March 12, 1940. W. BECK 2,193,683

DRIVE MECHANISM

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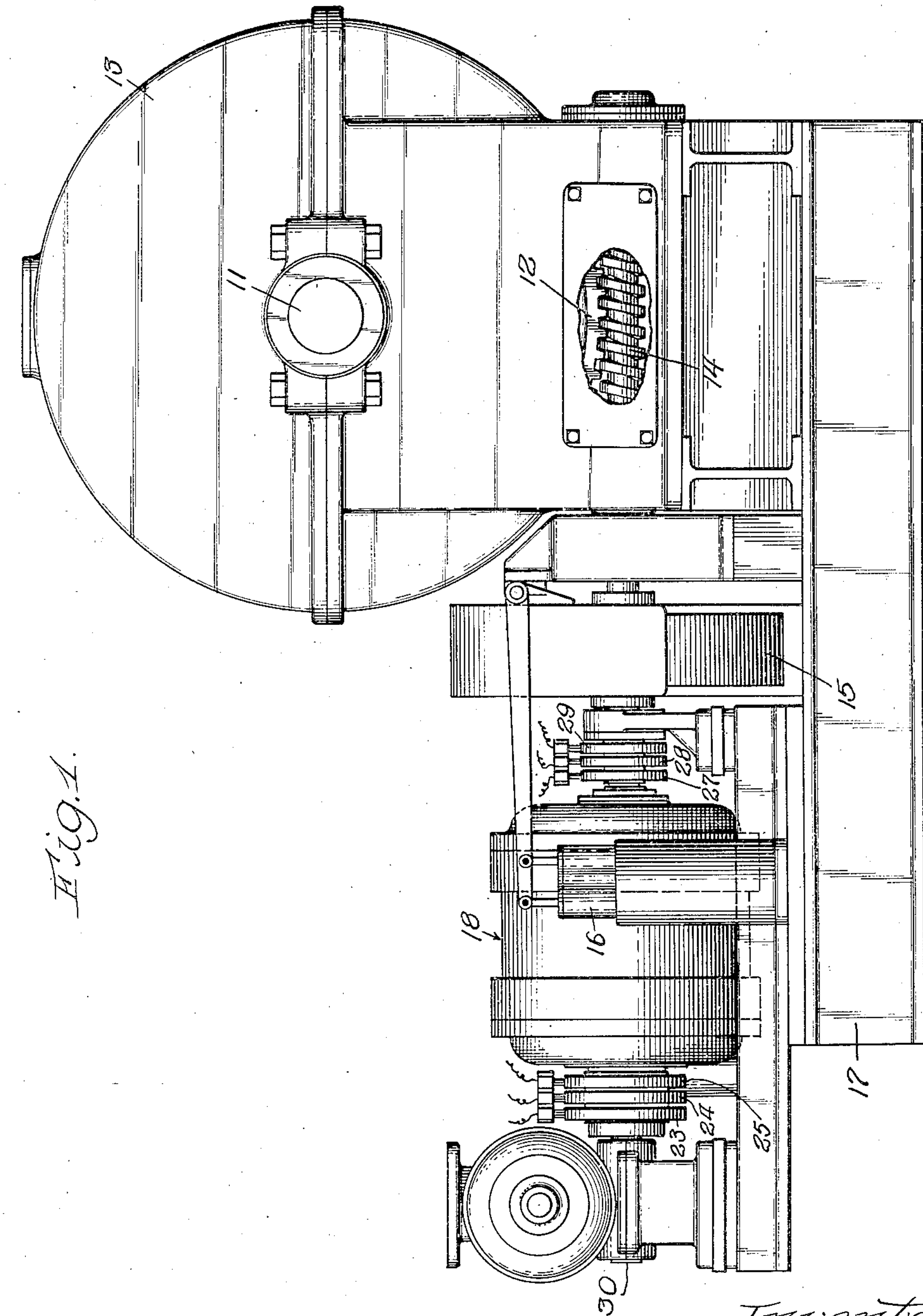
Fig. 1

