of the car.

The reaction wheel assembly 92 has a second arm 98 which, in the event a car must be stopped precisely at a given point, is provided with a hook 99 adapted when extended to engage a depending lug or other member 100 on the car. The hook 99 is pivoted at the end of the arm 98 and is moved to the left or right by an air cylinder or similar linear motor 101. In this particular arrangement, when a car is to be stopped at the station controlled by the reaction wheel assembly 92 the linear motor or air cylinder 95 pivots the reaction wheel assembly 92 to a low speed position so that the car approaching the station is decelerated rapidly and advances at a slow or creeping pace. This continues until the depending member 100 engages the hook 99 at which time the forward creeping motion of the car pulls the arm 98 to rotate the reaction wheel assembly 92 into exact parallelism with track resulting in zero speed.

Should the inertia of the car cause it to overrun the desired stopping position the arm 98 and reaction wheel assembly 92 is pulled past the zero speed position and the car then moves backward until the reaction wheel assumes the precise zero speed position.

It is desirable, particularly if the cars can approach the station at a high speed to provide a decelerating zone ahead of the station. This is provided by link 102 having one end pivotally connected to an intermediate point of the arm 98 and that has, at its other end, a lost motion connection to a pin 103 on an arm 104 of the next reaction wheel assembly 105. When the reaction wheel assembly 92 is pivoted to its approximately zero speed position the next reaction wheel assembly 105 is moved to a low speed position to provide the decelerating zone ahead of the station.

It may be desirable to include more than one additional reaction wheel assembly in the decelerating zone in which case another link similar to the link 102 is used between the reaction wheel assembly 105 and the next reaction wheel assembly along the track. This may be continued as far as necessary to provide any length of deceleration zone. Since each reaction wheel assembly is rotated a fraction of the amount that the previous one is rotated the car velocity as it travels through such a zone is reduced in increments which may be approximately equal. Since the link 102 need transmit tension forces only a length of wire rope or chain may be substituted. Similarly a smooth rod which is allowed to slide through a pin corresponding to the pin 103 may provide the lost motion connection.

It is quite possible in many loading and unloading situations that a series of cars accumulate at the approach to a station. This is commonly called queuing. In this situation it is desirable as soon as a car is stopped at the reaction wheel assembly 92 that the next succeeding assembly wheel 105 then be pivoted or rotated to its zero position. This is accomplished by a limit switch device or car detector 106 adapted to contact the car and initiate operation of a linear motor 107 that is connected to an arm 108 of the next reaction wheel assembly 105. This pivots the reaction wheel assembly 105 to its zero speed position so that a second car approaching the station will be stopped before it runs into the first car. The lost motion provided by the slot in the link 102 allows the second reaction wheel assembly 105 to go to its zero speed position without interfering with the preceding reaction wheel assembly 92. Additional car detecting devices and linear motors may be provided for succeeding stations of the queuing line.

When the first car is to be released a signal transmitted to the control 97 causes the hook 99 to be withdrawn from the member 100, the air cylinder 95 to be released and the reaction wheel assembly 92 pivoted by the spring 96 to its full speed position. The car then leaves the first station in the line. This releases the car detecting limit switch 106 so that the second car is then accelerated. Whether or not the second car is stopped in the first position depends upon whether or not the control 97 is actuated after the first car has left and before the second car reaches the stopping position. The same action takes place on succeeding stations along the queuing line so that release of the first car causes all of the remaining cars to advance at least one station.

In some cases it is desirable that the car approach a station at a fixed speed and that it arrive at the station at a fixed time in relation to other events or operating mechanism. The mechanism illustrated schematically in FIG. 13 provides this type of operation. As shown in this figure a roller chain 110 passes around a course that includes five guide sprockets 111–115. The guide sprocket 112 is driven by drive chain 116 engaging a duplicate sprocket carried on the same shaft as the sprocket 112. The sprockets 112 and 114 are carried on fixed axles which also carry arms 117 and 118. The sprockets 111 and 115 are carried on the ends of arms 117 and 118 respectively. Furthermore, the arms 117 and 118 are connected with a drag link 119 which at its center is connected to an arm 120 of a reaction wheel assembly 121. The assembly is normally rotated to its zero speed position by a tension spring 122, the arm being stopped in or near the zero speed position by the engagement of the arm 120 with a stop 123.

