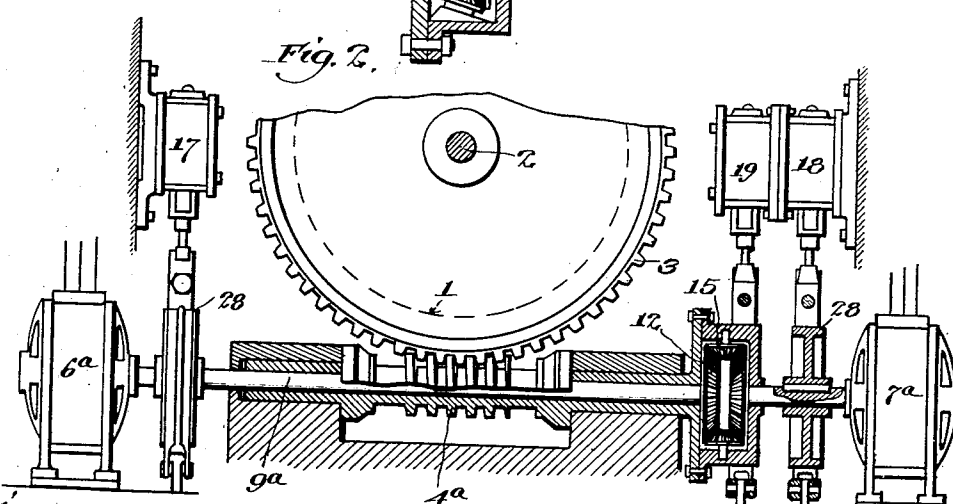
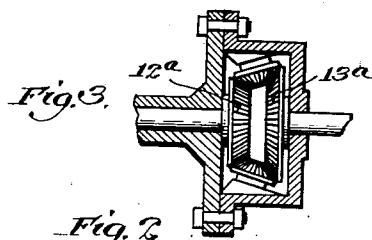
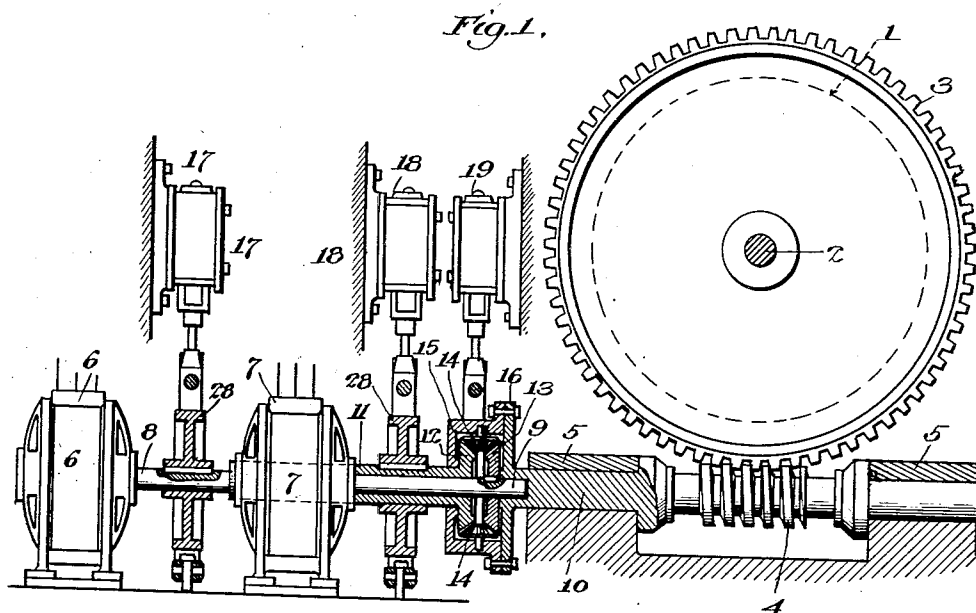


R. H. GAYLORD & G. B. CAPPS.  
ELECTRICAL MOTIVE APPARATUS.  
APPLICATION FILED JULY 23, 1914.

1,235,132.

Patented July 31, 1917.  
3 SHEETS—SHEET 1.



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Fig. 5.

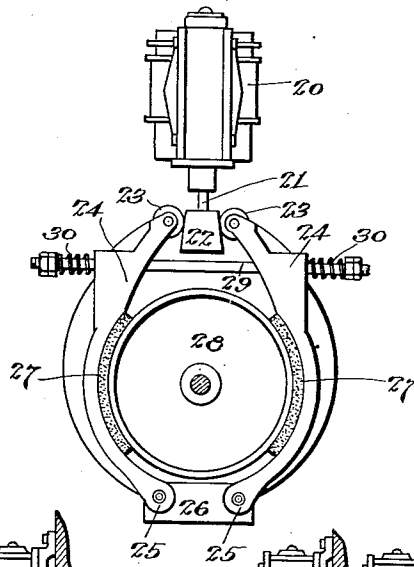


Fig. 4.