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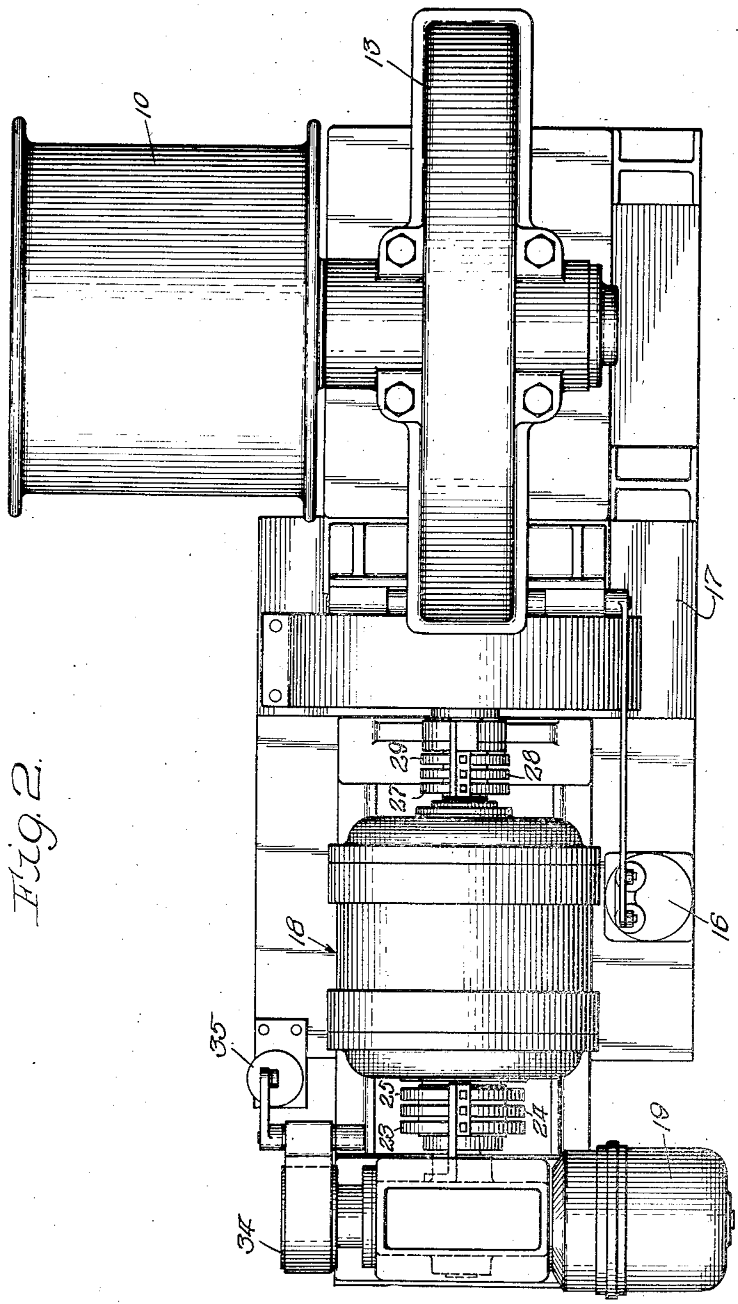


Fig. 2.

