Jan. 26, 1960 W. J. HEACOCK 2,922,625

CAR HAUL

Filed Oct. 25, 1956 3 Sheets-Sheet 1

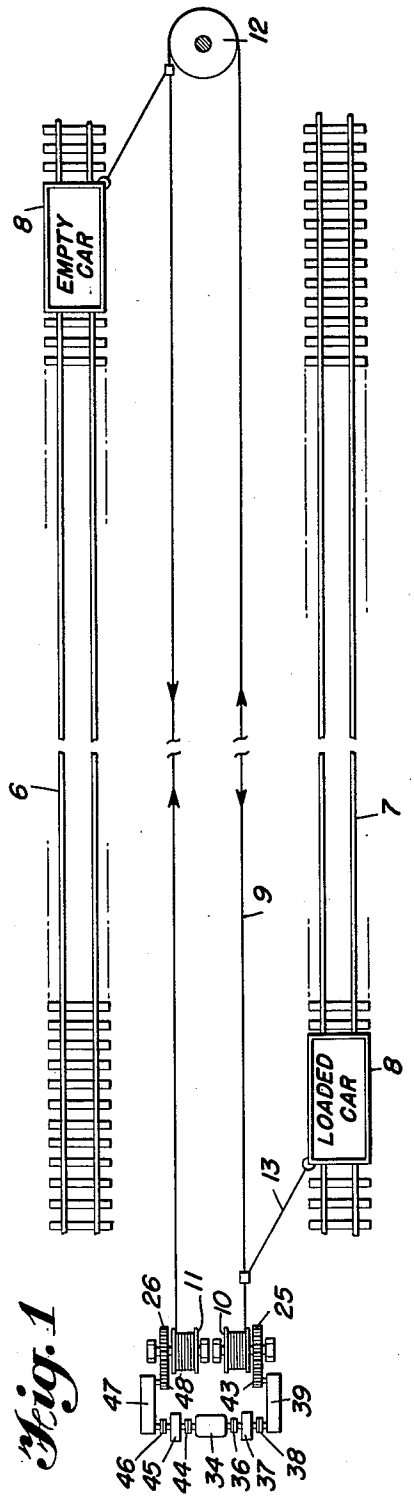

Fig. 1.

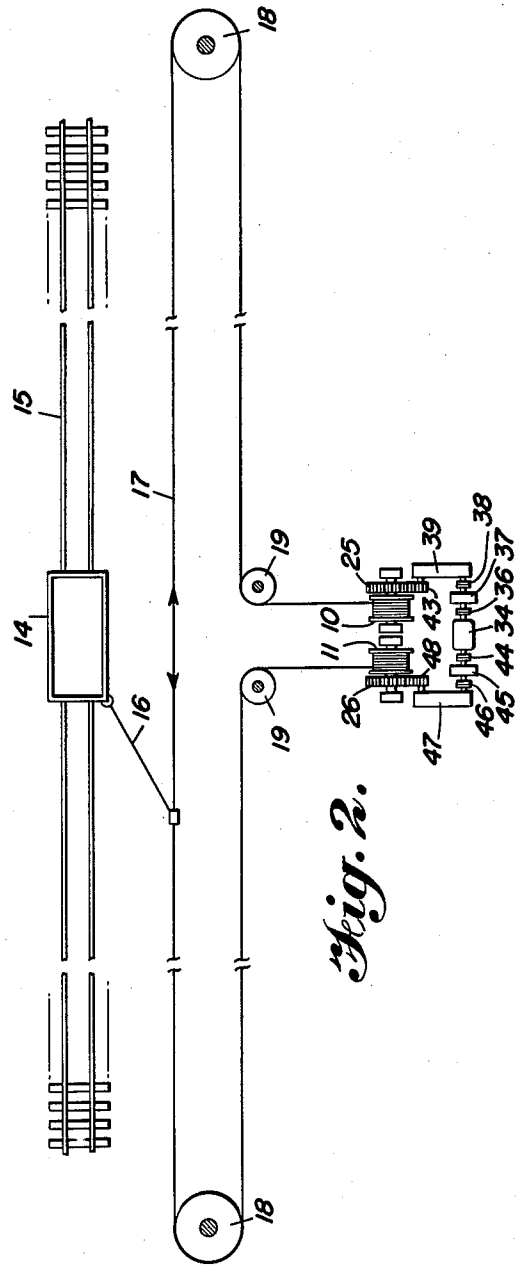

Fig. 2.