The chain 110 carries dogs 124, 125 either of which may engage a depending member or lug 126 carried on each of the cars. In this arrangement as a car comes into the station it meets the zero speed positioned reaction wheel assembly 121 thus decelerating the car. This continues until one of the dogs 124, 125 engages the lug 126 on the car. When the dog 125 engages the lug 126 the chain between the sprockets 115 and 111 is retarded thus rotating the arms 117, 118 and 120. This pivots the reaction wheel assembly 121 toward its full speed position. This rotation of the reaction wheel assembly 121 continues until the velocity of the car equals the velocity of the chain 110. Any tendency of the car to run faster than the chain results in the spring 122 turning the reaction wheel assembly 121 toward a slower speed position thus decelerating the car and any tendency of the car to lag behind results in a movement of the arm 120 and reaction wheel assembly 121 toward a higher speed position. Thus the car is accurately driven at a speed and timing corresponding to the speed and timing of the dogs 124 or 125 on the drive chain 110. Obviously by proper mechanical connections the drive chain may be synchronized to any external mechanism with which the car movement must be synchronized.

One example of the use of the structure shown in FIG. 13 is in advancing the cars into an elevator that lifts the cars one at a time from one level to another level.

A typical example of a queuing line is illustrated in FIG. 14 which shows the arrangement for advancing cars from a branch line onto a main line. As shown cars normally travel along a main line 130 in the direction of the arrow 131. Cars from a loading station or storage area approach along a branch line 132.

As each car moving along the main track 130 passes a car detector 133 a signal is delivered to a timer 134 which through controls similar to the control 97 sets the last station 135 to the stop condition. The car detector is located far enough from the junction of the main and branch tracks so that a car starting from rest at the station 135 may safely enter the main line ahead of a car just ready to pass the detector 133. The timer 134 is set to deliver a stop or hold signal to the control at the last station 135 for a time interval long enough for the car on the main line to reach the junction ahead of a car on the branch line that passes the last station **135** just after the timer times out and restores the station **135** to its "go" condition. The timer **134** is reset for a new timing interval each time the car detector **133** operates, regardless of whether or not a timing interval is in progress.

The branch line may have a number of stations, interconnected as shown in FIG. **12**, to accommodate a number of cars on the branch line until a break or gap in the traffic on the main line occurs.

If it is anticipated that the traffic on the main line **130** may be so heavy that the probability of long enough gaps in the traffic for admitting cars from the branch track is small, means may be employed to create such gaps. This may be done, as indicated in FIG. **15**, by dividing the main track ahead of a junction into a series of zones including a high speed zone A, a deceleration zone B, and two consecutive variable length, variable speed zones C and D, the zone D extending to the car detector **133**.

As long as the branch track or siding **132** is vacant, all of the zones are set for high speed and the traffic flow is not disturbed. When a car detector **136** on the branch line **132**, which detector may include a timer, indicates that a car is present and has waited a predetermined time, the first reaction wheel assembly in zone C is turned to a slow speed position. This provides the deceleration zone B, a minimum length low speed zone C and a long high speed zone D.

Then, in sequence, at a rate slightly less than the high speed of a car, successive reaction wheel assemblies in zone D are moved to slow speed position thus extending zone C and shortening zone D. This continues until zone D vanishes. As soon as the leading car in the extended zone C reaches the end of that zone all of zones B, C and D are returned simultaneously to high speed operation. The signal to return to high speed operation may be generated in a car detector located at the end of extended zone C and controlling a signal circuit that is completed when the reaction wheel assembly at that point is in its low speed position and a car arrives at that point.