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DRIVE MECHANISM

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Fig. 3

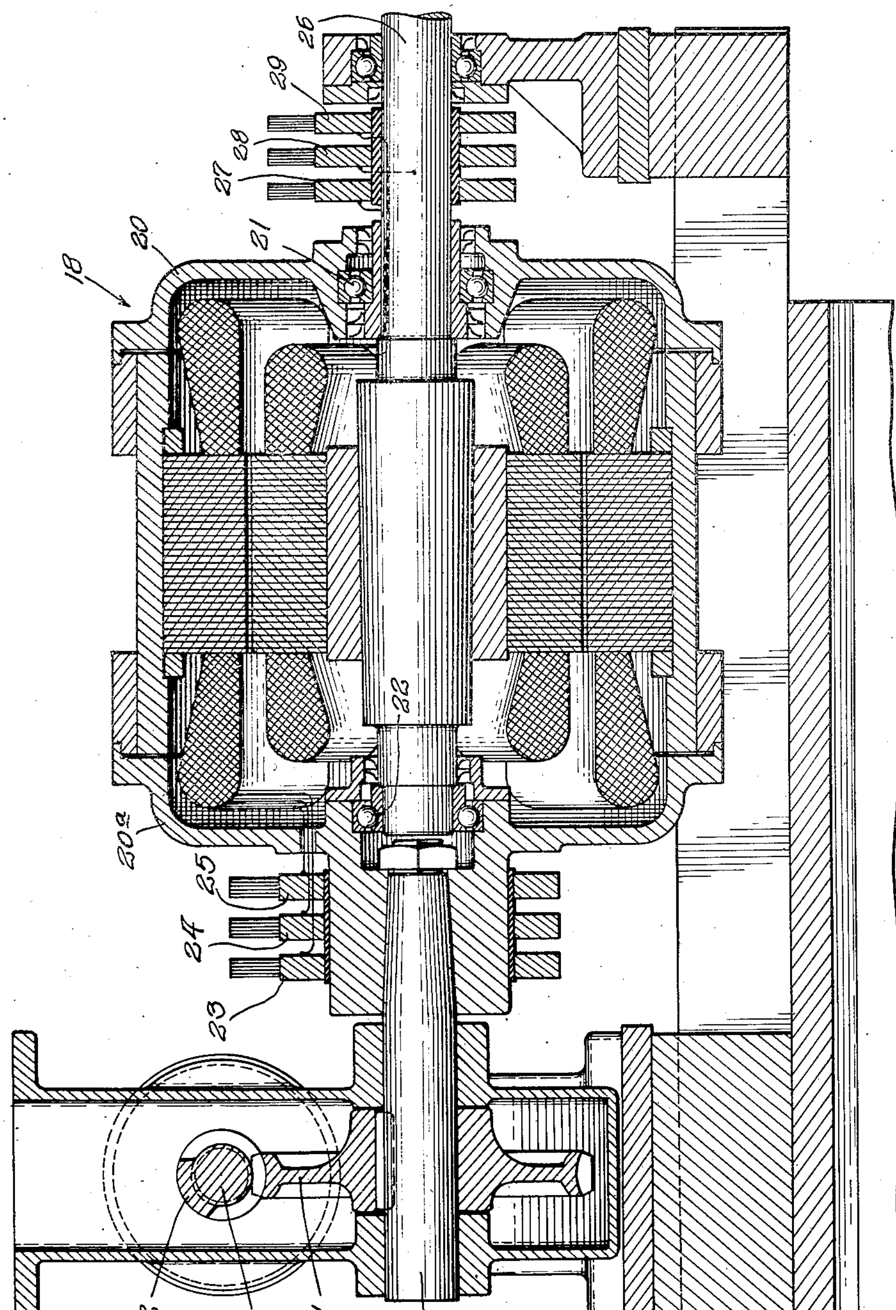


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Fig. 4.