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Fig. 3

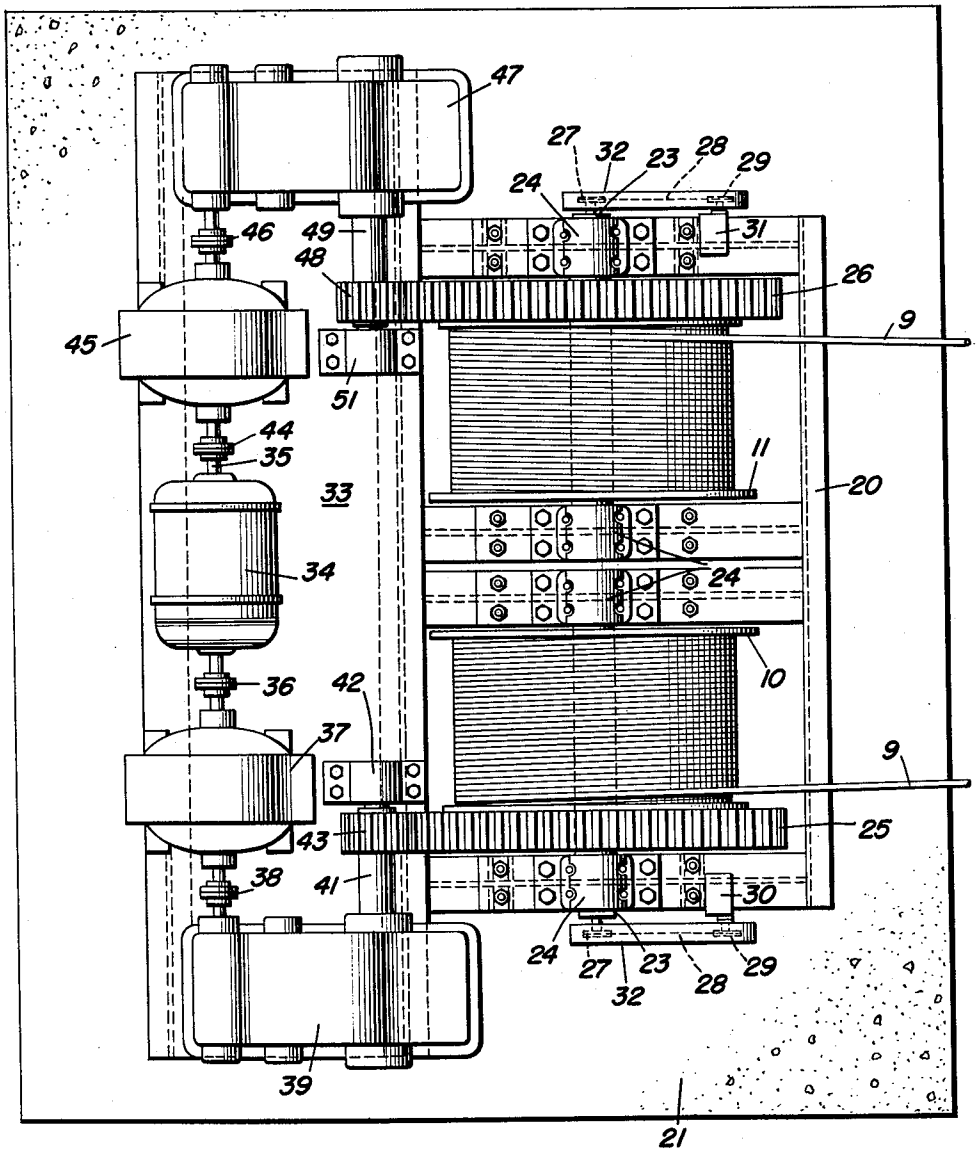

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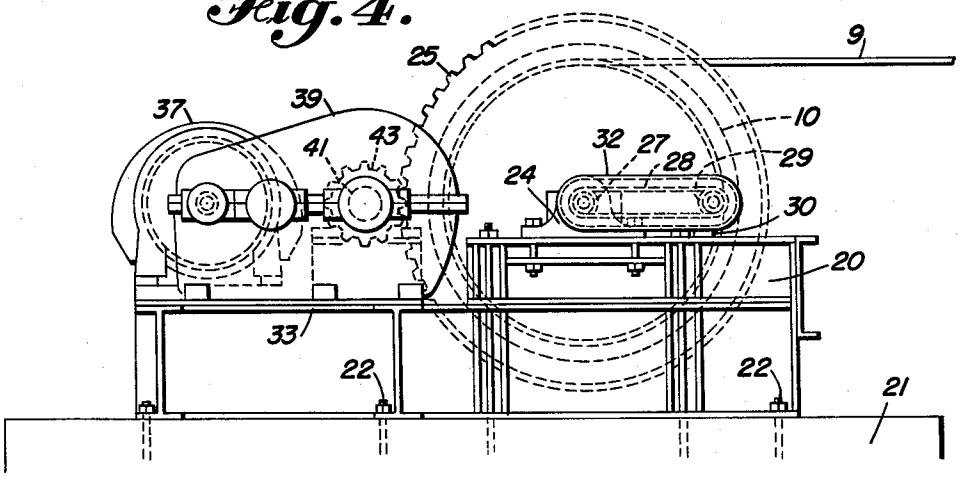
Fig. 4.



