No. 748,488. PATENTED DEC. 29, 1903.

A. C. EASTWOOD.

CONTROLLING SYSTEM FOR CONVEYERS.

APPLICATION FILED OCT. 16, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.

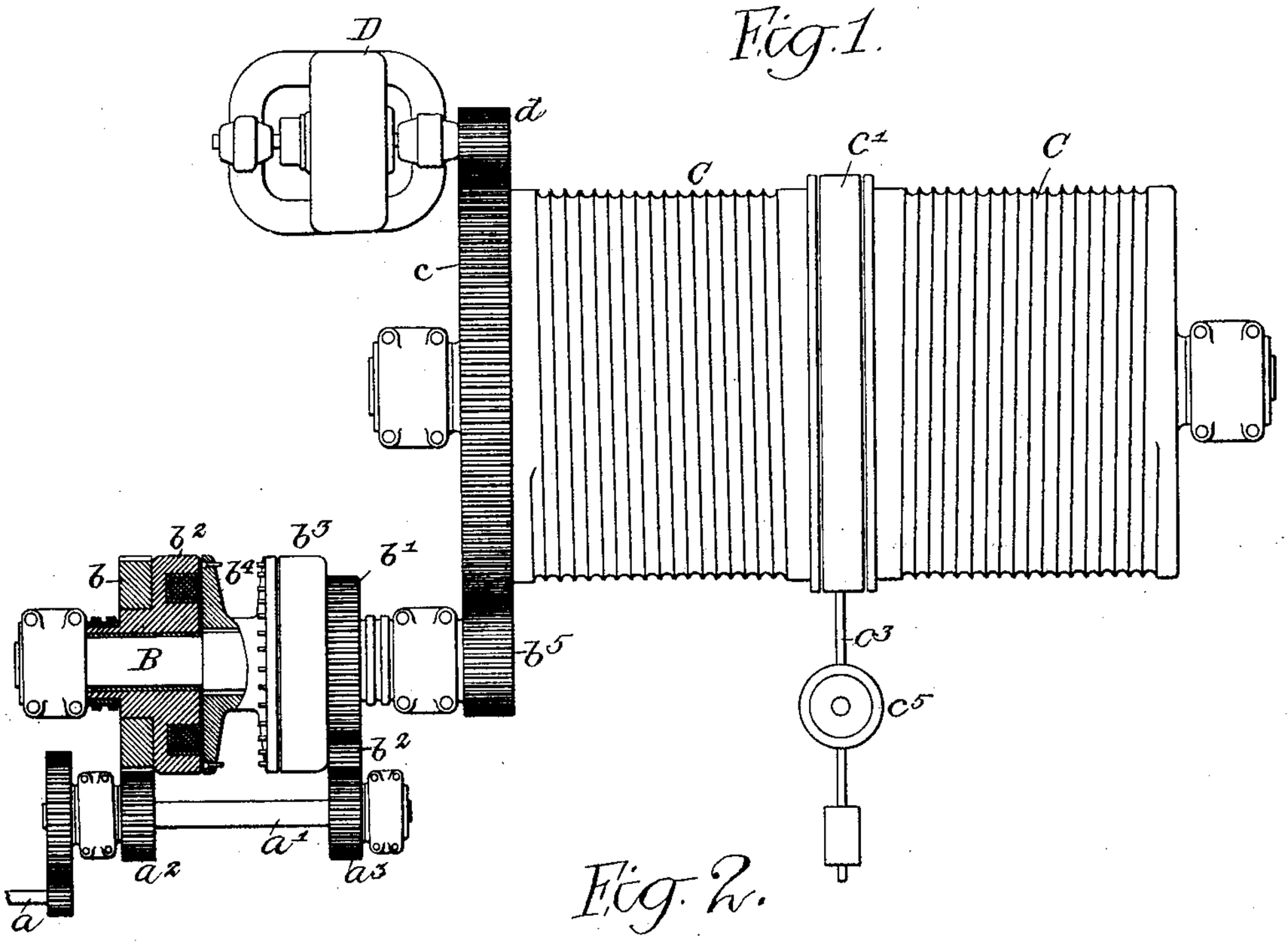
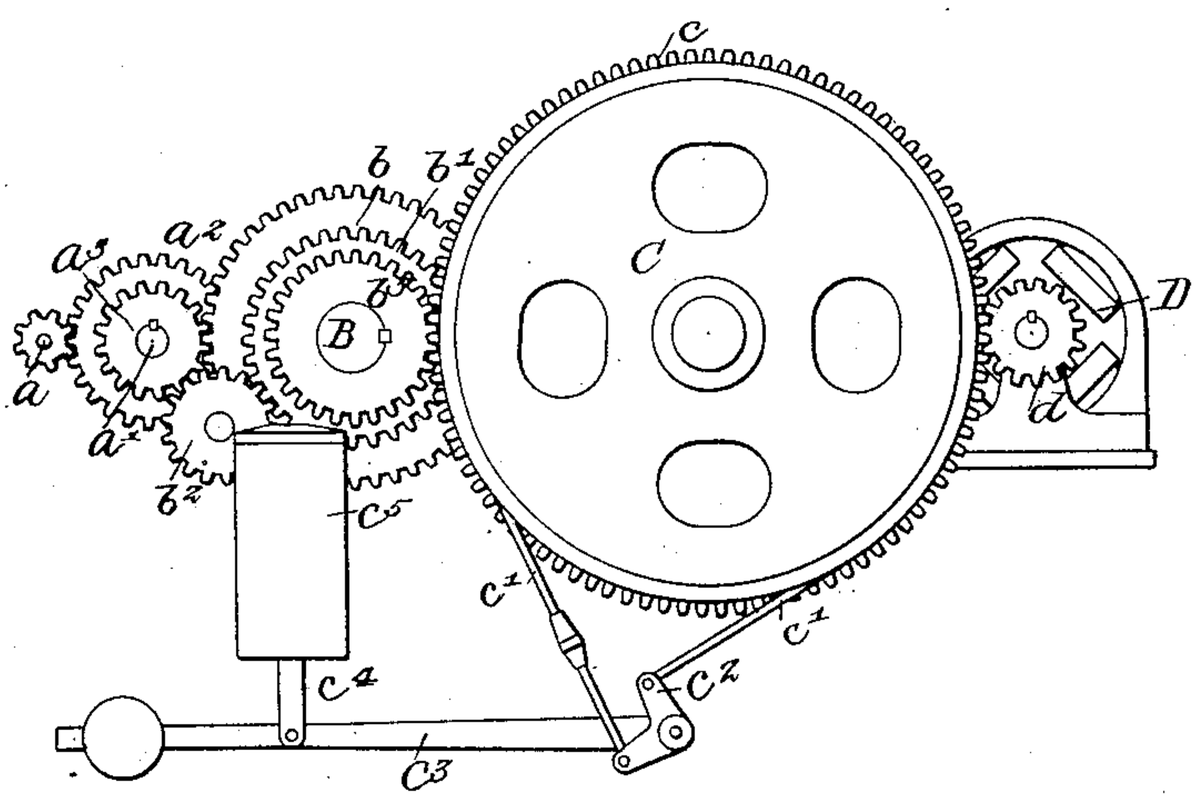