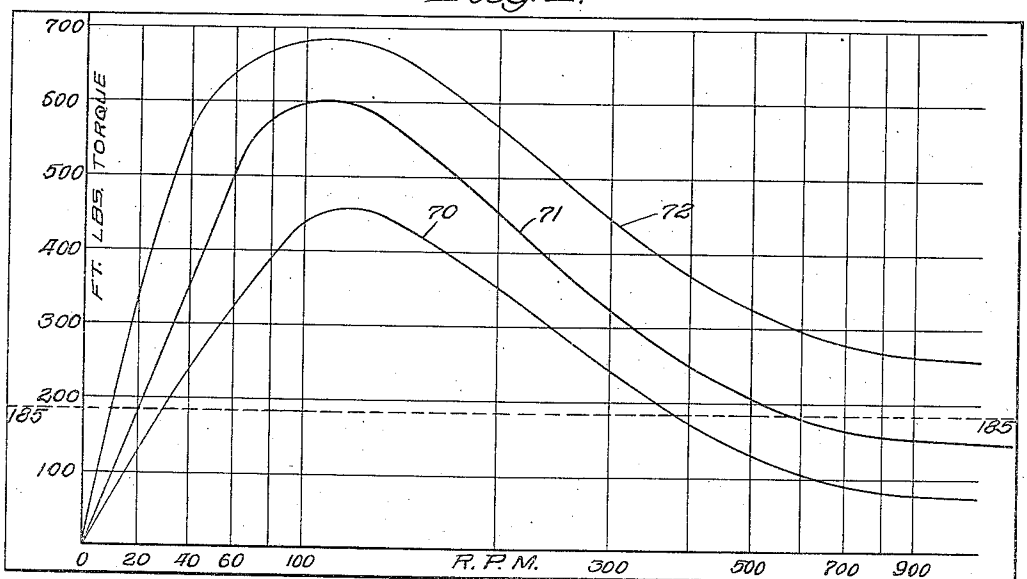



Fig. 5.

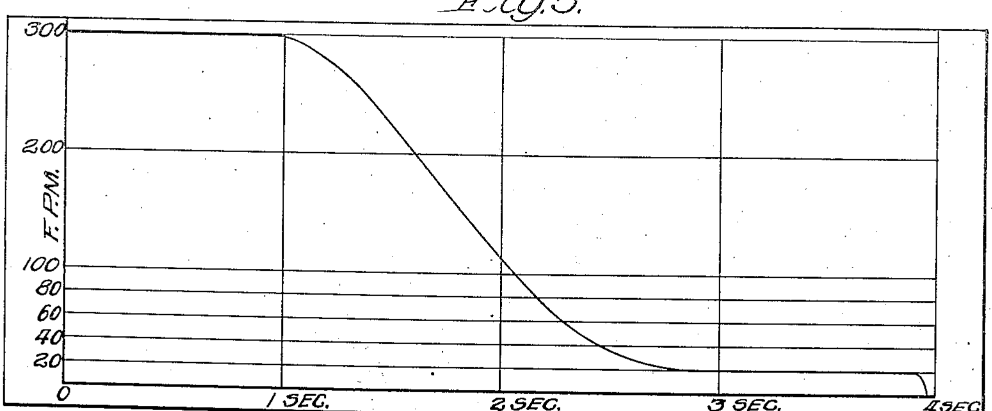
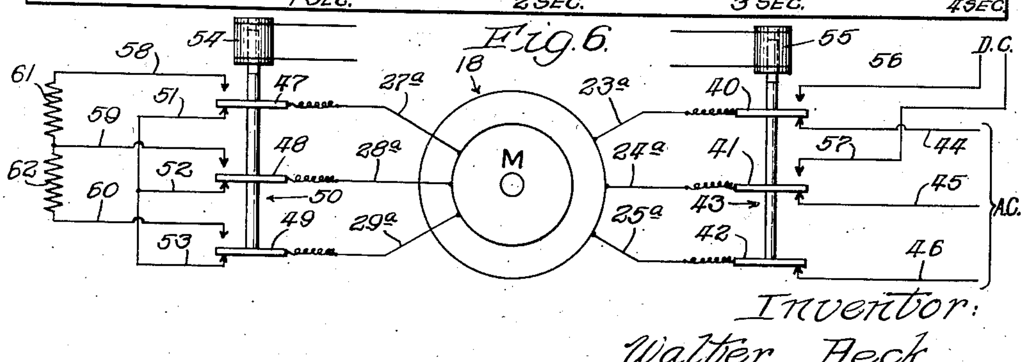



Fig. 6.

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Patented Mar. 12, 1940

2,193,683

# UNITED STATES PATENT OFFICE

2,193,683

## DRIVE MECHANISM

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Application March 17, 1939, Serial No. 262,554

15 Claims. (Cl. 172—239)

This invention relates to a drive mechanism, and more particularly to a mechanism adapted to provide high and low speed drives.

One feature of this invention is that it provides simple and effective high and low speed drives; another feature is that means is provided for smoothly effecting a transition from the high speed to the low speed of operation; still another feature of this invention is that one or more motors of conventional and simple type may be used; a further feature of this invention is that the motor or motors may be driven by alternating current; yet another feature of this invention is that it is particularly adapted for driving an elevator; other features and advantages of this invention will be apparent from the following specification and the drawings, in which:

Figure 1 is a side elevation of apparatus embodying my invention in a geared elevator drive; Figure 2 is a top plan view of the apparatus shown in Figure 1; Figure 3 is a fragmentary vertical sectional view; Figure 4 is a chart showing torque characteristic curves; Figure 5 is a chart particularly illustrating the transition from high speed to low speed operation; and Figure 6 is a simplified schematic circuit diagram.