This operation creates a gap or break in the main line traffic since any cars in zone D proceed at high speed without delay while any cars in zones B and C proceed at slow speed, thus opening up a gap between the last car in zone D and the leading car in zone C. If the low speed is half the high speed the maximum gap thus produced in the traffic flow downstream from zone D is equal to the combined lengths of zones C and D. Thus the car detector **133** should be located downstream from the end of zone D by this distance.

If the branch line traffic is moderate to heavy, zone C and D may be quite long so that the created gaps are longer and a queue of cars from the branch line may enter each gap.

The gap may be shortened when the maximum length is not needed by restoring zone C to high speed as the car detector **136** on the branch line indicates that the line is vacant.

The sequential transfer from high to low speed and the simultaneous return to high speed is effected, for example, by employing a moving contact, such as a timed stepping switch, to sequentially energize a series of relays, each of which seals or latches in its on condition, one for each reaction wheel assembly in zones C and D. The relays, either through solenoids or through solenoid valves are air cylinders pivot the reaction wheels to their slow positions. The reaction wheels are simultaneously returned to their high speed positions by breaking the relay holding circuit or unlatching the relays. Such control devices are well known and therefore not illustrated in the drawings.

We claim:

1. A speed control for regulating the movement of individual cars of a transportation system in which each car is propelled by contact between a rotating drive tube on the car and a reaction wheel positioned along the path of the car, comprising signal means that are energized if the car speed is to be reduced at a particular station, pivotal means supporting a reaction wheel located at such station, motor means along the trackway operatively connected to the pivotal means, and means responsive to the signal for energizing the motor to pivot the reaction wheel to a slow speed position.

2. In a speed control according to claim **1** car detecting means at a station, and means connecting said car detecting means to the reaction wheel pivoting means at an adjacent station behind the car for pivoting said reaction wheel to its zero speed position.

3. In a speed control system according to claim **1**, a series of speed control means located along a portion of the path of the cars, means for sequentially setting said control means to low speed position to produce an expanding low speed zone and a collapsing high speed zone, and means for simultaneously returning all of said series of control means to high speed position, whereby the spacing between the cars is reduced in said low speed zone and the cars are accelerated to high speed without increase in spacing.

4. In a speed control according to claim **1** means coupling the pivoting means of a series of reaction wheels for pivotal movement of the wheels to selected positions by operation of a single reaction wheel pivoting means.

5. A speed control according to claim **4** in which said coupling means pivots successive wheels of the series of reaction wheels different amounts whereby a speed changing zone is established.

6. In a speed control according to claim **5** car detecting means at a station and means connecting said car detecting means to the reaction wheel pivoting means of the next station behind the car for pivoting that wheel to zero speed position and successive reaction wheels to reduced speed positions whereby the presence of a car at a station establishes a deceleration zone extending from said next station.

7. In a speed control according to claim **1** car position control means for pivotally deflecting the reaction wheel controlling the car in accordance with the position of the car relative to a fixed point comprising catch means operatively connected to the reaction wheel pivoting means and a member on the car cooperating with the catch means.

8. A speed control according to claim **7** in which the catch is operatively fixed with respect to the reaction wheel pivoting means, and serves in cooperation with the member on the car to position the reaction wheel precisely in its zero speed position.

9. In a speed control according to claim **7** means for moving the catch with respect to the reaction wheel pivoting means along the path of the car.

10. In a speed control system according to claim **1**, car detecting means on one path of a car leading to a junction of paths, a timer operatively connected to said car detecting means, a pivoted reaction wheel on a second path leading to the junction, and control means responsive to said timer operatively connected to said pivoted reaction wheel for pivoting said wheel to its zero speed position during the timing interval of said timer.

11. A speed control system according to claim **10** in which the timing interval is measured from the last operation of the car detecting means.

12. In a speed control system according to claim **10**, a series of pivoted reaction wheels along said second path, and means interconnecting the wheels for pivoting a reaction wheel of the series as the next downstream wheel is pivoted.

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