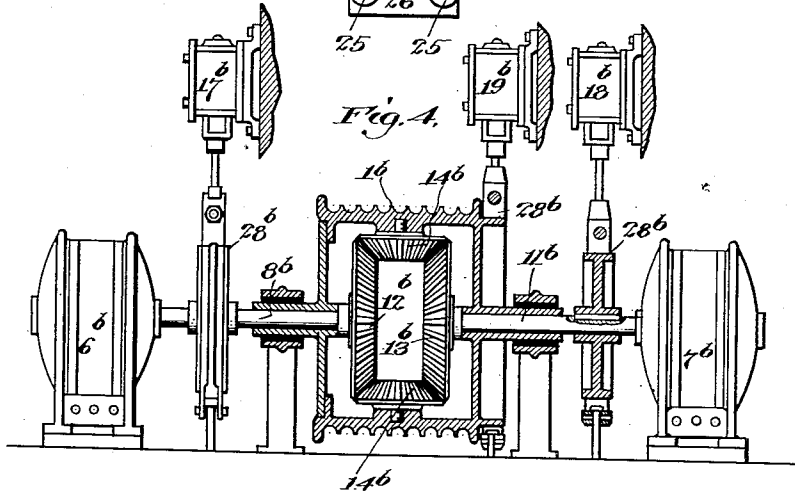
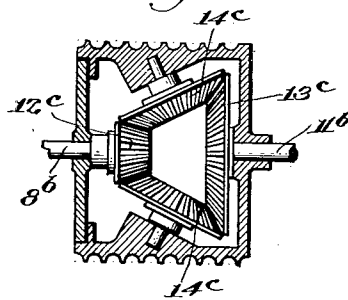


Fig. 6.



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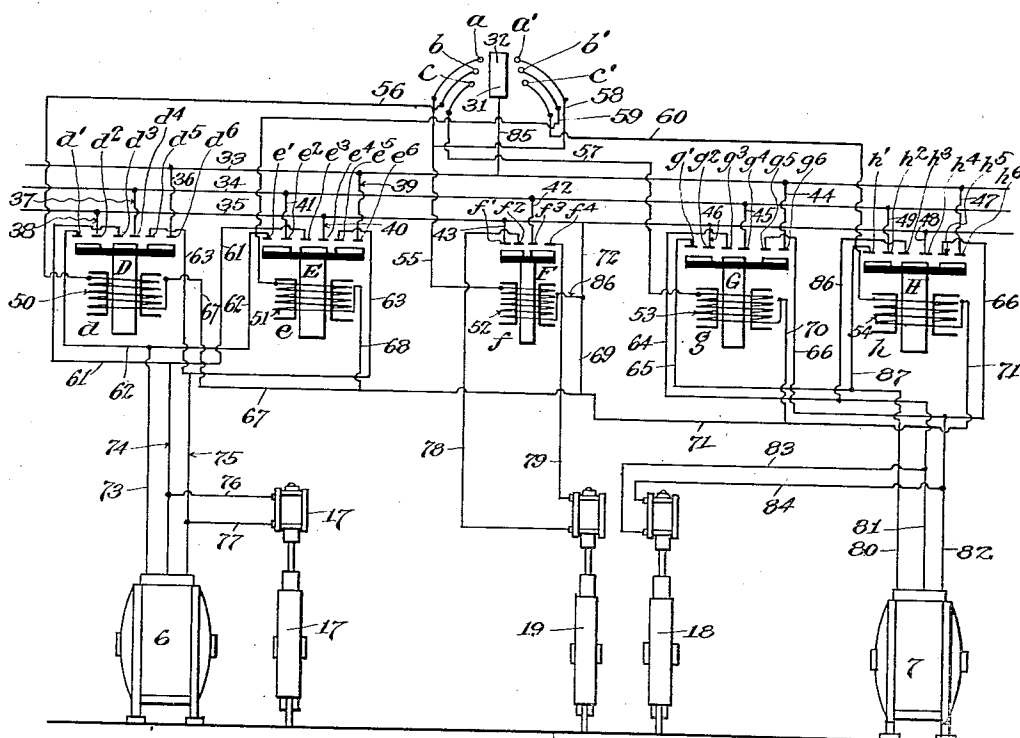
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3 SHEETS—SHEET 3.

Fig. 7.



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# UNITED STATES PATENT OFFICE.

ROBERT H. GAYLORD, OF PASADENA, AND GUY B. CAPPS, OF LOS ANGELES, CALIFORNIA.

## ELECTRICAL MOTIVE APPARATUS.

1,235,132.

Specification of Letters Patent.

Patented July 31, 1917.

Application filed July 23, 1914. Serial No. 852,531.

*To all whom it may concern:*

Be it known that we, ROBERT H. GAYLORD, residing at Pasadena, in the county of Los Angeles and State of California, and GUY B. CAPPS, residing at Los Angeles, in the county of Los Angeles and State of California, both citizens of the United States, have invented a new and useful Electrical Motive Apparatus, of which the following is a specification.

This invention relates to electrical motive apparatus for operation of elevators, or hoists, or other apparatus presenting considerable momentum when in operation, and the main object of the invention is to provide for increasing the effective speed of the motive means relatively to the speed of the elevator or other apparatus, in starting and stopping the same, so as, on the one hand, to facilitate starting of the motive means under load, and, on the other hand, to enable the said motive means to run above the normal speed when the apparatus is being brought to rest, and to thereby enable the said motive means to deliver electrical energy to the operating line or circuit at the same time producing an efficient dynamic brake.

