(No Model.) 8 Sheets—Sheet 1.

T. A. EDISON.

ELECTRIC LOCOMOTIVE.

No. 493,425. Patented Mar. 14, 1893.

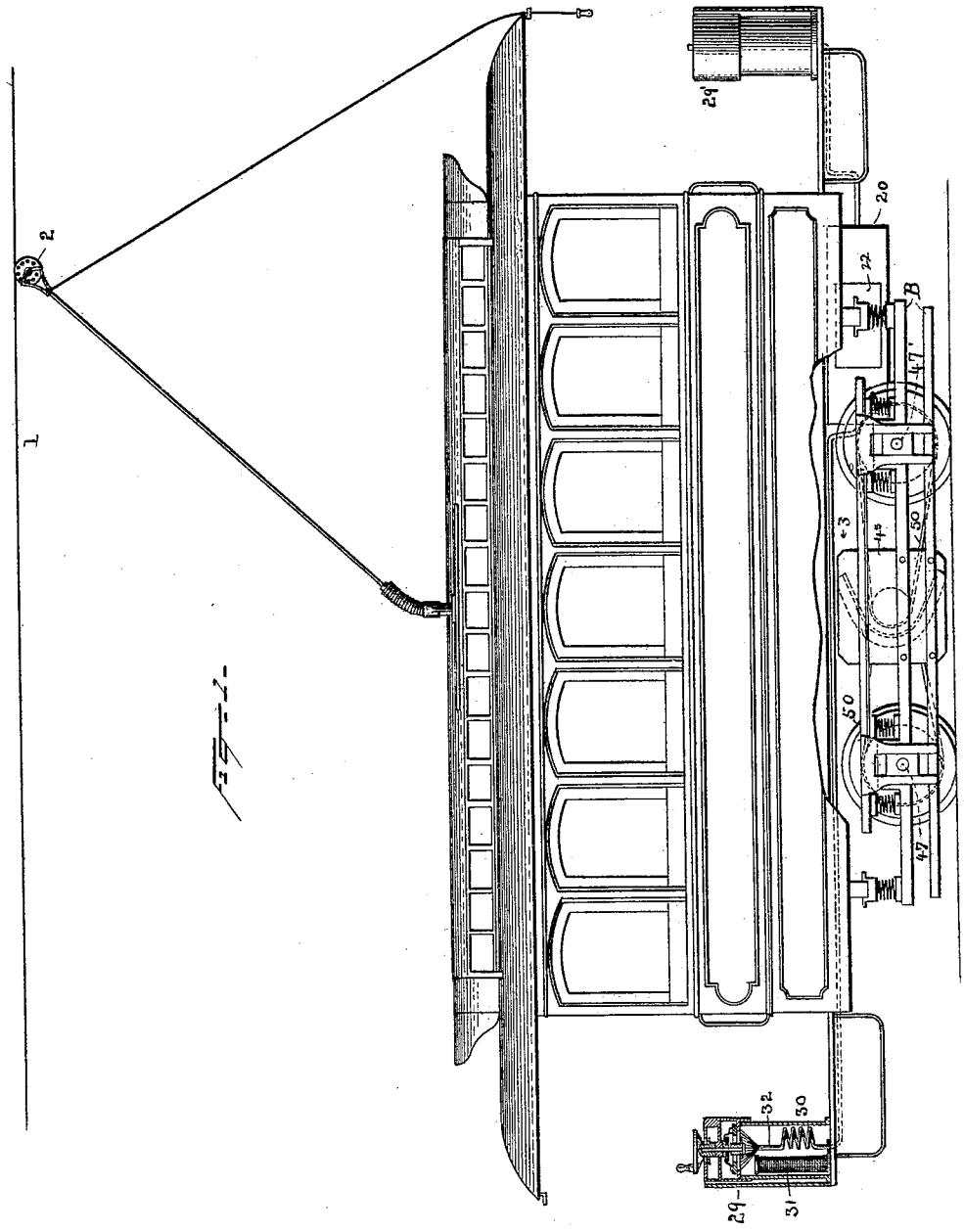

Fig. 1.