It is very desirable in a number of drive applications, such as hoists and elevators, to provide a high speed drive and a low speed drive for use only during a short interval before the drive is terminated. For example, in elevator work it is desirable to have a high speed drive that will move the car rapidly from floor to floor during the major part of its travel; and a low speed drive which comes into effect only when it is desired to stop the car at a floor, and enables the car to be brought to a stop at exactly the desired point. This low speed drive is generally known in the elevator art as the leveling drive. In order to enable proper leveling, this drive should be quite low speed relative to the main drive, generally being adapted to drive the car at one-sixth or less of the high speed drive. The provision of the two drives, and particularly the transition from high speed to low speed drive, provides a number of problems.

While these problems are not as serious in low speed direct current installations or ultra-high speed gearless installations, they are particularly difficult to overcome in medium speed alternating current installations, especially of the geared type; and this class comprises the major number of elevator installations.

Two different methods of drive have heretofore been commonly used in this last-mentioned type of installation, the one employing a two-speed multiple pole motor, and the other variable voltage control. Both have certain objections, particularly in the way of weight, size and expense.

My invention provides a two-speed drive readily adapted to use substantially conventional alternating current motors, and effects a smooth transition from high speed to low speed of operation. The main or high speed drive may be of substantially any desired type. In order to effect a transition to and continue to drive at a low speed, I provide an electric motor with both the armature and field elements thereof rotatable; drive one of these elements at a low speed of rotation by auxiliary drive means; and so arrange matters that the two elements electrically resist relative rotation, so that the object being driven is slowed down to and driven at substantially the speed of rotation of the motor element being driven by the auxiliary means.

In the particular embodiment disclosed herewith my invention is shown in connection with a geared medium speed drive for an elevator wherein the main source of power is alternating current, a type of installation wherein my drive is particularly advantageous. Referring first to Figures 1 and 2, the righthand half of the apparatus illustrated is of conventional type. A drum 10 adapted to have the elevator cables pass thereover is mounted on a shaft 11 on which is also mounted a worm gear 12 in the gear housing 13, this gear being driven by the worm 14. A brake drum 15 is provided on the worm shaft and has operatively associated with it brake mechanism of conventional type including the operating solenoid 16, this brake mechanism being used to make the final stop at a floor. All of the drive apparatus is for convenience generally mounted on a single base, as 17.

The lefthand part of the apparatus, shown in more detail in sectional view in Figure 3, includes a main drive motor 18 and a smaller secondary or auxiliary motor 19. The main motor 18 is here shown as comprising two rotatably mounted elements, the outer comprising bonnets 20 and 20a and field structure rotatable on the bearings 21 and 22, these bonnets carrying a wound field of the type generally found in three-phase alternating current motors, the three leads of the field windings being brought out to the slip rings 23, 24 and 25. The inner element is here shown as a phase wound armature rigidly mounted on the shaft 26, which is the same shaft on which are mounted the brake drum 15 and the worm 14.

The leads from the armature are brought out to slip rings 27, 28 and 29.