Fig. 2.



Witnesses:-
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Titus H. Sons

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NO MODEL. 3 SHEETS—SHEET 2.

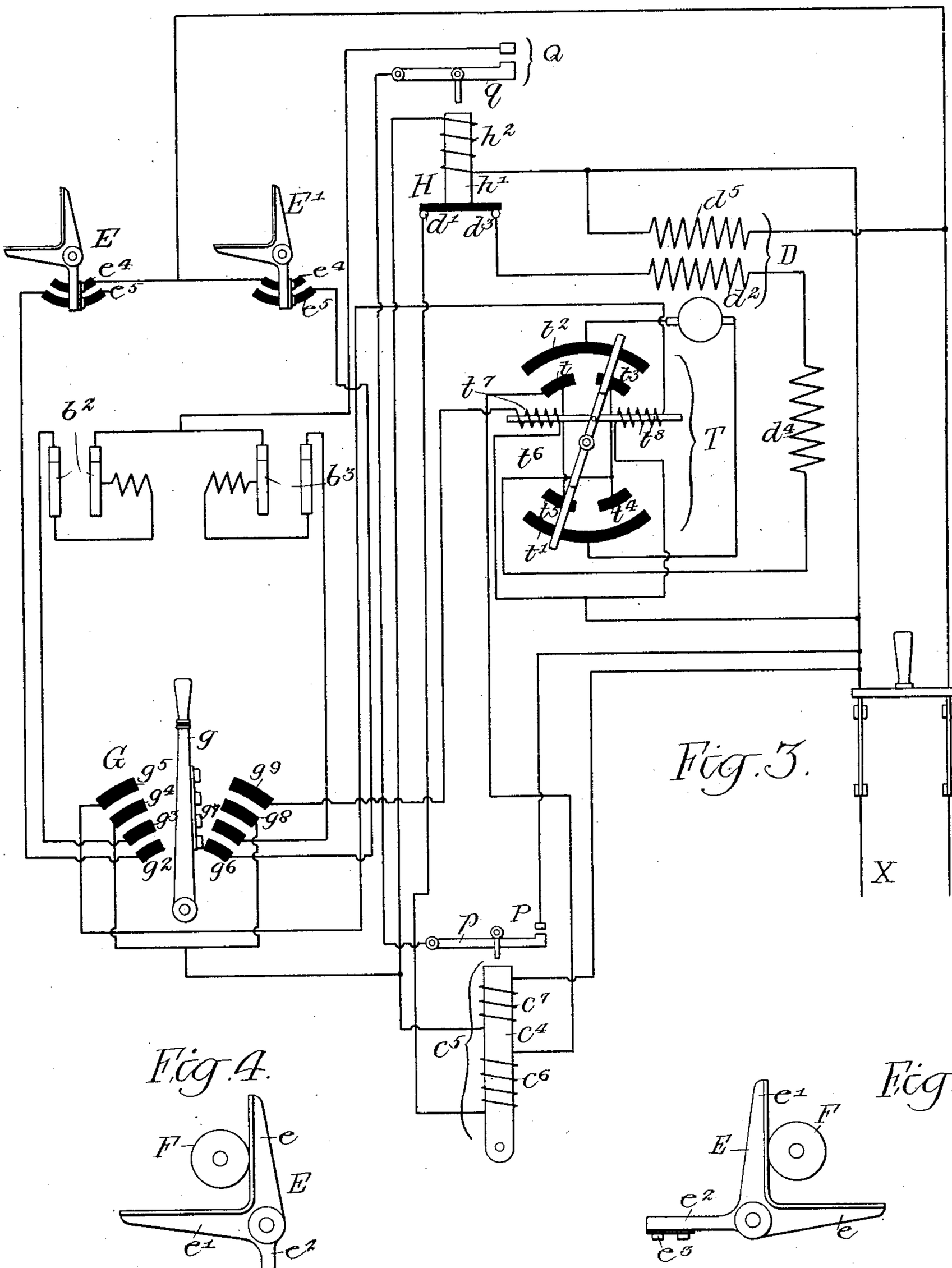

Fig. 3.

Fig. 4.

Fig. 5.