Witnesses
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Inventor
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By his Attorneys
Dyer & Seely.

(No Model.) 8 Sheets—Sheet 2.

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Fig. 2.

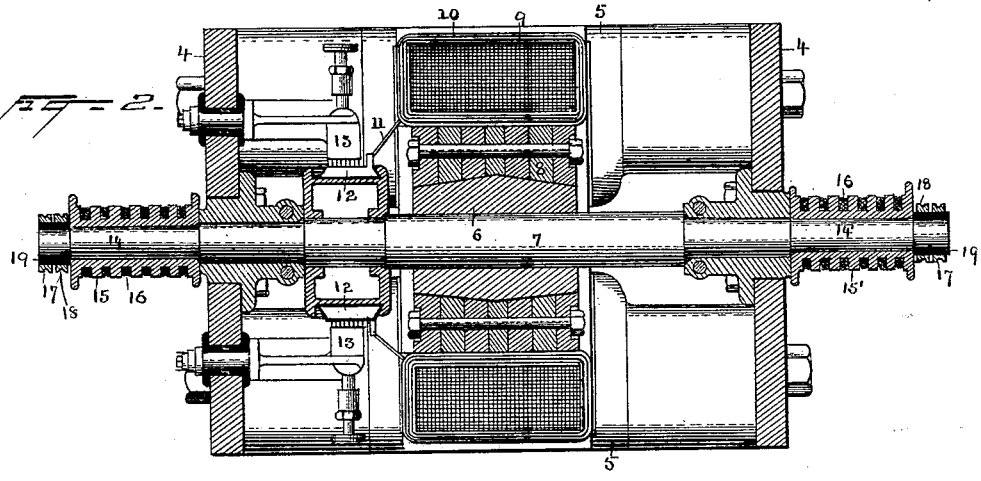


Fig. 3.

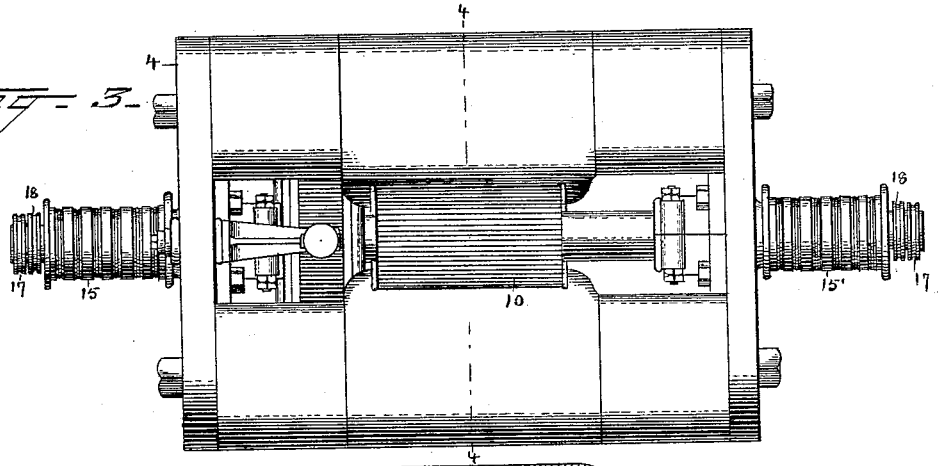
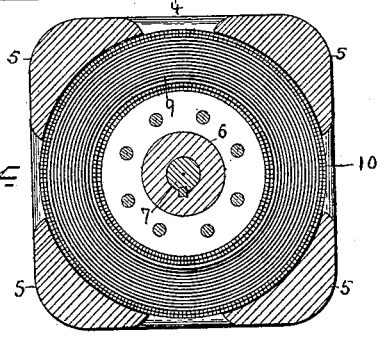


Fig. 4.



Witnesses
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(No Model.) 8 Sheets—Sheet 3.