The bonnet $20^a$ of the field element is rigidly connected to a stub shaft 30 which, while it is axially aligned with the main shaft 26, has no connection thereto. The stub shaft 30 has mounted thereon, in an appropriate housing, a worm gear 31 adapted to be driven by a worm 32 on a cross shaft 33. The shaft 33 has mounted on one end thereof the armature of the secondary motor 19; and on the other end thereof a brake drum 34 and cooperative brake mechanism including an operating solenoid 35. In the operation of the particular embodiment illustrated herewith during high speed drive, the field element of the motor 18 is held stationary by actuating solenoid 35 in such a way as to apply the break to the drum 34; this acts through the shaft 33 and the gears 31 and 32 to hold the stub shaft 30 on which the field element is mounted. Three-phase alternating current is then supplied to the field windings through the slip rings 23, 24 and 25 to effect rotation of the armature element in accordance with conventional induction motor practice. This rotates the shaft 26 and, through the gears 14 and 12, the drum 10 to provide the high speed drive for the elevator. When it is desired to slow the elevator down to and drive it at the low or leveling speed, the alternating current is removed from the slip rings leading to the field and direct current supplied to any two of these rings; at the same time resistances are inserted in the armature circuit, the brake holding the drum 34 is released, and the small secondary motor 19 is energized. The motor 19 drives the field element at some desired slow speed of rotation; and the circuit arrangement in connection with the motor 18 is now such that the two elements thereof electrically resist relative rotation. This causes the armature element to be electrically braked to substantially the speed of rotation of the field element, and then driven by the field element to provide the low speed movement of the car. When the car has reached the desired level with respect to the floor all power is cut off, in accordance with conventional practice, and the car stopped by the main friction brake operating on the drum 15.

The circuit arrangements for accomplishing these desired results are shown in simplified diagrammatic form in Figure 6. The field and armature connection of the main motor would be led out through the slip rings and brushes, $23^a$, $24^a$ and $25^a$ supplying the current to the slip rings 23, 24 and 25; and leads $27^a$, $28^a$ and $29^a$ being connected, respectively, to the slip rings 27, 28 and 29. These leads may be connected to any desired switching and control arrangement to secure the desired results. For example, leads $23^a$, $24^a$ and $25^a$ may be connected to the bars 40, 41 and 42 of a relay 43. When this relay is in the position shown, the bars 40, 41 and 42, and thus the field winding of the motor 18, would be connected to the leads 44, 45 and 46 of a conventional three-phase alternating current supply. At the same time the armature windings of the motor might be arranged to be short-circuited, as by the connections through the bars 47, 48 and 49 of the other relay 50 and the interconnected leads 51, 52 and 53.

When it is desired to drop from high speed to low speed and operate at such low speed, the operating coils 54 and 55 might be energized to lift the movable members of the relays 50 and 43. The bars 40 and 41 would then be in contact with the leads 56 and 57 to supply direct current from some conventional source, as a motor generator set or rectifier, to the field of the motor; and the bars 47, 48 and 49 would be connected to the wires 58, 59 and 60 to interconnect the windings of the armature through the resistances 61 and 62 to achieve the desired dynamic braking or electrical resistance to relative rotation between the field and armature elements of the motor 18. At the same time the secondary drive motor 19 could be energized and the brake solenoid 35 de-energized by any conventional control mechanism not specifically shown here, since such specific mechanism does not comprise the present invention.

It will be understood, of course, that the circuit shown in Figure 6 is extremely simplified. In practice, the resistances 61 and 62 would be star or delta arranged and might form part of the main or high speed drive starting resistances; and resistances or other means might be provided in the direct current source to enable adjustment of the amount of such current supplied. I have found that the best results in effecting a smooth transition from high to low speed is obtained by using a star wound field and energizing only two leads thereof with D. C.