Our invention is especially advantageous in the operation of apparatus such as above described by alternating current, an important object of the invention being to enable elevators and other apparatus to be driven by alternating current, at higher speed than is practicable with the usual motive arrangements, while permitting of effective control in starting and stopping.

A further object of the invention is to provide, in an apparatus driven by induction motors, means of control for variation of the speed, without undue complication of the control apparatus, and particularly without the use of shift gears.

Our invention, as hereinafter described, is particularly designed for the operation of electric elevators by alternating current, in such manner as to provide for such operation under the conditions of speed generally obtained in practice. Electric elevators, particularly passenger elevators, are in common practice, operated at a rate of speed as high as six hundred feet per minute, and for such high speeds the alternating current motor drive has not been found practicable, for the reasons hereinafter stated.

It has not been possible to obtain with

an induction motor, the high starting torque required with high speed elevators, without excessive current flow in starting, which seriously affects the circuit and the source of supply.

It has not been practicable to obtain efficiently with an induction motor, the variable speeds and gradual acceleration necessary for high speed elevator operation, without making the control apparatus too complicated. An induction motor of the variable speed type is wasteful of energy at any speed other than its normal speed, and at any other than normal speed, will vary with the load, so that with the controlling lever in a given position, the motor will run slower under a heavy load than under a light load, making it difficult for the operator to accurately judge the speed of his car and thereby make an accurate stop.

Another and most serious difficulty in connection with the use of the induction motor in high speed elevator work is the incapability of such motors of producing dynamic braking action, by working either in a closed braking circuit or in connection with the supply circuit. For this reason, elevators driven by an induction motor must depend wholly on a mechanical brake for deceleration and stopping. While the mechanical brake is suitable for low speed elevators, where the speed does not exceed two hundred feet per minute, it is not suitable for high speed service, for the reason that the brake must be adjusted so that it will bring a fully loaded car to a positive stop and when it is so adjusted, a lightly loaded car will be stopped too abruptly. Moreover, the distance that the car will travel after throwing off the current and putting on the brake, will, with a mechanical brake, vary greatly with the load and speed, since the braking resistance is constant and the energy to be absorbed varies directly as the mass and as the square of the velocity of the car. Therefore the operator has to judge his stopping distance according to the load and speed of the car, and often overruns or falls short, by misjudgment. The dynamic brake, where it can be used, largely overcomes this difficulty, as the braking resistance increases with the velocity, so that the greater the momentum of the car the greater will be the braking action, and the braking or stopping distance will vary relatively little under variations of load and speed.

The induction motor, as generally applied, however, is not capable of dynamic brake action, as it will not operate as a generator on a closed braking circuit, nor is it capable of braking by delivering electric energy to the line when it is slowing down and therefore running below normal speed.

Our invention provides for changing the ratio of motor speed to car speed, whereby the speed of the car may be varied while permitting the motor operating the same to be run at its normal and most efficient speed. By providing for increase in the ratio of motor speed to car speed, in starting, we are enabled to reduce the starting torque required, so that a low starting torque motor may be used, and the motor will start under load without drawing an excessive current from the line, and at the same time give a rapid and gradual acceleration to the car. By providing for temporarily speeding up the motor relatively to the car speed, in stopping or deceleration, the motor may be caused to run faster than synchronous speed, and to deliver electrical energy to the line, so as to exert a braking effect on the car.

While our invention is applicable generally in connection with electrical motor driven apparatus, we have for the purpose of illustration, shown it in the accompanying drawings as applied to operation of an elevator driven by induction motors.

Referring to the drawings:

Figure 1 is a side elevation partly in section, showing one form of the invention.

Fig. 2 is a view similar to Fig. 1, showing a modified form.

Fig. 3 is a cross section through the differential gearing, showing another form of gearing.

Fig. 4 is a view similar to Fig. 1, showing a form used for traction or high speed elevators.

Fig. 5 is a side elevation in detail of a brake.

Fig. 6 is a cross section through a modified form of differential gearing.

Fig. 7 is a diagrammatic view showing the connections.

In the form shown in Fig. 1, 2 designates the shaft of the driven apparatus, said shaft carrying, for example, drum 1 for an elevator cable, and said shaft carrying a gear 3, which is driven from a worm 4, the latter being mounted in suitable bearings 5. 6 and 7 designate two alternating current induction motors, which are arranged axially in line, motor 6 having a shaft 8 which extends freely through the motor 7 with its end 9 journaled in the shaft 10 of the worm 4. The motor 7 has a hollow shaft 11, through which the shaft 9 freely passes, and carried rigidly on shaft 11 is a beveled gear 12, while rigidly mounted on the shaft 9 is a beveled gear 13, the gears 12 and 13 forming

the two members of a differential gearing, beveled pinions 14 meshing between the gears 12 and 13 and being carried by a casing 15, the latter being rigidly secured to a flange 16 on the shaft 10. Brakes 17, 18 and 19 are respectively employed for shaft 8 of motor 6, shaft 11 of motor 7, and the differential case 15, these brakes being similar in construction, and illustrated in detail in Fig. 5. 20 designates an electromagnetic device formed in this instance by a solenoid with armature 21 having a wedge 22, which is adapted to act between rollers 23 on brake members 24 pivoted at 25 to a block 26, and having friction segments 27 adapted to bear against a friction drum 28. A rod 29 extends through both members 24, and compression springs 30 act to force the members 24 toward each other and cause the friction segments 27 to bear against the drum 28 and apply the brake. Release of the brake is effected by energization of the solenoid 20, which raises its armature 21, causing the wedge 22 to force apart the members 24 and thus release the drum 28.