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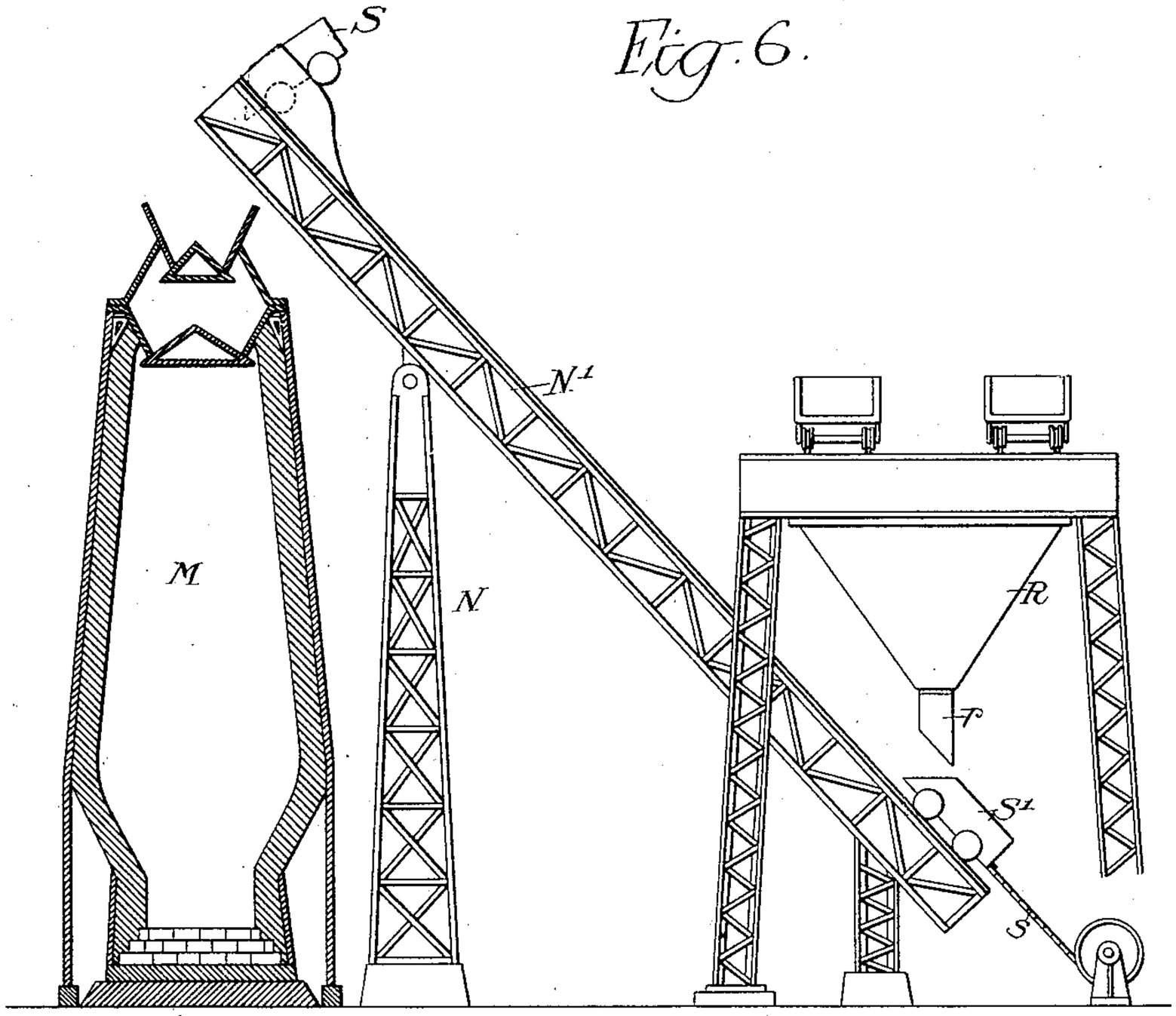
NO MODEL. 3 SHEETS—SHEET 3.

Fig. 6.



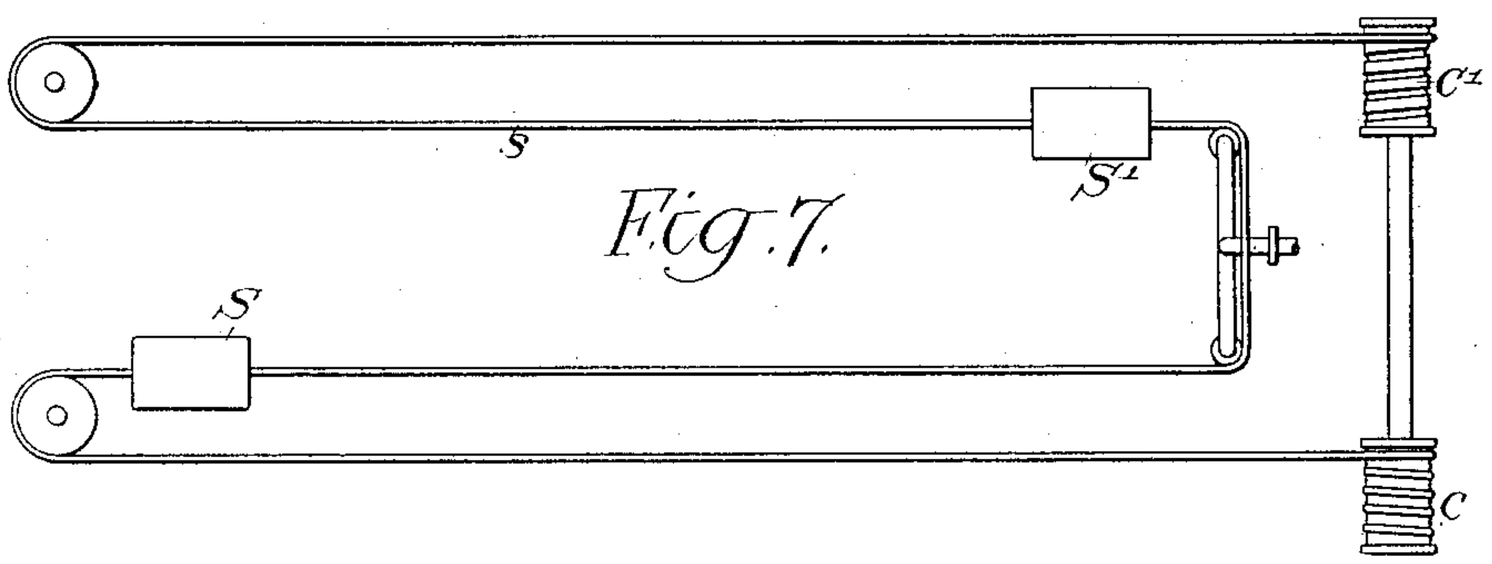


Fig. 7.

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No. 748,488. Patented December 29, 1903.

UNITED STATES PATENT OFFICE.

ARTHUR C. EASTWOOD, OF CLEVELAND, OHIO.