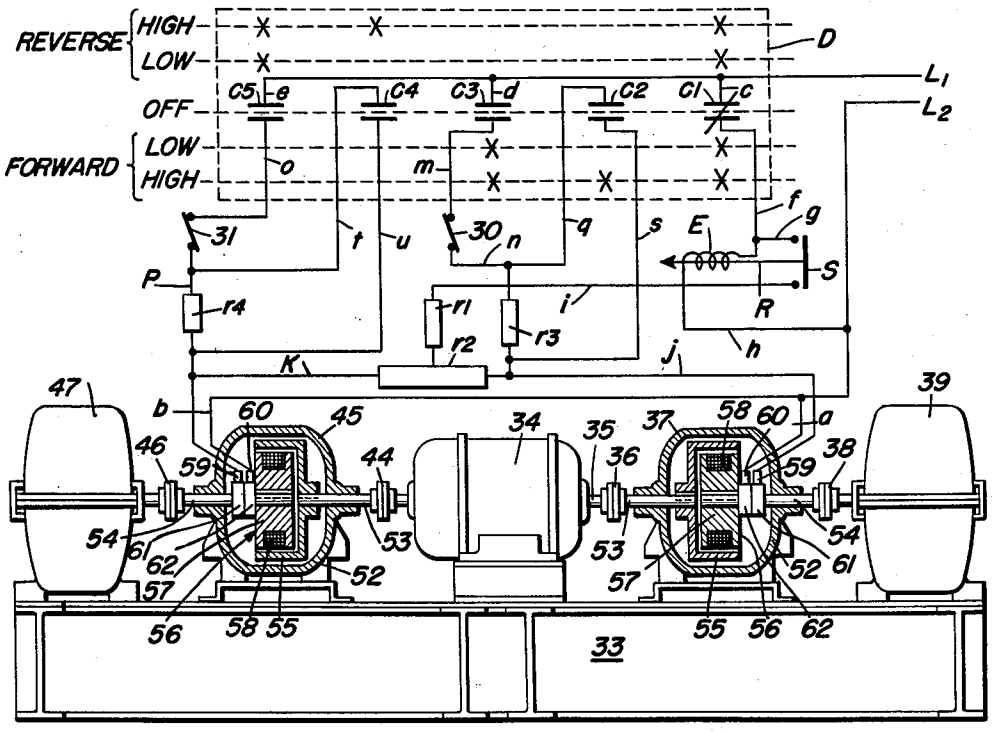


Fig. 5.

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2,922,625

CAR HAUL

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Application October 25, 1956, Serial No. 618,270

4 Claims. (Cl. 254—185)

This invention relates to new and useful improvements in car hauls and deals more particularly with apparatus for driving traction cables that are employed for hauling cars and the like.

Car hauls employing traction cables have, in the past, been arranged so that the cable formed a loop with one run extending along the section of track over which the cars were to be hauled. Opposite end portions of the looped cable were wound in opposite directions around two drums supported on a single shaft so that the opposite end portions of the cable were simultaneously wound onto and off of their respective drums. In this type of installation, elaborate and costly take-up devices were necessary to compensate for stretching of the cable and for the differences in the winding and unwinding rates as the diameters of the turns of the cable on the drums varied in inverse relationship. Further, the loop of the cable was always under tension and, therefore, subject to damage by impact with falling or moving objects.

Other known types of car hauls have employed two separately supported and independently rotated drums for alternately winding in one end portion of a looped traction cable on its drum while a brake resisted rotation of the other drum to maintain proper cable tension. In this type of installation a mechanical clutch was required to drivingly connect the prime mover to the drum selected for rotation and both the clutch and brake were subjected to excessive wear so that constant maintenance and frequent repairs were necessary.