With this construction it is obvious that if motors 6 and 7 revolve at the same speed and in the same direction as one another they will rotate gears 12 and 13 at the same speed, thereby rotating the differential gear case 15 at the same speed, and with it the worm 4, thus driving the shaft 2, drum 1 and car, not shown, at the maximum speed. If one of the motors is held stationary, the other motor will through its connected gear 12 or 13 and pinions 14, drive the differential gear case 15 at a slower speed, giving a corresponding slow speed of the drum and car.

The control of the motors is indicated in the diagram in Fig. 7, and referring thereto: 31 designates a controlling switch having lever 32 adapted to be moved into engagement with contacts *a*, *b*, or *c*, to give a forward movement or to engage with the contacts, *a'*, *b'* or *c'* for a reverse movement. *d*, *e*, *f*, *g* and *h* designate controlling switches, switch *d* having contacts *d*<sup>1</sup>, *d*<sup>2</sup>, *d*<sup>3</sup>, *d*<sup>4</sup>, *d*<sup>5</sup>, *d*<sup>6</sup>, and switch *e* having contacts *e*<sup>1</sup>, *e*<sup>2</sup>, *e*<sup>3</sup>, *e*<sup>4</sup>, *e*<sup>5</sup>, *e*<sup>6</sup>, switch *f* having contacts *f*<sup>1</sup>, *f*<sup>2</sup>, *f*<sup>3</sup>, *f*<sup>4</sup>, switch *g* having contacts *g*<sup>1</sup>, *g*<sup>2</sup>, *g*<sup>3</sup>, *g*<sup>4</sup>, *g*<sup>5</sup>, *g*<sup>6</sup>, switch *h* having contacts *h*<sup>1</sup>, *h*<sup>2</sup>, *h*<sup>3</sup>, *h*<sup>4</sup>, *h*<sup>5</sup>, *h*<sup>6</sup>. 33, 34 and 35 designate the three leads of the motor circuit. Wire 33 is connected by a wire 36 with contact *d*<sup>5</sup>. A wire 37 connects wire 34 with contact *d*<sup>4</sup>. Wire 38 connects wire 35 with contact *d*<sup>2</sup>. Wire 39 connects wire 33 with contact *e*<sup>6</sup>. Wire 40 connects wire 35 with contact *e*<sup>4</sup>. Wire 41 connects wire 34 with contact *e*<sup>2</sup>. Wire 42 connects wire 34 with contact *f*<sup>3</sup>. Wire 43 connects wire 35 with contact *f*<sup>1</sup>. Wire 44 connects wire 33 with contact *g*<sup>6</sup>. Wire 45 connects wire 34 with contact *g*<sup>4</sup>. Wire 46 connects wire 35 with contact *g*<sup>2</sup>. Wire 47 connects

wire 33 with contact  $h^9$ . Wire 48 connects wire 35 with contact  $h^4$ . Wire 49 connects wire 34 with contact  $h^2$ . A solenoid 50 is provided for switch  $d$ , a solenoid 51 for switch  $e$ , a solenoid 52 for switch  $f$ , a solenoid 53 for switch  $g$ , and a solenoid 54 for switch  $h$ . A wire 55 connects contact  $a$  with one pole of solenoid 52. A wire 56 connects contact  $b$  with one pole of solenoid 50. A wire 57 connects contact  $c$  with one pole of solenoid 53. A wire 58 connects contact  $a'$  with wire 55. Wire 59 connects contact  $b'$  with one pole of solenoid 51. A wire 60 connects contact  $c'$  with one pole of solenoid 54. A wire 61 connects contacts  $d^3$  and  $e^8$ . A wire 62 connects contacts  $d'$  and  $e'$ . A wire 63 connects contacts  $d^6$  and  $e^5$ . A wire 64 connects contacts  $g^3$  and  $h^3$ . A wire 65 connects contacts  $g^1$  and  $h^1$ . A wire 66 connects contacts  $g^5$  and  $h^5$ . A wire 67 is connected with solenoid 50, and is connected by a wire 68 with solenoid 51, and by a wire 69 with solenoid 52, and by a wire 70 with solenoid 53, and by a wire 71 with solenoid 54. A wire 72 leads from wire 69 to wire 35.