CONTROLLING SYSTEM FOR CONVEYERS.

SPECIFICATION forming part of Letters Patent No. 748,488, dated December 29, 1903.

Application filed October 16, 1903. Serial No. 177,293. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR C. EASTWOOD, a citizen of the United States, residing in Cleveland, Ohio, have invented certain Improvements in Controlling Systems for Conveyers, of which the following is a specification.

My invention relates to certain new and useful improvements in systems for control of conveyers, such as hoists and the like; and it consists more particularly in improvements in that class of hoisting-machines wherein the conveying device is started by an operator and is automatically stopped when a predetermined point has been reached by the load moved. Hoists of this character are particularly designed for use in elevating stock to the tops of blast-furnaces, and for this purpose said stock, which usually consists of ore, limestone, coke, &c., is conveyed from the stock-house or storage-bins to the top of the furnace by means of cars or buckets moving on an inclined runway or skip, the cars being hauled by a wire rope connected to a suitable winding-engine. As the top of the blast-furnace is a place of considerable danger on account of the escape of poisonous gases and because of occasional explosions, it is extremely desirable that the skip-car be made to automatically discharge its load into the hopper of the furnace, so as to do away with the necessity for laborers performing the dangerous work of dumping stock into said hopper. To accomplish this, it is necessary that the skip-car be elevated and brought to rest at a definite and predetermined point, and as the considerations for safety noted above make it advisable to place the hoisting operator at some distance from the furnace-top it is essential that some automatically-operating device be provided to bring the car to rest at the proper point. The most approved apparatus now in use involves the use of a direct-current compound-wound motor suitably geared to winding-drums for the reception of hoisting-cable, and after the skip-car has been started by an operator closing the necessary switches to supply current to the motor its speed is automatically accelerated by the action of electromagnetic switches, which effect the necessary connections for causing the armature of the driving-motor to be brought up to full speed. After the winding-drum has made a predetermined number of revolutions a switching device actuated by the motion of the drum or by the gearing connected thereto makes the necessary connections to the above-noted electrically-operated switches, so as to slow down the speed of the motor and finally cause a holding-brake to be applied to the armature of the motor. Since not only the skip-car, with its load, but also the armature of the motor, the gearing, and the drums, must be accelerated up to full speed each time the skip is started, which is frequently at intervals of less than two minutes, the strain on the motor and its connected parts is extremely severe, there being, moreover, very rapid destruction of the contacts on the controlling apparatus due to the arcing which necessarily occurs in the breaking of circuits carrying from four hundred to eight hundred amperes, with the result that the apparatus requires constant inspection and frequent renewals of a number of its various parts. The controlling apparatus frequently employs as many as sixteen magnetically-operated switches for governing the connections in the armature, the series and shunt field-circuits of the motor, and as there are four wires leading to each switch, including two main-circuit wires and the two wires for the energizing the coil of the switch, the mass of connections necessarily involved is very confusing and can be understood only by one highly skilled in the art. On account of the fact that the wrong connection or breakage of any one of these wires may render the whole system inoperative, considerable delay is invariably experienced in making repairs which involve any disconnection or change of the wiring, and, as will be understood by those skilled in the art, such delays are particularly serious in connection with a blast-furnace, not only on account of the loss of output during the delay, but also from the fact that the furnace will not recover its normal condition for a considerable time after charging has been resumed. It will therefore be understood that controlling apparatus having to do with mechanism or systems of the class above noted should be of the simplest possible form.

It is further to be noted that in the class of hoists above referred to a very large amount of energy is stored in the drums, gearing, and

armature of the motor, due to their velocity when in motion, and this energy, in addition to that due to the motion of the car and its load, must be transformed and dissipated by the brakes each time the hoisting-engine is stopped, thus causing excessive wear, as well as necessitating frequent adjustment of the brakes. Again, the rapid acceleration of the moving apparatus necessarily required makes it advisable to employ a compound-wound hoisting-motor, which, as is well known, has a speed characteristic varying inversely as the load. As there is a wide difference in the weight of the material carried by the skip-car, depending on whether the load consists of ore, limestone, or coke, its speed will therefore vary considerably. As the energy stored in a mass due to its motion varies directly as said mass and as the square of its velocity, it is evident that a fixed braking force will not suffice to bring a load to rest at the same point when there are variations both in its mass and in its velocity, such as occur in this case. For this reason devices at present known to the art cannot, so far as I am aware, be relied upon to stop the skip at the same point under varying loads, and the consequence is that damage is frequently done to the skip-car by its striking the end of the skipway, in addition to which frequent adjustment in the length of the hoisting-cables is necessary owing to their stretching under the above-noted treatment.

The objects of my present invention are, therefore, to produce a system of hoisting apparatus which will be of such simplicity of construction and operation that it may be readily understood and maintained in operating condition by persons not especially skilled in the art and in which the cost of maintenance and repair shall by reason of the small current carried by the automatic controlling device be reduced to a minimum. It is further desired that the construction shall be such that the system may be driven by any constantly-operating prime mover, as a steam-engine, an internal-combustion engine, a direct or alternating current motor, &c., the gearing between said prime mover and the hoisting-drums being also operated continually at a substantially constant rate of speed, thus obviating the necessity of accelerating these parts every time the car is started and also absorbing the energy due to their motion every time such car is stopped.

Another object of the invention is to provide a brake for arresting the motion of the car and hoisting-drums which will automatically vary the braking force to suit the variation in the mass and the velocity of the car and its load.

A further object is to provide means by which the device for making the electrical connection employed for operating the automatic stopping device will be actuated directly by the motion of the skip-car and not by the winding-drum, thus avoiding any derangement of the system by reason of the stretching of the hoisting-cable.

These objects I attain as hereinafter set forth, reference being had to the accompanying drawings, in which—

Figure 1 is a plan view of my improved system, showing a portion of the gearing and one of the clutches in section. Fig. 2 is an end elevation of the apparatus shown in Fig. 1. Fig. 3 is a diagrammatic view illustrating the electrical connections of the different pieces of apparatus employed in my system. Figs. 4 and 5 are side elevations showing the preferred form of cut-out switch employed in connection with my invention, said switch being illustrated both in its open and in its closed position. Fig. 6 is a side elevation illustrating a portion of a furnace plant and showing the skipway and one of the skip-cars, and Fig. 7 is a plan view showing diagrammatically the cable connections of the skip-cars.