The primary object of this invention is to provide a device for driving the traction cable of a car haul alternately in opposite directions while the prime mover of the driving device operates continuously in a single direction.

Another important object of this invention is to provide a device for driving the traction cable of the car haul alternately in opposite directions with the cable being maintained under proper tension during operation of the drive and with the tension on the cable being released when movement of the cable stops.

A further important object of the invention is to provide a device for driving the traction cable of the car haul in such a manner that the force transmitted by the cable may be both varied and reversed in direction and with the cable being maintained under proper tension during the driving operation.

Still another object of the invention is to provide a device for driving a traction cable alternately in opposite directions with the drive between the prime mover of the device and the cable including an electrical coupling which permits application of the driving or braking force to the cable without frictional or positive engagement between the portions of the coupling.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this specification and in which like reference characters are employed to designate like parts throughout the same,

Figure 1 is a schematic view of a car haul installation embodying the invention and employed for moving cars in opposite directions along either of two parallel track sections,

Figure 2 is a schematic view of a modified car haul installation embodying the invention and employed for moving cars in either direction along a single track section,

Figure 3 is a top plan view of the drive employed in the car hauls of Figs. 1 and 2,

Figure 4 is an end elevational view of the drive illustrated in Fig. 3, and

Figure 5 is a side elevational view, partly in cross section, of the drive of Figs. 3 and 4, and a diagrammatic view of the electrical system for controlling operation of the drive.

In the drawings, wherein for the purpose of illustration is shown the preferred embodiment of the invention, and first particularly referring to Fig. 1, there is shown a pair of spaced parallel track sections 6 and 7 over which cars 8 are to be moved. In this installation, the cars 8 may be moved in either direction along either of the two track sections by the single traction cable 9. The opposite end portions of the traction cable 9 are wrapped around drums 10 and 11 and the cable extends from the drums through an elongated loop which is positioned between the two track sections 6 and 7 and has its closed portion supported by a pulley 12. Draft devices 13 are employed for detachably connecting the cars 8 to the adjacent sides of the loop in the traction cable 9 so that alternate rotation of the drums 10 and 11 to wind in their associated end portions of the cable will cause the two sides of the loop and any cars that are connected thereto to be moved alternately in opposite directions along the track section 6 and 7. The drive for alternately rotating the drums 10 and 11 and the controls for the drive will be later described.

The car haul illustrated in Fig. 2 is employed for moving cars 14 alternately in opposite directions along a single track section 15 by means of draft devices 16 which detachably connect the cars to a traction cable 17. The traction cable 17 forms an elongated loop adjacent one side of the track section 15. The cable 17 passes around and is supported by pulleys 18 at opposite ends of the loop in the cable and at the side of the loop most remote from the track section 15 a pair of spaced pulleys 19 are provided for guiding movement of the cable laterally from the loop to the drums 10 and 11 around which the opposite end portions of the cable are wrapped. The drums 10 and 11 and the drive for rotating the drums along with its controls are identical to those illustrated in Fig. 1 and the following description thereof is equally applicable to the car hauls of both Figs. 1 and 2.

Referring now to Figs. 3 and 4 for a detail description of the drums 10 and 11 and the manner in which they are mounted for independent rotation, it will be seen that the drums are supported on a base 20 formed of suitably arranged structural members and rigidly connected to a foundation 21 by anchor bolts 22, or the like, as illustrated in Fig. 4. Each of the drums 10 and 11 is rigidly mounted on a shaft 23 and the two shafts are axially aligned and have their opposite end portions supported for rotation on the base 20 by bearings 24.

Between the outer end of the drum 10 and the adjacent bearing 24 there is provided a gear 25 which is rigidly connected to the drum for rotating the latter. A gear 26 is similarly mounted at the outer end of the drum 11 for rotating the latter.

At the outer end of the shaft 23 of the drum 10, there is provided a small sprocket 27 which is connected by a chain 28 to the sprocket 29 of a limit switch 30. A second sprocket 27 is similarly mounted on the shaft of the drum 11 and connected by a chain 28 to the sprocket

29 of a limit switch 31. The sprocket 27, chain 28 and sprocket 29 associated with each shaft 23 are enclosed by a guard 32. Each of the two limit switches 30 and 31 is of the type which is closed by any rotation of its sprocket 29 away from a given position and will remain closed until the direction and number of subsequent rotations have returned the sprocket to its initial position. In other words, the limit switches 30 and 31 may be adjusted to open when the drums 10 and 11, respectively, have been rotated to wind a selected amount of cable onto or off of the drum. The manner in which the limit switches 30 and 31 are connected into the electrical circuit for controlling the operation of the drive for rotating the drums 10 and 11 will be later described.