A lead 73 from motor 6 connects with wire 62. A lead 74 from motor 6 connects with wire 61. A lead 75 from motor 6 connects with wire 63. A wire 76 connects lead 74 with one pole of solenoid of brake 17, and a wire 77 connects lead 75 with the other pole of solenoid of brake 17. A wire 78 connects contact  $f^2$  with one pole of solenoid of differential gear brake 19, and a wire 79 connects contact  $f^4$  with the other pole of the solenoid of differential gear brake 19. One lead 80 from motor 7 connects with wire 65. Another lead 81 from motor 7 connects with wire 64. Another lead 82 from motor 7 connects with wire 66. A wire 83 connects lead 81 with one pole of the solenoid of switch 18, and a wire 84 connects the lead 82 with the other pole of the solenoid of switch 18. Wire 85 connects lever 32 with wire 33. D, E, F, G, H designate the respective armatures for the respective solenoids  $d$ ,  $e$ ,  $f$ ,  $g$  and  $h$ .

The operation is as follows: For starting at slow speed, lever 32 is moved onto contact  $a$ , hereby closing a circuit as follows: from line wire 33 through lever switch 32 to contact  $a$ , through wire 55, through solenoid 52 and wire 86 to wire 72 and wire 35, energizing solenoid 52, and lifting its armature F, which closes circuit between contacts  $f^1$ ,  $f^2$ , and between contacts  $f^3$ — $f^4$ , thereby establishing the following circuit: from wire 35 through wire 43 to contact  $f^1$  to contact  $f^2$  to wire 78, solenoid of brake 19, through wire 79 to contact  $f^4$  to contact  $f^3$  to wire 34. Solenoid of differential gear brake 19 is thus energized, which releases that brake. The controlling lever 32 is next moved to contact  $b$ , which establishes a cir-

cuit from contact  $b$  through wire 56 through solenoid 50, energizing the latter, through wire 67, 69 and 72 to wire 35, and when the solenoid 50 is energized it lifts its armature D, closing contact  $d^1$  and  $d^2$ ,  $d^3$  and  $d^4$ ,  $d^5$  and  $d^6$ , whereupon the circuits are established as follows: from wire 35 through wire 38 to contact  $d^2$  to contact  $d^1$  wire 62 wire 73 to motor 6,—also from wire 34 to contact  $d^4$  to contact  $d^3$  through wire 61 to wire 74 and motor 6, and also from wire 33 through wire 36 to contact  $d^5$  to contact  $d^6$  and through wire 63 to lead 75 and motor 6, and also establishes a circuit from wire 74 through wire 76 to solenoid of brake 17 and from this solenoid through wire 77 to wire 75, thereby releasing brake 17 of motor 6, and also closing the circuit through motor 6, whereupon as motor 7 is still stationary and under its brake 18, motor 6 operates through its shaft 8 to drive gear 13, and through the pinions 14 operates the differential gear casing 15 around the stationary gear 12, the latter being held stationary with shaft 11 of motor 7, and thereby driving the differential gear casing 15 and shaft 10 attached thereto together with worm 4, gear 3 and drum 1 at a reduced speed.

After this starting, to obtain full speed, the lever 32 is moved still farther onto contact  $c$ , thereby establishing circuits as follows: from contact  $c$  through wire 57 through solenoid 53 through wire 70 to wire 71 to wire 35, thereby energizing solenoid switch  $g$  and attracting its armature G thereby closing contacts  $g^1$ ,  $g^2$ ,  $g^3$ ,  $g^4$ ,  $g^5$  and  $g^6$ , which establishes the following circuits: from wire 35 through wire 46 to contact  $g^2$  to contact  $g^1$  through wire 65 to wire 80 and motor 7, and from wire 34 through wire 45 to contact  $g^4$  to contact  $g^3$  through wire 64 to wire 81 and motor 7, and from wire 33 through wire 44 to contact  $g^6$  to contact  $g^5$  through wire 66 to wire 82 and motor 7, and also from wire 81 through wire 83 and solenoid of brake 18, and from this solenoid through wire 84 to wire 82, thereby releasing the brake 18 and starting motor 7. As all three brakes are now released and motor 7 is running, it operates through its shaft 11 and gear 12 to coact with gear 13 driven from motor 6 to drive the differential gear casing 15 at the same speed as the motor shaft, thereby driving worm 4, gear 3 and drum 1 at maximum speed.

When it is desired to slow down, the lever 32 is moved off from contact  $c$ , thereby cutting off the current through the before described connections from motor 7, and de-energizing the solenoid of brake 18 and permitting brake 18 to hold shaft of motor 7 stationary, thereby tending to reduce the speed of the differential housing and the car connected thereto. The momentum of the drum and car tends to maintain the

speed of the worm shaft and of the differential housing connected thereto. The motor 7 being at rest, the differential housing through gears 14 drives gear 13 and shaft of motor 6, faster than the differential housing so that motor 6 is driven at a speed in excess of synchronism. Under this condition motor 6 will act as a generator producing thereby a dynamic brake effect. To come to a full stop, the lever 32 is then moved off from contact *b*, which shuts off current from motor 6 through the beforedescribed connections and deenergizes solenoid of brake 17, causing the latter to set, and then the lever 32 is moved off from contact *a*, which deenergizes the solenoid of brake 19, which causes the latter to set tight on the differential gear casing 15, and thus act as a further brake, although it will be apparent that the brake on the differential gear casing 15 is not an essential feature, but is an added safeguard.