My invention consists in the use of a prime mover driving one or more drums through a pair of magnetic clutches, of which one is so driven as to impart a hoisting motion and the other a lowering motion to said drums, so that the energizing one or the other of the clutch-magnets will determine whether the drum will be turned so as to lower or hoist, and deënergizing the said magnets will disconnect the drums altogether from the prime mover. To start the skip-car, the operator will close the circuit of one of the clutches, causing it to be operatively connected to the drum, and thus move the skip-car through the medium of the connecting-cable. When the car has reached a certain point on the skipway, it will engage and open a switch included in the circuit of the clutch-magnet, thus disconnecting the drum from the source of power.

From the winding-drum a suitable train of gearing or equivalent means is made to drive an electric generator of comparatively small size, whose armature-circuit is held open by a magnetically-operated switching device as long as the drums are turned. The energizing-coil of this switch is in circuit with a cut-out switch, which controls the clutch-circuits and is so arranged that when either of said circuits are opened the circuit of the armature of the generator will be closed through a fixed resistance so designed as to have a large heat-radiating area. Upon the closing of the armature-circuit the generator will immediately begin to produce and force current through the resistance, thus compelling the winding-drum and the apparatus attached thereto to do work, and consequently expend the energy due to their motion.

The braking-generator is compound wound, it being noted that its braking effect can be made to vary directly as the square of the velocity of the load, owing to the fact that an increase in speed of the revolution of the armature increases the voltage of the current

generated by the armature, and this in turn increases the quantity of current which will flow through the fixed resistance. Further, the magnetic flux due to the field of the generator will naturally increase with the series field-current, and as the torque varies as the product of the armature-current and of the magnetic flux said torque will increase in a compound ratio relatively to the increase in speed. As pointed out above, this is the result to be desired, since the energy to be given up by the moving mass will vary as the square of its velocity. The energy due to the motion of the skip-car and of the drums, &c., will thus be expended in the form of heat by the resistance in the circuit of the generator geared to the hoisting-drum, which resistance can be made a practically constant quantity and of such a nature that it will dissipate the heat generated without wear or appreciable depreciation.

A powerful band-brake actuated by a weight or spring and released by an electromagnet or solenoid is applied to the winding-drum, and said magnet is provided with two windings—one a shunt excited directly from the source of current-supply and the second a separate winding in series with the armature of the brake-generator. The connections to this magnet are so made that the circuit of the shunt-winding must be closed before either of the clutch-circuits are closed, thus making it impossible to throw either of the clutches into action until the brake is released, and by a similar arrangement the armature-circuit of the brake-generator must be opened by the magnetically-operated switch before either clutch-circuit can be closed, the connections being such that the shunt-winding of the brake-magnet is energized whenever either of the clutch-coils is supplied with current. Said winding continues to be supplied with current until the skip-car trips a cut-out switch on the runway, so as to open the circuit containing said shunt-winding, while at the same time the magnetically-operated switch, having its magnet deënergized, closes the circuit of the generator through the fixed resistance. The current from said generator also passes through the second winding of the brake magnet, and consequently continues to hold the weight raised and the brake in its released condition even though the shunt-winding is deënergized. As the speed of the drum is gradually reduced because of the load on the generator, the current through the second windings of the brake-magnet decreases until finally it reaches zero at the moment the armature of the brake-generator, and hence the winding-drum, comes to rest, at which instant the brake is applied.

In order that current supplied by the generator may always flow in the same direction through the windings to which said generator is connected irrespective of the direction of rotation of the armature, I provide some means for reversing the direction of flow of said current—as, for example, a device for automatically shifting the brushes upon the commutator of the generator as it reverses its direction of motion or an electromagnetic switch operated from the controlling-switch for changing the connections of the armature relatively to the windings in circuit therewith.

In the above-mentioned drawings, a is a shaft continuously driven from any desired source of power at a preferably constant speed and geared to a counter-shaft a', upon which are carried two gear-wheels a^2 and a^3, as indicated in the figures. The gear a^2 meshes directly with a gear b, loosely supported upon a shaft B, while the gear a^3 has interposed between it and a gear-wheel b', also supported by the shaft B, an intermediate gear b^2, so that said gear b' is caused to rotate in a direction opposite to that of the gear b. In the present instance both of the gears b and b' are rigidly connected to portions of magnetic clutches b^2 and b^3, while between said two portions is an armature-section b^4, keyed to the shaft B, though free to move upon it to a limited extent and so placed as to be acted upon by either of the clutches b^2 or b^3 to operatively connect either of the gear-wheels b or b' with the shaft B. Said shaft carries at one end a pinion b^5, which gears with a toothed wheel c, fastened to a pair of hoisting-drums C C', there being suitable bearings for the shaft on which said drums and the gear are carried. A brake-generator D has fixed to its armature-shaft a pinion d, which meshes with the wheel c, so that the armature of said generator is forced to rotate whenever the shaft B is turned.

Between the two drums C is formed a braking-surface having a brake-band c' placed to act upon it, there being a bell-crank lever c^2 connected to said band and fixed to a shaft carrying a weighted arm c^3, connected to the armature c^4 of the brake-magnet c^5 in such manner that when the said magnet is deënergized the weight upon the arm c^3 automatically acts to apply the brake.

Figs. 4 and 5 illustrate my preferred form of cut-out switch E, which in the present instance is particularly adapted for use in connection with blast-furnace skip-cars. This consists of a three-armed pivotally-supported piece, whose arms e and e' are at an angle to each other, while the third arm e^2 carries a pair of electrically-connected contacts e^3, which, however, are insulated from the arm itself.