At one side of the base 20 there is provided an elongated platform 33 which serves as a base for the various components of the drive for rotating the drums 10 and 11. Mounted on the platform 33 with its axis in parallel relationship with the axes of the shafts 23 is a drive motor 34 having its drive shaft 35 extending from the opposite ends thereof.

One end of the drive shaft 35 is connected through a flexible coupling 36 to the input shaft of an electromagnetic coupling 37, which will be later described. The output shaft of the coupling 37 is connected through a flexible coupling 38 to the input shaft of a gear reduction unit 39 at one end of the platform 33. The output shaft 41 of the gear reduction unit 39 has its outer end portion supported by a bearing 42 and a spur gear 43 is keyed to this output shaft in meshing engagement with the gear 25 that is rigidly connected to the drum 10. The opposite end of the drive shaft 35 is similarly connected through a flexible coupling 44, electromagnetic coupling 45, flexible coupling 46, gear reduction unit 47, and spur gear 48 to the gear 26 associated with the drum 11. The gear 48 is mounted on the output shaft 49 of the gear reduction unit 47 and the outer end of the output shaft is rotatably supported by a bearing 51.

Referring now to Fig. 5 for a detail description of the electromagnetic couplings 37 and 45, it will be seen that they are of identical construction so that the following description of the coupling 37 is equally applicable to the coupling 45 and like reference characters have been applied to the corresponding parts of each. A coupling housing 52 rotatably supports the input and output shafts 53 and 54, respectively, in axial alignment and with their inner ends in closely spaced relationship with each other. Rigidly mounted on the inner end of the input shaft 53 is an open-ended drum 55, the inner cylindrical surface of which surrounds and is spaced radially from the adjacent end portion of the output shaft 54. Keyed to the inner end portion of the output shaft 54 is a field assembly 56 which includes a suitably constructed core 57 and a field coil 58. The periphery of the field assembly 56 lies in closely spaced relationship with the inner cylindrical surface of the drum 55 but is separated therefrom by a uniform clearance or air gap so that the drum and field assembly are free to rotate independently of each other when no current is supplied to the field assembly. Electric current is conducted to the field coil 58 of the field assembly 56 through brushes 59 and 60 which contact slip rings 61 and 62, respectively, that are mounted on the output shaft 54 and rotate with the field assembly.

When the field coil 58 is energized, the core 57 becomes a magnet and the magnetic lines of force established in the core will flow between the north and south poles of the field assembly through the adjacent portion of the drum. Relative rotation between the drum 55 and field assembly 56, therefore, will cause these magnetic lines of force to be sheared in the air gap between the drum and field assembly and eddy currents will be generated in the portion of the drum adjacent the field assembly. These induced eddy currents develop a second magnetic field which has an attraction to the magnetic field of the field assembly 56 and will cause the field assembly to rotate with the drum 55, to transmit torque from the input shaft 53 to the output shaft 54. The amount of the torque delivered to the input shaft 53 that is transmitted to the output shaft 54 will vary in accordance with the magnitude of the eddy current field in the drum 55 which in turn varies in accordance with the strength of the magnetic field in the field assembly 56 and with the slip or difference in speeds between the drum and the field assembly. In other words, the torque delivered by the output shaft 54 may be varied without changing the operation of the motor 34 by increasing or decreasing the current supplied to the field coil 58 through the brushes 59 and 60. Of course, when no current is supplied to the field coil 58, no torque will be transmitted by the output shaft 54 despite the continued rotation of the drum 55 by the motor 34.

As illustrated in Fig. 5, current for energizing the two couplings 37 and 45 is supplied through lines L1 and L2 which lead to a source of supply of electrical energy, not shown. The line L2 is connected directly to the brush 60 of each of the two couplings 37 and 45 by branch lines *a* and *b*, respectively. The supply of current from the line L1 to the brushes 59 of the two couplings 37 and 45 is controlled by a set of five contactors C1 to C5, inclusive, the first of which is normally closed and the remainder normally open. The contactors C1 to C5, inclusive, are arranged for operation by a multiple position drum type actuator D which is movable in either direction from its "off" position to a "low" position and is further movable past each of the two "low" positions to a "high" position as illustrated in Fig. 5.