In running in the opposite direction, the lever 32 is first moved onto contact *a'* through wire 58 to wire 55 through solenoid 52 wire 86 and wire 72 to wire 35, thereby energizing solenoid 52 and raising its armature *F*, and closing contacts *f*<sup>1</sup>, *f*<sup>2</sup>, *f*<sup>3</sup>, *f*<sup>4</sup>, whereupon a circuit is established as follows: from wire 35 through wire 43 to contact *f*<sup>1</sup> to contact *f*<sup>2</sup> and wire 78 to solenoid of differential gear brake 19 through wire 79 to contact *f*<sup>4</sup> to contact *f*<sup>3</sup> to wire 34, thus releasing brake 19 of the differential gear. The lever 32 is next moved onto contact *b*<sup>1</sup>, whereupon circuits are established as follows: from contact *b*<sup>1</sup> through wire 59 to solenoid 51 through wire 68 to wire 69 and wire 35, thereby energizing solenoid 51 and attracting armature *E*, thereby establishing a circuit through motor 6 and solenoid of brake 17, thereby releasing brake 17, the circuits through motor 6 being as follows: from wire 33 through wire 39 to contact *e*<sup>6</sup> to contact *e*<sup>5</sup> to wire 63 to wire 75 and motor 6; from wire 34 through wire 41 to contact *e*<sup>2</sup> to contact *e*<sup>1</sup> and wire 62 to wire 73 and motor 6; and from wire 35 through wire 40 to contact *e*<sup>4</sup> to contact *e*<sup>3</sup> to wire 61 to wire 74 and motor 6, these circuits giving a reverse rotation of the motor 6, by reason of the wires 41 and 40 of solenoid switch *e* being connected respectively to wires 34 and 35, while in forward running, the connections are through solenoid switch *d*, in which wires 38 and 37 are respectively connected to wires 35 and 34.

The motor 6 thus operates through the beforedescribed gearing to revolve the drum 1 in the opposite direction at the reduced speed, as at this time the motor 7 is stationary and its brake 18 holds shaft 11 and gear 12 stationary.

To run reversely at full speed the lever 32 is next moved onto contact *c*<sup>1</sup>, whereupon

circuits are established as follows: from contact *c*<sup>1</sup> through wire 60 to solenoid 54 and wire 71 to wire 69 wire 72 and wire 35, thereby energizing solenoid 54 and attracting armature *H*, whereupon circuits are established as follows: from wire 33 through wire 47 to contact *h*<sup>6</sup> to contact *h*<sup>5</sup> to wire 66 to wire 82 to motor 7; also from wire 34 through wire 49 to contact *h*<sup>2</sup> to contact *h*<sup>1</sup> wire 87 to wire 80 and motor 7, and also from wire 35 through wire 48 to contact *h*<sup>4</sup> to contact *h*<sup>3</sup> to wire 86 and wire 81 and motor 7. Circuit is also established from wire 81 through wire 83 solenoid of brake 18 and wire 84 to wire 82. This energizes the solenoid of brake 18 and releases brake 18 and supplies current to motor 7, which now operates in unison with motor 6 and drives the worm 4, gear 3, and drum 1 at full speed. When thus moving reversely to come to a reduced speed, the lever 32 is moved off from contact *c*<sup>1</sup>, thereby through the before described connections stopping motor 7 and setting brake 18. The momentum of the drum and car will have a tendency to revolve the worm 4 ahead of the normal speed of motor 6, which will be retarded by motor 6, which will act as a brake. In coming to a stop, the lever 32 is moved off from contact *b*<sup>1</sup>, which stops motor 6 and sets brake 17 and by moving lever 32 off from contact *a*<sup>1</sup> the solenoid of the differential gear brake is deenergized, setting that brake also.

When running in either direction at full speed, upon slowing down to reduce speed by moving lever 32 off from contacts *c* or *c*<sup>1</sup> the motor which continues in operation speeds up in excess of synchronism, due to the car momentum driving same and acts as a dynamic brake, causing the motor to act as a generator, and the current thus produced is returned to the line. Thus, the energy which is employed to bring the car to a stop is in part turned back into the line, whereas in other systems where a direct current motor is employed and the dynamic braking effect made use of, resistance is utilized, and the energy is wholly dissipated. When the motor, acting as a generator, gradually overcomes the car momentum and the motor has slowed down to synchronism with the alternating supply circuit, its dynamic braking action ceases, and the generator automatically becomes a motor and maintains the reduced speed. The motor is then brought to rest by moving lever 32 off contacts *b* or *b*<sup>1</sup>, thereby cutting off the current supply to the motor and deenergizing its brake 17, the speed being then sufficiently slow to be readily controlled by such brake. With the form of differential gearing shown, the car will be running at half speed with motor 6 running at normal speed. By suitably proportioning the gears

of the differential, the ratio of speeds of the motor and car may be increased so that the car may be slowed down to any desired fraction of its full speed before the dynamic braking effect is exhausted. Thus, as shown in Fig. 3, the gear 12<sup>a</sup>, may be smaller than the gear 13<sup>a</sup>, so as to increase the speed reduction of the car relatively to the motor, in starting or at slow speed, and to increase the speeding up of the motor in stopping, so as to extend the dynamic braking action.