The general arrangement of the skip and its cars relatively to a furnace is shown in Fig. 6, where M illustrates a blast-furnace having adjacent to it an elevated structure N, supporting the skip way or bridge N'. Over the lower end of this is supported a hopper R, having discharge-spouts, of which one is shown at r so placed as to deliver material from the hopper to the skip-cars S and S', which are connected to each other by a

hoisting-cable *s* in the manner indicated in Fig. 7. In the present instance two cut-out switches E and E′ are employed, one adjacent to each of the tracks of the skipway N′ at a suitable distance from the top thereof.

The contacts e^3 of the switch-arm are so placed as to electrically connect two contact-plates e^4 and e^5, which are included in the circuit between the controlling-switch and one of the supply-mains, both the three-armed pieces and said contact-plates being mounted upon a suitable plate of insulating material placed along the skipway. Any suitable projection—as, for example, a roller F—may be carried by the skip-car, so as to engage one of the arms *e* or *e′* to turn the movable member upon its pivot as the car passes the switch, and the parts of the switch are preferably so balanced that said member will remain in stable equilibrium in either of the positions shown in Figs. 4 and 5.

Referring to Fig. 3, the operating-switch is indicated at G, and this consists of a vertically-supported lever *g*, carrying in the present instance four electrically-connected fingers or contacts *g′*, there being four contact-segments g^2, g^3, g^4, and g^5 on one side of it and four other contact-pieces g^6, g^7, g^8, and g^9 on the opposite side thereof. Both the lever and the contact-pieces are suitably mounted upon a slab or plate of insulating material. (Not shown.)

The two windings of the brake-magnet are indicated at c^6 and c^7, and it is to be noted that there is arranged adjacent to the armature c^4 thereof a switch P, having a pivoted arm *p*, the fixed contact of said switch being permanently connected to one of the supply-mains X, while said arm is connected to the movable element *q* of a second switch Q, supported adjacent to the armature *h′* of an electromagnetic switch H, the fixed member of said switch Q being connected to a wire extending between the magnets of the clutches b^2 and b^3.

It will be seen that the winding h^2 of the magnet of the switch H is connected at one end to the supply-main X and at the other end to both of the contact-pieces g^4 and g^8 of the controlling-switch G, while the movable switch-arm attached to the armature *h′* of said magnet is so placed as to complete the circuit between a pair of terminals *d′* and d^3, the latter of which is connected to the series field d^2 of the compound-wound brake-generator D. The terminal *d′* of the switch H is connected through the winding c^6 of the brake-magnet c^5 to the segment *t* of a magnetically-operated reversing-switch T. In the form of this device illustrated there are two segments *t′* and t^2, having respectively connected to them the armature-terminals of the generator D, there being in addition four other contact-segments *t*, t^3, t^4, and t^5, of which the segments *t* and t^5, as well as the segments t^3 and t^4, are connected to one another. The latter pair of segments are connected to one end of a fixed resistance d^4, whose opposite end is connected to the series field-winding d^2 of the generator.

A pivoted arm t^6 carries at its ends two sets of contacts, which, while being insulated from each other, are so placed as to connect either of the segments *t* or t^3 with the segments t^2, as well as either of the segments t^4 or t^5 to the segment *t′*. This arm may be automatically swung on its pivot by either of the two solenoids t^7 or t^8, of which each has one terminal connected to the positive supply-main X, while the two remaining terminals are connected, respectively, to the contacts g^5 and g^9 of the switch G. The shunt field d^5 of said generator has its terminals connected between the supply-mains X and X′.

Both of the contact-pieces e^4 of the two cut-out switches E and E′ are connected to the negative supply-main X′, while the contact-piece e^5 of the switch E′ is connected to the contact-piece g^6 of the controlling-switch G, and a similar contact-piece of the switch E is likewise connected to the contact-piece g^2 of said switch. The contact-piece g^3 of the controlling-switch G connects with the free terminal of the winding of the clutch b^2, while the contact-piece g^7 connects with the other end of the magnet of the clutch b^3.

It is to be noted that the two switches P and Q are not closed until either of the brake-magnet windings, as well as the magnet of the switch H, is energized, since they depend respectively upon the armatures of these devices to move and hold their movable elements *p* and *q* in their closed position. If, therefore, a skip-car to be elevated is at the bottom of the skipway and the lever *g* of the controlling-switch be moved to the right of its central position, current will pass from the current-supply main X′ through the cut-out switch E′ and to the contact-piece g^6 of the controlling-switch G. From here it passes to the three other contact-fingers upon the lever *g*, a portion flowing to the contact-pieces g^7 and energizing the winding c^7 of the brake-magnet c^5 and also the coil h^2 of the switch H, causing both the switch and the brake-magnets to move their respective armatures. This results in the case of the switch H in breaking contact between the terminals *d′* and d^3, so as to open the independent circuit containing the generator D. It will therefore be seen that the armature of the generator D has one of its terminals connected through segment *t′*, arm t^6, segment t^5, segment *t*, and winding c^6 of the brake-magnet to the terminal *d′* of the switch H, while the second terminal d^3 of said switch is connected to the series field d^2, resistance d^4, segment t^3, switch-arm t^6, and segment t^2 to the armature of said generator. Current from the contact-piece g^6 also passes into the contact-segments g^9, energizing the solenoid t^7 to move the arm t^6 of the reversing-switch T into the position shown. Since the energiza-

tion of the windings h^2 and c^7 has raised the armatures of the switch H and of the brake-magnet, as above noted, the two switches P and Q are closed thereby, so that current can flow from the contact g^7 of the switch G to energize the winding of the clutch b^3. Thus it will be seen that the weight attached to the brake-lever is lifted by the motion of the armature c^4 before the magnet of the clutch b^3 has operatively connected the constantly-driven gear-wheel b' with the shaft B and its attached hoisting-drums, and it will be noted, moreover, that the armature of the generator D will be freely turned by said drums.