The "low" and "high" positions on one side of the "off" position have been arbitrarily designated as "reverse" positions and the "high" and "low" positions on the opposite side of the "off" position as "forward" positions to simplify the subsequent description of the movement imparted to the cables 9 by movement of the drum actuator D to its various positions.

Mounted on the drum actuator D are a plurality of actuating devices X for engaging and operating the contactors C1 to C5, inclusive. The actuating devices X in circumferential alignment with contactor C1 are arranged to open the normally closed contactor in all positions of the drum actuator except the "off" position. Arranged in circumferential alignment with the contactor C2 is an actuating device X which will engage and close the contactor C2 only when the drum is in the "high" position on the "forward" side of its "off" position. The contactor C3 will be closed by actuating devices X on the drum actuator D when the latter is in either its "low" or its "high" position on the "forward" side of its "off" position. The contactor C4 will be closed by an actuating device X on the drum actuator D when the latter is in its "high" position on the "reverse" side of the "off" position and the contactor C5 will be closed by actuating devices X on the drum actuator D when the latter is in either its "low" or its "high" position on the "reverse" side of the "off" position.

The line L1 is connected by branch lines *c*, *d* and *e* to one side of the contactors C1, C3 and C5, respectively. The opposite side of the contactor C1 is connected by a line *f* to the coil E of a conventional timing relay R and by a branch line *g* to one side of the switch S operated by the coil E. The circuit through the coil E is completed by a line *h* which leads to the line L2. The other terminal of the switch S is connected through a line *i* and a resistor *r*1 to the center tap of a resistor *r*2 the end taps of which are connected by lines *j* and *k* to the brushes 59 of the couplings 37 and 45.

The side of the contactor C3 opposite to the branch line *d* is connected by a line *m* to one side of the limit switch 30 and the opposite side of the limit switch 30 is connected by a line *n* through a resistor *r*3 to the wire *j*.

The side of the contactor C5 opposite its connection to the branch line *e* is connected by a line *o* to one side

of the limit switch 31 and the opposite side of the limit switch is connected by line *p* through the resistor *r*4 to the line *k*.

The opposite sides of the contactor C2 are connected by lines *q* and *s* and to the line *n* on opposite sides of the resistor *r*3 so that the lines *q* and *s* form a by-pass circuit around the resistor when the contactor C2 is closed. The contactor C4 is similarly connected by lines *t* and *u* to the line *o* on opposite sides of the resistor *r*4 to form a by-pass circuit around the resistor when the contactor C4 is closed.

The operation of the circuit described above in controlling the amount of torque transmitted by the couplings 37 and 45 and the direction of movement imparted to the cable 9 thereby will be described as follows:

Referring to Fig. 1, it will be readily apparent that the opposite sides of the loop in the cable 9 adjacent the two track sections 6 and 7 will be moved alternately in opposite directions and will impart corresponding movements to any cars 8 connected thereto when the drums 10 and 11 are alternately rotated to wind the cable thereon. Of course, when the cable is being wound onto either of the two drums 10 or 11, a corresponding amount of cable must be unwound from the other drum. Further, if the drum 10 or 11 from which the cable is being unwound is restrained or retarded in its rotation, the cable 9 will be maintained in proper tension to prevent overhauling of the cable by the moving cars 8.

By reference to Fig. 2, it will be readily apparent that the side of the loop in the cable 17 adjacent the track section 15 will be moved alternately in opposite directions and will impart similar movements to any cars 14 connected thereto by alternate rotation of the drums 10 and 11 in the same manner as was described in connection with Fig. 1.

Before describing the operation of the drive for actuating the two drums 10 and 11, it will be noted that the motion produced in the cable 9 when it is wound onto the drum 10 and unwound from the drum 11 is arbitrarily designated as being a "forward'" movement, and the movement of the cable in the opposite direction by being wound onto the drum 11 and unwound from the drum 10 has been designated a "reverse" movement. It will also be noted that because the two end portions of the cable 9 are wound around the drums 10 and 11 in the same direction, the two drums must be rotated in the same direction to wind cable thereon or, stated in a different manner, the two drums must be rotated in opposite directions when the cable is wound onto one drum and off of the other drum.

Before describing the operation of the drive for rotating the drums 10 and 11, it will be noted that the motor 34 is continuously operated in a direction to produce a torque which, when transmitted to the two drums, will tend to rotate both of them in the same direction to wind the associated portions of the cable 9 thereon. With the drum actuator D in its "off" position, as illustrated in Fig. 5, the contactor C1 will be closed and the remaining contactors C2 to C5, inclusive, will be open. Also, the timing relay R will have opened the switch S so that no current will flow through the field coil 58 of either the coupling 37 or the coupling 45. The drums 55 of the two couplings, therefore, will be rotating entirely independently of their associated field assemblies 56 and no torque will be transmitted from the motor to either of the two drums 10 or 11.