By the above described means the car may be run at either low or high speed without the use of shift gears and with the induction motive means running at normal speed. As such means also provides for reducing the starting torque on the starting motor, it enables a motor with low starting torque to be used and also eliminates the overdraft on the supply circuit and source of current by rush of current to the induction motor, in starting under excessive load.

Fig. 2 shows a modified form in which the motors 6<sup>a</sup> and 7<sup>a</sup> are on opposite sides of the worm 4<sup>a</sup>. In this form it is necessary to carry the shaft 9<sup>a</sup> of motor 6<sup>a</sup> completely through the worm 4<sup>a</sup> to connect with the differential gear. In this form, the operation is precisely the same except for the relative arrangement of the motors and their brakes.

The form shown in Fig. 4 is adapted for traction elevators in which 1<sup>b</sup> designates the drum, which constitutes the casing of the differential gear consisting of gears 12<sup>b</sup> and 13<sup>b</sup>, which are respectively carried on shafts 8<sup>b</sup> and 11<sup>b</sup> of motors 6<sup>b</sup> and 7<sup>b</sup> respectively, pinions 14<sup>b</sup> being mounted directly on the drum. The brake 28<sup>b</sup> of solenoid 19<sup>b</sup> is directly mounted on the drum 1<sup>b</sup>, and the brake 28<sup>b</sup> of motor 7<sup>b</sup> is operated by solenoid 18<sup>b</sup>, while brake 28<sup>b</sup> of motor 6<sup>b</sup> is operated by solenoid 17<sup>b</sup>.

Fig. 6 shows differential gearing adapted to be used in the traction type of Fig. 4, to give a different gear reduction in which the gear 12<sup>c</sup> is smaller than the gear 13<sup>c</sup> and pinions 14<sup>c</sup> are set at a corresponding angle.

What we claim is:

1. A driven element, two induction motors, braking means for the motors respectively, and means connecting said motors to the driven element whereby when the motors are operated at synchronous speed in the same direction as one another the driving element is driven and when one motor is held against rotating the other motor will be operated by the driven element at a greater speed than synchronous speed so that said operating motor will produce dynamic braking action.

2. The method of electric drive, which method comprises operating induction motors in the same direction as one another

at normal speed to drive a driven element, and then reducing the speed of one motor to cause the driven element to drive the other motor at a higher rate of speed than said normal speed so as to produce dynamic braking action of said other motor.

3. A driven element, two motors, gearing between the two motors for driving the driven element, a brake for each motor, solenoids for controlling said brakes, controlling means, a supply circuit, means operated by said controlling means in one position for connecting one motor and the associated brake solenoid with the supply circuit, and when in another position to also connect the other motor and its brake solenoid to the supply circuit.

4. The combination of two electric induction motors, electric supply connections therefor, bevel gears connected respectively with said motors, an intermediate member carrying bevel gears engaging the aforesaid bevel gears to form a differential gearing adapted to permit turning of the motors in the same direction as one another, a load device connected to be driven by and to drive said intermediate member, and means for arresting one of said motors to cause the other motor to run at an increased speed by operation of said load device.

5. A driven element, two motors, a hollow shaft on one motor, a shaft on the other motor extending through the hollow shaft, a gear on each shaft, pinions between said gears, a casing carrying said pinions and driving the driven element, a brake for the hollow shaft, and a brake for the other shaft.

6. A driven element, two motors, a hollow shaft on one motor, a shaft on the other motor extending through the hollow shaft, a gear on each shaft, pinions between said gears, a casing carrying said pinions and driving the driven element, a brake for the hollow shaft, a brake for the other shaft, and a brake for the casing.

7. A driven element, two motors, a hollow shaft on one motor, a shaft on the other motor extending through the hollow shaft, a gear on each shaft, pinions between said gears, a casing carrying said pinions and driving the driven element, a brake for the hollow shaft, a brake for the other shaft, and a solenoid for releasing such brake, each solenoid being in circuit with the associated motor.

8. In elevator operating mechanism, two electric induction motors, electric supply connections therefor, a differential gearing comprising two gear members connected respectively to said motors and an intermediate member provided with gears engaging the aforesaid gear members to permit of turning of the motors in the same direction as one another, said intermediate member

being connected to the elevator car to drive the same and to be driven thereby, and means for arresting one of said motors to cause the other motor to be driven at an increased speed so as to act as a dynamic brake.

9. In combination a differential gear comprising two opposite gear members, an intermediate member provided with gears rotatably mounted thereon and engaging the aforesaid gear members, two electric induction motors adapted to turn in the same direction as one another and connected respectively to said opposite gear members to drive said opposite gear members and the intermediate member at the same rotative speed, and means for arresting one of said motors to enable the intermediate member to drive the other motor at an increased speed, so that said other motor will act as a dynamic brake.

10. In combination with an alternating current supply circuit, two induction motors connected thereto, a driven element, a differential gearing having opposite members connected to said motors and having an intermediate member connected to said driven element to allow turning of the motors in the same direction as one another, and means for arresting one of said motors to cause the other motor to operate at a high speed relatively to the driven member.

11. In combination with an alternating current supply circuit, an induction motor connected thereto, a driven element, means connecting said driven element to said motor to drive said driven element at a definite speed when the motor is running at normal speed, and means for changing the connection between the motor and driven element to cause the motor to run above normal and above synchronous speed, while the driven element is running at or below normal speed, whereby the motor is caused to act as a generator, and as a dynamic brake.