For a given main motor 18 variation in the amount of direct current supplied to the field windings and variation of the amount of resistance inserted in circuit with the armature windings regulates the shape and maximum amplitude of the curve characteristic of the resistance to relative motion between the elements. With a given D. C. excitation, for example, three different values of resistance in the armature circuit will give the three curves reproduced as Figure 4, referred to for convenience as curves 70, 71 and 72. In the particular installation chosen for an example the main motor rotates, when at full speed, at 900 R. P. M. to provide the high speed drive. Under an average assumed load the car might require 185 foot pounds of torque to raise it. Under these circumstances the electrical braking apparatus would preferably be arranged to employ the curve 71. When the car is moving upwardly at high speed and it is desired to stop it at a given floor the main power would be cut off at an appropriate place, by a manual or automatic controller, and the electrical braking apparatus thrown into operation. Inasmuch as the torque curve 71 is less than 185 foot pounds at 900 R. P. M., there would be no jar or jolt to the passengers when it came into effect. Since the torque resisting rotation of the armature, and consequently upward movement of the car, increases as the speed drops, the deceleration of the car would be increased until it reached a maximum at a little over 100 R. P. M. difference in speed from the outer or field element of the main motor. The foot pounds of torque resisting relative rotation between the motor elements, and thus the deceleration of the car, would then decrease until the armature element was rotating at the speed of rotation of the field element, which, as before described, is being rotated at a relatively slow speed by the secondary motor 19. This speed of rotation of the field element may be assumed, for example, to be 80 R. P. M. When the speed of rotation of the armature has become the same as that of the field element it will start to slip backward with respect thereto, because of the resistance to rotation imposed by the load of the car, and the torque curve resulting from relative rotation between the elements will again start to climb from zero. When the armature is traveling at 20 R. P. M. slower than the field element, the torque between the two parts would again be 185 foot pounds, sufficient to drive the car and its assumed load upwardly. Now, however, the car is being driven upwardly at a low speed by the secondary motor 19. Under the conditions of the installation chosen as an example, the car would be moving at a speed corresponding to 60 R. P. M. of the armature, the speed of rotation of the field element (80 R. P. M.) minus the differential speed between the two elements (20 R. P. M.) necessary to provide the necessary foot pounds of torque. In accordance with conventional practice, the car would be driven at this low speed until it was within a matter of a few inches of where it was desired to stop it at the floor level, whereupon all driving power would be discontinued and the main brake set to bring it to a stop at the floor.

If it be assumed that the size of the drum and the ratio of the main driving gearing is such that the car travels one foot per minute for each three revolutions of the armature shaft 26, the action of the car under the conditions given as an example is shown in Figure 5. With the main driving motor rotating at full speed of 900 R. P. M., the car would be traveling at its high speed at 300 feet per minute, as shown in the first portion of the chart. At the point corresponding to one second the main driving power is thrown off and the electrical braking apparatus brought into play, whereupon the deceleration described above causes the velocity of the car to drop as shown. In about one and three-fourths seconds after the electrical braking and secondary drive have been brought into action the car has been brought down to the desired low speed of twenty feet per minute, and for the following second is driven at that low speed in the manner described. Thereupon, just before the end of the chart, the entire driving current is thrown off and the car brought to a stop by the main braking apparatus. It will be understood, of course, that choice of the amount of direct current excitation of the field and resistance in the armature will control the slope and length of the middle portion of the curve shown in Figure 5. That is, if the resistance to relative rotation between the elements is made very high the car will be decelerated very rapidly from high to low speed; on the other hand, if it is so arranged that the braking torque is relatively low the deceleration portion of the curve can be stretched out considerably. While the conditions assumed above for descriptive purposes have been in connection with raising a load, it will be apparent that all of the advantages of my invention come into play equally in lowering a load.

A geared elevator drive with a three-phase induction motor having a phase-wound armature surrounded by a star-wound field was chosen for illustration. It will be readily apparent, however, that the relation of the field and armature elements could be reversed, a squirrel cage rotor could be used, or a completely independent main drive means could be provided. It is also readily apparent that, while my invention is shown embodied in a two-speed drive, it can be employed in a drive having a greater number of speeds. For example, the secondary motor 19 may be a two-speed motor; or it may be rotated during operation of the main motor to provide a drive having a speed which is the sum of the rate of rotations of both elements or the difference therebetween, depending upon whether the secondary motor is driving the rotatable field element in the direction of rotation of the armature of the main motor, or oppositely thereto, during excitation of the main motor.

While I have described certain embodiments of my invention it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

I claim:

1. Drive apparatus of the character described, including: an electric motor comprising a field element and an armature element, both elements being rotatable about a common axis; means for energizing the motor to effect rotation of one of the elements with respect to the other; means for energizing the motor with direct current to cause it to electrically resist any relative rotation between the elements thereof; and means for rotating the other element.

2. Apparatus of the character claimed in claim 1, wherein the last mentioned means rotates said other element at a relatively slow speed.