Assuming then that motion is to be imparted to the cable 9 in a "forward" direction, the drum actuator D is moved to the "low" position on the "forward" side of the "off" position. In this position, the contactor C1 will be opened and the contactor C3 closed. The remaining contactors C2, C4 and C5 will remain in their open positions. Current will thereupon flow from the line L1 through the branch line *d*, contactor C3, line *m*, limit switch 30, line *n*, resistor *r*3 and line *j* to the brush 59 of the coupling 37 and from the brush 60 of the coupling through line *a* to the line L2 so that a circuit is closed through the field coil 58 of this coupling. A much smaller current will also flow from the line *j* through the resistor *r*2 and line *k* to the brush 59 of the coupling 45 and from the brush 60 of this coupling through the line *b* to line L2 so that a circuit is closed through the field coil 58 of the coupling 45 when the coupling 37 is energized. Since the current flowing to the field coil 58 of the coupling 37 exceeds that flowing to the field coil 58 of the coupling 45, the torque transmitted by the coupling 37 will exceed that transmitted by the coupling 45 and will be transmitted through the gear reduction unit 39 and gears 43 and 25 to rotate the drum 10 in a direction to wind the cable 9 thereon. The lower torque transmitted through the coupling 45, however, will be transmitted through the gear reduction unit 47 and gears 48 and 26 to apply a torque to the drum 10 in a direction to cause this drum to resist the unwinding of the cable 9 therefrom. This resistance to the unwinding will cause the cable 9 to be maintained under tension during movement thereof in a "forward' direction.

If the torque transmitted to the drum 10 by movement of the drum actuator D to the "low" position on the "forward" side of the "off" position is insufficient, a higher torque may be transmitted by movement of the drum actuator to the "high" position on the "forward" side of the "off" position. In this position of the drum actuator D, the contactors C1 and C3 will remain in their open and closed positions, respectively, the contactor C2 will be closed and the contactors C4 and C5 will remain open. The closing of the contactor C2 closes a by-pass circuit through the lines *q* and *s* around the resistor *r*3 to increase the flow of current to the brush 59 of the coupling 37 and to thereby increase the torque transmitted by this coupling.

When sufficient "forward" movement has been imparted to the cable 9 to accomplish the desired movement of the cars attached thereto, the drum actuator D is returned to its "off" position at which time the contactor C1 will be closed and the remaining contactors C2 to C5, inclusive, will be opened. The closing of the contactor C1 will permit current to flow through the branch line *c* and the line *f* to the coil E of the timing relay R, the opposite side of the coil being connected by the line *h* to the line L2. The timing relay R will thereupon immediately close the switch S to permit the flow of current through the lines *c*, *f*, *i* and the resistor *r*1 to the center tap of the resistor *r*2 and in opposite directions through the resistor *r*2 to the wires *j* and *k* and to the brushes 59 of the couplings 37 and 45, respectively. This equal flow of current to the field coils 58 of the two couplings 37 and 45 will cause the latter to transmit equal torques to their associated drums 10 and 11 to apply a braking action against further movement of the cable 9. After a predetermined time interval during which movement of the cable 9 will stop, the timing relay R will open the switch S to stop all flow of current to the two couplings 37 and 45 so that no torque will be transmitted to either of the drums 10 or 11. These drums then will be free to rotate so as to release the tension on the cable 9 so that any objects falling onto the cable, or colliding therewith, will not damage the cable or any of the drive components.

During the above described "forward" movement of the cable 9, the sprockets 29 of the two limit switches 30 and 31 will be rotated by their associated sprockets 27 and chains 28. The limit switch 30, therefore, may be adjusted so that "forward" movement of the cable 9 to a desired limit will cause the limit switch 30 to be opened to prevent any further flow of current to either of the two couplings 37 or 45.

If the cable 9 is to be moved in a "reverse" direction, the drum actuator D is moved to the "low" position on

the "reverse" side of the "off" position at which time the contactor C1 is opened and the contactor C5 is closed, the remaining contactors C2, C3 and C4 remaining in their open positions. Current will thereupon flow through the lines *e* and *o*, limit switch **31**, line *f* and resistor *r4* to the brush **59** of the coupling **45**. A smaller current will also flow from the line *p* through the line *k*, resistor *r2* and line *j* to the brush **59** of the coupling **37**. The greater torque transmitted to the drum **11** through the coupling **45** will thereupon cause the drum **11** to wind in the cable **9**. At the same time, the cable will be unwound from the drum **10** against the lesser torque transmitted thereto through the coupling **37**.