Under the above-described conditions the cable attached to one of the skip-cars is wound upon one of the drums, as C, while the cable attached to the second skip-car is unwound from the drum C', and when finally the first car S has been raised—so that its projecting roller F engages the cut-out switch E', for example—said switch is immediately moved to its open position, as indicated in Fig. 5, both the magnet of the clutch b^3 and the winding c^7 being deënergized, as is also the magnet of the switch H. This switch H therefore permits its armature to drop, thus making connection between the terminals d' and d^3, so that the generator D, whose shunt field d^5 is permanently excited, immediately causes a flow of current which, passing through the winding c^6 of the brake-magnet, prevents the armature thereof from dropping. The amount of this current is controlled directly by the fixed resistance d^4 and the load thus thrown on the generator exerts a braking force upon the hoisting-drums, tending to bring them, with the cars S and S' and their attached parts, to rest. As the system is slowed down the speed of the generator, and consequently the current generated by it, diminishes until when said drums, and consequently the skip-cars, come to rest the current flowing is zero. The armature c^4 being then free to fall causes the brake-band c' to hold the drums, &c., from further motion.

It will be understood that by the time the skip-car S has been elevated to the extent indicated some form of automatic dumping devices—as, for example, that suggested in Fig. 6—has been brought into action, so as to cause the material in said car to be discharged. As soon, therefore, as the system has come to rest, as above indicated, the operator throws the controlling-lever g of the switch G to the opposite side of its central position, and thereby energizes the magnet of the clutch b^2, whose circuit is again broken, as before described, when the second skip-car reaches the top of its runway, it being noted that the energization of the solenoid t^8 of the reversing-switch T, which also occurs, changes the relative connections of the series field and the armature of the generator D, so as to cause the reversed current from said armature to continue to produce the proper polarity in the fields of the generator. As the car S descends the runway it engages the movable portion of the switch E' and resets said switch in its closed position, although it will be seen that this in no way immediately affects the operation of the apparatus, since the contact-piece g^5, connected to the switch, is not engaged by the lever g.

From the description above given it will be understood that the compound-wound brake-generator by imposing upon the hoisting-drum after the latter has been disconnected a load which is proportional to the speed at which said drum is moved brings the skip-cars operated thereby to rest at a definite and fixed point irrespective of the mass of the load carried by said cars, as well as irrespective of the speed at which said cars are run, the brake holding the drum, and consequently the cars, at said point without having been previously worn in the act of bringing the system to rest.

It is to be noted that the clutch-magnets b^2 and b^3 are constantly in rotation, and as they are of considerable mass and turn at a comparatively high speed their fly-wheel action will materially assist in starting the load. In fact, if they are constructed with sufficient fly-wheel capacity and the driving prime mover is given a speed characteristic such that it will slow down slightly when the load is applied the power required in accelerating such load may be made less than that required to drive it at full speed. It will further be understood by those skilled in the art that the windings of the clutch-magnets may be so proportioned that the magnetization will be applied but gradually after the circuit of said winding is closed, thus causing the clutches to pick up the load gradually without bringing undue strain on the hoisting apparatus.

I claim as my invention—

1. The combination of driving means, a driven member, a current-generator, and means for causing said generator to retard the motion of the driven member only when the driving means is out of action, substantially as described.

2. The combination of a driving member, a driven member, a clutch between said two members, a current-generator actuated by the driven member and means for causing the said generator to retard the motion of said member after it has been disconnected from the driving member, substantially as described.

3. The combination of driving means, a driven member, a current-generator actuated therefrom, and automatically-acting means for causing said generator to deliver current when the driven member becomes disconnected from the driving means, substantially as described.

4. The combination of a driving and a driven member having an electromagnetic clutch for connecting them, a current-generator, and means for simultaneously deëner-

gizing the clutch and completing the circuit of said generator, substantially as described.

5. The combination of a driving and a driven member having an electromagnetic clutch for connecting them, a current-generator and means for simultaneously deënergizing the clutch and completing the circuit of said generator, said generator having an electromagnetic brake in circuit with it, substantially as described.

6. The combination of driving means and a driven system with a current-generator, means for normally keeping said generator on open circuit, with means actuated by the driven system for disconnecting it from the driving means and for closing the circuit of the generator, substantially as described.

7. The combination of driving means and a driven system with a current-generator actuated by said driven system, means including a switch for normally keeping said generator on open circuit, with means actuated by the driven system for operating said switch to close the circuit of the generator, said means also disconnecting said system from the driving means, substantially as described.

8. The combination of driving means, a driven system, a clutch connecting the driving means therewith, a current-generator, an electromagnetic switch in circuit with the generator and a switch placed to be operated by the driven system and having connections whereby it causes the clutch to be released and the electromagnetic switch to be closed, substantially as described.

9. The combination of driving means, a driven member, a current-generator, means for causing the generator to retard the motion of the driven member when the driving means is out of action and a brake having means holding it from being applied as long as the driven member is moved, substantially as described.

10. The combination of driving means, a driven system including a conveyer, a current-generator, with means operated by said conveyer for causing the generator to retard the action of the system, substantially as described.

11. The combination of driving means, a driven system including a conveyer, a current-generator, means for normally retaining said generator on open circuit and means operated by the conveyer for closing said circuit, substantially as described.

12. The combination of driving means, a driven system including a conveyer, a current-generator, means operated by the conveyer for disconnecting the said system from the driving means and a switch actuated by the operation of said means for closing the circuit of the generator, substantially as described.

13. The combination of driving means, a driven system, a compound-wound current-generator, means operated by a portion of said system for disconnecting it from the driving means and a switch actuated by the operation of said means for closing the series circuit of the generator, substantially as described.

14. The combination of driving means, a driven system, a current-generator, an electromagnetic clutch connecting said system with the driving means, an electromagnetic switch in circuit with the generator and a switch controlling the flow of current to the clutch and to the magnet of the said electromagnetic switch, substantially as described.

15. The combination of driving means, a driven system including a conveyer, a current-generator, an electromagnetic clutch connecting said system with the driving means, an electromagnetic switch in circuit with the generator and a switch placed to be operated by the conveyer for controlling the flow of current to the clutch and to the magnet of said electromagnetic switch, substantially as described.

16. The combination of driving means, a driven system, a current-generator, with means operated by a portion of said system for causing the generator to retard the action of the system and a brake provided with means whereby it is thrown into action when the said system becomes substantially motionless, substantially as described.

17. The combination of driving means and a driven system including a current-generator, means for operatively connecting or disconnecting said system and the driving means and means for causing the generator to produce current when the driven system is disconnected from the driving means, with an electric brake in circuit with said generator, substantially as described.