3. Multi-speed drive apparatus of the character described, including: an electric motor comprising a field element and an armature element, both elements being rotatable about a common axis; means for energizing the motor to effect rotation of one of the elements with respect to the other, said rotation being relatively rapid to provide a high speed drive; means for energizing the motor with direct current to cause it to electrically resist any relative rotation between the elements thereof; and means for rotating the other element at relatively slow speed, while the resisting means is operative, to effect rotation of the first mentioned element to provide a low speed drive.

4. Multi-speed drive apparatus of the character described, including: an electric motor comprising a field element and an armature element, both elements being rotatable about a common axis; means for energizing the motor to effect rotation of one of the elements with respect to the other, said rotation being relatively rapid to provide a high speed drive; means for holding the other element stationary during such drive; means for energizing the motor with direct current to cause it to electrically resist any relative rotation between the elements thereof; and means for rotating the other element at relatively slow speed, while the resisting means is operative, to effect rotation of the first mentioned element to provide a low speed drive.

5. Multi-speed drive apparatus of the character described, including: an electric motor comprising a field element and an armature element, both elements being rotatable about a common axis; means for energizing the motor to effect rotation of one of the elements with respect to the other, said rotation being relatively rapid to provide a high speed drive; means for holding the other element stationary during such drive; means for rotating the other element at relatively slow speed; and means for energizing the motor with direct current to cause it to electrically resist any relative rotation between its elements, said rotating and resisting means both becoming operative immediately upon deenergization of the motor, whereby the first mentioned element is

electrically braked to and driven at substantially the speed of rotation of the other element.

6. Apparatus of the character claimed in claim 1, wherein the rotating means is a second smaller electric motor.

7. Apparatus of the character claimed in claim 5, wherein the holding means includes a friction brake.

8. Apparatus of the character claimed in claim 5, wherein the slow speed rotating means is a second smaller motor.

9. Multi-speed drive apparatus for an elevator, including: an electric motor comprising a field element and an armature element, both elements being rotatable about a common axis and one element being adapted to be geared to the cable drum of the elevator to act as the drive element therefor; means for energizing the motor to effect rotation of the drive element with respect to the other to provide a high speed drive for the elevator; and means for rotating the other element at relatively slow speed and simultaneously energizing the motor with direct current to cause it to electrically resist any relative rotation between the elements thereof to provide a low speed drive for the elevator.

10. Apparatus of the character claimed in claim 9, including means for holding the other element stationary while the motor is being energized to provide the high speed drive.

11. Multi-speed drive apparatus for an elevator, including: an electric motor comprising a field element and an armature element, both elements being rotatable about a common axis and one element being adapted to be geared to the cable drum of the elevator to act as the drive element therefor; means for energizing the motor to effect rotation of the drive element with respect to the other to provide a high speed drive for the elevator; means for holding the other element stationary during such drive; means for rotating the other element at relatively slow speed; and means for energizing the motor with direct current to cause it to electrically resist any relative rotation between its elements, said rotating and resisting means both becoming operative immediately upon deenergization of the motor, whereby the drive element is electrically braked to and driven at substantially the speed of rotation of the other element.

12. Apparatus of the character claimed in claim 11, wherein the holding means is a friction brake and the slow speed rotating means is a smaller electric motor.

13. Drive apparatus of the character described, including: a device comprising a field element and an armature element, both elements being rotatable about a common axis; main drive means; means for rotating one element of said device; and means for energizing the field with direct current to cause the two elements of said device to resist any relative rotation therebetween.

14. Multi-speed drive apparatus of the character described, including: a device comprising a field element and an armature element, both elements being rotatable about a common axis; main drive means for providing a high speed drive; means for energizing the field element of the device with direct current to cause the elements to electrically resist any relative rotation therebetween; and means for rotating one of said elements at relatively slow speed while the resisting means is operative to effect rotation of the other element to provide a low speed drive.

15. Multi-speed drive apparatus of the character described, including: a device comprising a field element and an armature element, both elements being rotatable about a common axis; main drive means for providing a high speed drive, one of the elements being connected thereto; means for rotating the other element at relatively slow speed; and means for energizing the field element with direct current to cause the device to electrically resist any relative rotation between the elements, said rotating and resisting means becoming operative upon discontinuance of the main drive, whereby the first mentioned element is electrically braked to and driven at substantially the speed of rotation of the other element.

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