If a greater torque is required, the drum actuator D may be moved to its "high" position on the "reverse" side of the "off" position. In this position, the contactors C1 and C5 will remain in their open and closed positions, respectively, the contactor C4 will be closed and the contactors C2 and C3 will remain in their open positions. A by-pass circuit is thereby closed through the lines *t* and *u* around the resistor *r4* so that a greater current will flow to the brush **59** of the coupling **45** to increase the torque transmitted by this coupling.

When the drum actuator D is returned to its "off" position, the contactor C1 will again be closed and the remaining contactors C2 to C5, inclusive, will be opened so that the timing relay R will again close the switch S to apply equal currents to the two couplings **37** and **45** so as to equalize the torques transmitted by the couplings. This applies a braking action on the movement of the cable **9**. Subsequent reopening of the switch S will again release the drums **10** and **11** for sufficient movement to relieve the tension in the cables **9**.

Rotation of the sprocket **29** for the limit switch **31** during "reverse" movement of the cable **9** will open the limit switch **31** at a desired limit.

The above described drive for the cable **9** provides for its alternate movement in opposite directions and for braking action against further movement of the cable by movement of the drum actuator D to the various positions described, and, by means of the limit switches **30** and **31**, prevents excessive movement of the cable in either a "forward" or a "reverse" direction. Further, it will be noted that no frictionally engaged parts are employed for the transmission of torque to or the application of a braking effect on the drums **10** or **11** so that maintenance and replacement of parts is maintained at a minimum.

It is to be understood that the form of this invention herewith shown and described is to be taken as a preferred example of the same, and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

Having thus described the invention, I claim:

1. In a traction cable drive including a pair of drums supported for independent rotation with each having an associated end portion of the cable wound thereon, a prime mover, and an electromagnetic coupling associated with each of said drums for drivingly connecting said prime mover to each drum to rotate the latter in a direction to wind in the end portion of the cable associated therewith and for transmitting varying amounts of torque thereto in response to variations in the electrical energy supplied to the respective coupling, the improvement which comprises control means actuatable at the will of the operator to electrically energize said couplings, and means operable upon deactuation of said control means by the operator to initially energize each of said couplings with substantially equal amounts of electrical energy to stop the rotation of said drums through oppositely directed tension forces applied to said cable and to subsequently deenergize said couplings after the lapse of a predetermined time to stop the transmission of torque to said drums and release the tension in said traction cable, said control means comprising a separate circuit for supplying electrical energy to the coupling associated with each drum, a branch circuit having an electrical resistance therein extending between said separate circuits for supplying a restricted amount of electrical energy from either separate circuit to the coupling associated with the other separate circuit, and switch means operable to alternately close a selected one of said separate circuits.

2. The improvement as defined in claim 1 wherein each of said separate circuits has a limit switch connected therein, and including means associated with each of said drums for operating each of said limit switches to open the separate circuit associated therewith when the coupling supplied with electrical energy by the circuit has rotated its drum to wind a predetermined length of cable thereon.

3. The improvement as defined in claim 1 wherein each of said separate circuits has an electrical resistance therein between said switch means and said branch circuit, a by-pass circuit arranged in parallel relationship with the resistance of each separate circuit, and switch means operable to close each of said by-pass circuits when the associated separate circuit is closed.

4. In a traction cable drive including a pair of drums supported for independent rotation with each having an associated end portion of the cable wound thereon, a prime mover, and an electromagnetic coupling associated with each of said drums for drivingly connecting said prime mover to each drum to rotate the latter in a direction to wind in the end portion of the cable associated therewith and for transmitting varying amounts of torque thereto in response to variations in the electrical energy supplied to the respective coupling, the improvement which comprises control means for electrically energizing said couplings, and additional means operable upon actuation thereof to initially energize each of said couplings with substantially equal amounts of electrical energy to stop the rotation of said drums through oppositely directed tension forces applied to said cable and for subsequently deenergizing said couplings at a predetermined time after said actuation to stop the transmission of torque to said drums and release the tension in said cable, said control means including a multiple position switch movable to different positions for causing the torque transmitted by one coupling to exceed the torque transmitted by the other coupling and movable to a further position for actuating said additional means.

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