18. The combination of driving means and a driven system having a clutch connecting them, a current-generator, a compound-wound electromagnetic brake having a winding in circuit with the generator, a switch also in circuit with the generator, with means for operating said switch and energizing the other winding of the brake, substantially as described.

19. The combination of driving means, a driven system detachably connected thereto, a current-generator operated from said system, an electromagnetic brake having means for retaining it out of action while the driven system is operated by the driving means, the brake including means in circuit with the generator for preventing application of said brake until the said driven system has come substantially to rest, substantially as described.

20. The combination of driving means, a driven system, a clutch for connecting said two members, a current-generator, and a brake tending to prevent motion of said system, with means for preventing the clutch from coupling the driving means with the

driven system until the brake has been released therefrom, substantially as described.

21. The combination of driving means, a driven system, a clutch for connecting said two members, a current-generator, with means preventing the clutch from coupling the driving means with the driven system until the generator-circuit has been opened, substantially as described.

22. The combination of driving means, a driven system, a clutch for connecting said two members, a generator having a circuit including a switch, and a brake tending to prevent motion of said system, with means for preventing the clutch from coupling the driving means with the driven system until the brake has been released therefrom and the generator-switch opened, substantially as described.

23. The combination of driving means, a driven system including a generator with a fixed resistance and a switch in circuit therewith, means for holding said switch in an open position, and a device operated by the driven system for affecting said holding means to cause said switch to be closed, substantially as described.

24. The combination of driving means, a driven system including a current-generator, a switch in circuit therewith, means for holding said switch open, a clutch for connecting the driven system with the driving means, and means coacting with the said switch-holding means for permitting the clutch to operatively connect the two members as long as said switch is open, substantially as described.

25. The combination of driving means, a driven system, a clutch for operatively connecting said system with said driving means, means for operating the clutch, means for automatically applying a braking force to said system, and automatically-acting means for holding the system motionless after said braking force has acted to bring it substantially to rest, substantially as described.

26. The combination of driving means, a driven system including a conveyer, a braking device operative upon said system, means for causing action of said device when the driving means ceases to actuate the system, said device including means for bringing the conveyer to rest within the same distance irrespective of the mass thereof, substantially as described.

27. The combination of driving means, a driven system including a conveyer, a braking device operative upon said system, means for causing action of said device when the driving means ceases to actuate the system, said device including a compound-wound generator having means for controlling the quantity of current produced, substantially as described.

28. The combination of driving means, a driven system, a braking device operative upon said system, said device including a compound-wound generator having one winding connected across supply-mains and another connected in an independent circuit, with means for controlling the time at which the generator is permitted to produce current, substantially as described.

29. The combination of driving means, a driven system, an electromagnetic brake for immovably holding said system, a device for applying a braking force to the system, said device including a compound-wound generator having one of its windings in circuit with the said electromagnetic brake and a switch having connections for throwing said brake into action independently of said generator, substantially as described.

30. The combination of driving means, a driven system, a braking device for said system, said device including a current-generator with means for reversing the direction of the current through the field-winding of the generator when the direction of rotation of said generator is reversed, substantially as described.

31. The combination of driving means, a driven system, a clutch for connecting the same with the driving means, a controlling-switch for throwing the clutch into action, a generator actuated from the driven system having means operated by the said controlling-switch whereby it is maintained on open circuit, and means operated by the driven system for causing deënergization of the clutch and closing the circuit of the generator, substantially as described.

32. The combination of driving means, a driven system, a clutch for detachably connecting the same with the driving means, a current-generator connected in a circuit including an electromagnetic switch, a second switch in circuit with the clutch and placed to be operated by the operation of said switch in the generator-circuit, with a controlling-switch for permitting current to flow to the electromagnetic switch and to the clutch, substantially as described.

33. The combination of driving means, a driven system, including a current-generator, a clutch for connecting the said system with the driving means, an electromagnetic switch for said generator-circuit, a brake for the driven system and a controlling-switch connected to the clutch, the brake and the winding of the electromagnetic switch, substantially as described.

34. The combination of driving means, a driven system including a current-generator, a clutch for connecting the said system with the driving means, an electromagnetic switch for said generator-circuit, a brake for the driven system, a reversing-switch connected to the field-winding and armature of the generator having means for operating it and a controlling-switch connected to the clutch, the brake, the winding of the elec-

tromagnetic switch and to the operating means of the reversing-switch, substantially as described.

35. The combination of driving means, a driven system including a current-generator and a conveyer, means for operating said conveyer in either of two directions, a controlling-switch for causing the generator-circuit to be made or broken and means for automatically changing the direction of the flow of current through the field-winding of the generator when its direction of rotation is changed, substantially as described.

36. The combination of a driving member with a driven system including a conveyer and current-generator, a clutch detachably connecting the driving means with the driven system, a switch for throwing the clutch into action and a second switch placed to be operated by the conveyer for throwing said clutch out of action, substantially as described.

37. The combination of driving means, a driven system including a conveyer and current-generator, a switch in the generator-circuit, a brake for preventing motion of the conveyer, a clutch for detachably connecting the driving means with the driven system, a controlling-switch connected to the brake and having means connected to it for opening the generator-switch, with a switch placed to be operated by the conveyer for causing the clutch to release the driven system from the driving means and to permit the closing of the generator-switch, substantially as described.

38. The combination of driving means with a driven system including a current-generator, a brake for preventing motion of said system, said brake having a plurality of windings, of which one is in circuit with the generator, and means whereby one of said windings is caused to be energized when the other is deënergized, substantially as described.

39. The combination of driving means with a driven system including a generator and conveyer, a brake having a plurality of windings of which one is connected to the generator, a clutch for connecting the driving means with the driven system, a switch for permitting current to flow to the clutch and the second winding of the brake, with means operated by a portion of the driven system for throwing the clutch and the second brake-winding out of action and means for causing the generator to produce current and thereby energize the first brake-winding, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ARTHUR C. EASTWOOD.

Witnesses:

C. W. COMSTOCK,

P. C. LILBES.