12. The method of electric drive, which method comprises operating differentially connected induction motors at normal speed to move a load, and then mechanically arresting one motor to cause the load to drive the other motor at a higher speed than said normal speed so as to produce dynamic braking action of said other motor.

13. The method of electric drive, which method comprises energizing differentially connected motors to cause operation thereof at synchronous speed in the same direction as one another to move a load, and then producing braking action on one of said motors and deenergization thereof so that the inertia of the moving load will run the other motor above synchronous speed.

14. In combination, two induction motors, a differential connection for said motors, a

rotative member connected to and driven by the differential when the motors are running at synchronous speed in the same direction as one another and driving the differential when one of the motors is cut out, there being means to reduce the speed of said motor, so that the speed of the other of said motors will tend to be increased and said other motor will in consequence function as a dynamic brake.

15. The combination with a load-device, of accelerating and retarding means therefore, comprising two electric motors having electrical energizing connections and provided with shafts, a driven member connected to said load-device to apply power to the load-device for accelerating the same and to receive power from the load-device for retarding the same, braking means for each motor shaft, and gearing connecting each motor shaft with the driven member to cause the driven member to operate at the same speed as the motor shafts when both motors are operating and to cause the driven member to operate at a reduced speed relative to one of the motors when the other motor is retarded by its brake, whereby the load device may be operated at a reduced speed in starting and may operate one of the motors at an increased speed in stopping to produce a dynamic braking action of said motor.

16. The combination of a driven member, two motors, each provided with driving connections and with a shaft, braking means for each shaft, differential gearing connecting both of said shafts to said driven member to operate the driven member by the joint action of said motors and to cause the driven member to operate one of the motors at an increased speed when the other motor is retarded by its braking means.

17. A driven element, differential gearing connected to drive the same, two motors connected to opposite members of said differential gearing for joint operation of said driven element, braking means for one of said motors to cause the driven member to operate at a reduced speed relative to the other motor so as to reduce the speed of the driven member in starting and to increase the speed of said other motor for producing a dynamic braking action of said other motor in stopping, and braking means for said other motor to bring the driven member to rest.

18. A load device, a differential gear connected to said load device to operate said load device and to be operated thereby, two motors provided with operating connections and having shafts connected to opposite members of said differential gear to operate the load device by the joint action of said motors, means for braking one of said motors to cause the load to operate at a reduced

speed relative to the other motor, whereby the load device may be operated at a reduced speed in starting and may operate the said other motor at an increased speed in stopping to produce a dynamic brake action, and means for braking said other motor to bring the load device to rest.

19. In combination, induction motors, a driven element differentially connected to the induction motors, brakes for the induction motors, and means to establish an electric circuit for release of one brake and energization of its associated motor and to then establish an electric circuit for release of the other brake and energization of its associated motor to drive said last named motor in the same direction and at the same speed as the first named motor.

20. In combination, induction motors, a driven element differentially connected to the induction motors, brakes for the induction motors, and means to establish electric circuits for release of the brakes and energization of their associated motors and to then break one of said circuits to deenergize one of said motors and to set the associated brake to allow the driven element to drive the other motor at a higher speed than synchronous speed so as to produce dynamic braking action of said other motor.

21. The method of electric drive, which method comprises operating induction motors at normal speed to drive a driven element, and then bringing one motor to a stop to cause the driven element to drive the other motor at a higher rate of speed than said normal speed so as to produce dynamic braking action of said other motor.

22. The combination of two induction motors, electric supply connections therefor, bevel gears connected respectively with said motors, an intermediate member carrying bevel gears engaging the aforesaid bevel gears to form a differential gearing, a load device connected to be driven by and to drive said intermediate member, and means for stopping one of said motors to cause the

other motor to run at an increased speed by operation of said load device.

23. In elevator operating mechanism two induction motors, electric supply connections therefor, a differential gearing comprising two gear members connected respectively to said motors, and an intermediate member provided with gears engaging the aforesaid gear members, said intermediate member being connected to the elevator car to drive the same and to be driven thereby, and means for stopping one of said motors to cause the other motor to be driven at an increased speed so as to act as a dynamic brake.

24. In combination, a differential gear comprising two opposite gear members and an intermediate member provided with gears rotatively mounted thereon and engaging the aforesaid gear members, two induction motors connected respectively to said opposite gear members to drive said opposite gear members and the intermediate member at the same rotative speed, and means for stopping one of said motors to enable the intermediate member to drive the other motor at an increased speed so that said other motor will act as a dynamic brake.

25. In combination with an alternating current supply circuit, two induction motors connected thereto, a driven element, a differential gearing having opposite members connected to said motors and having an intermediate member connected to said driven element, and means for stopping one of said motors to cause the other motor to operate at higher speed relative to the driven member.

In testimony whereof, we have hereunto set our hands at Los Angeles, California, this 16th day of July, 1914.

ROBERT H. GAYLORD.  
GUY B. CAPPS.

In presence of—

GEO. T. HACKLEY,  
LORRAINE E. DURROW.