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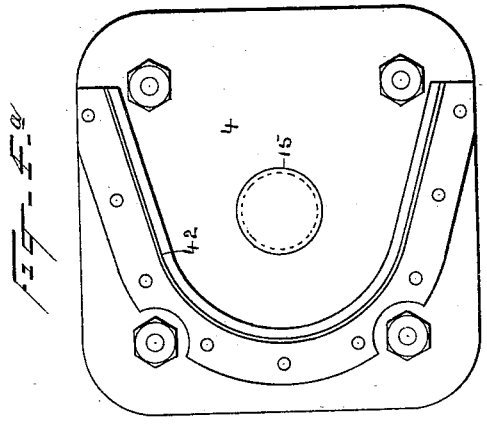

Fig. 5.

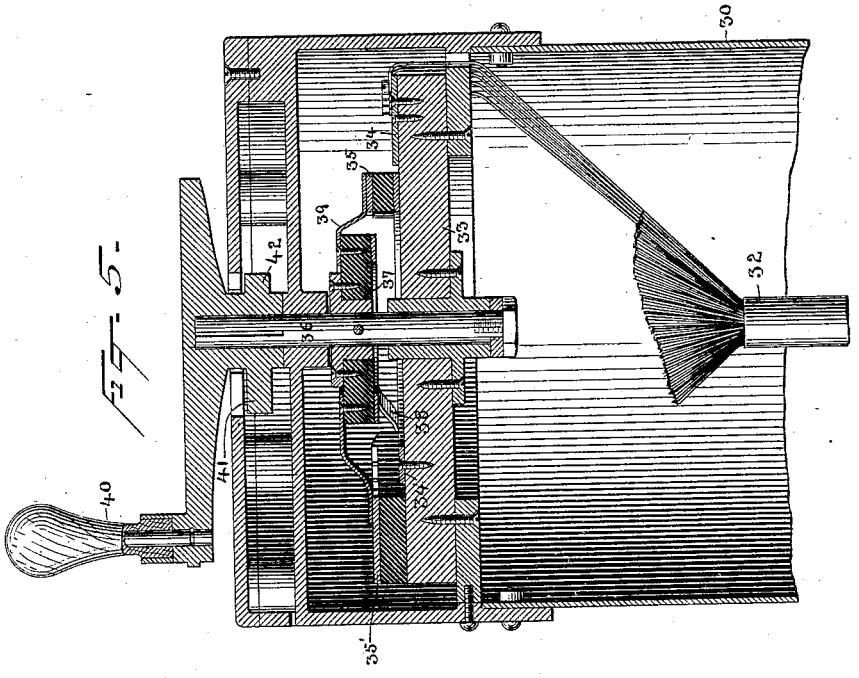

Fig. 6.

Witnesses
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(No Model.) 8 Sheets—Sheet 4.

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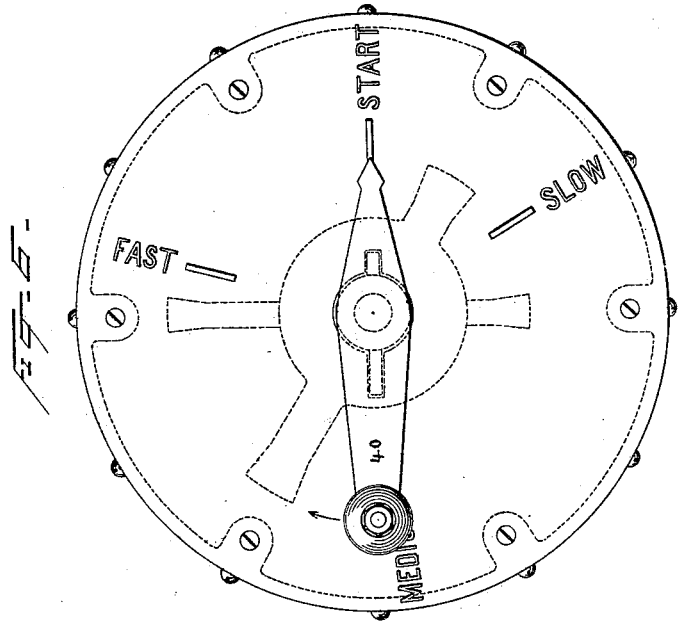

Fig. 6.

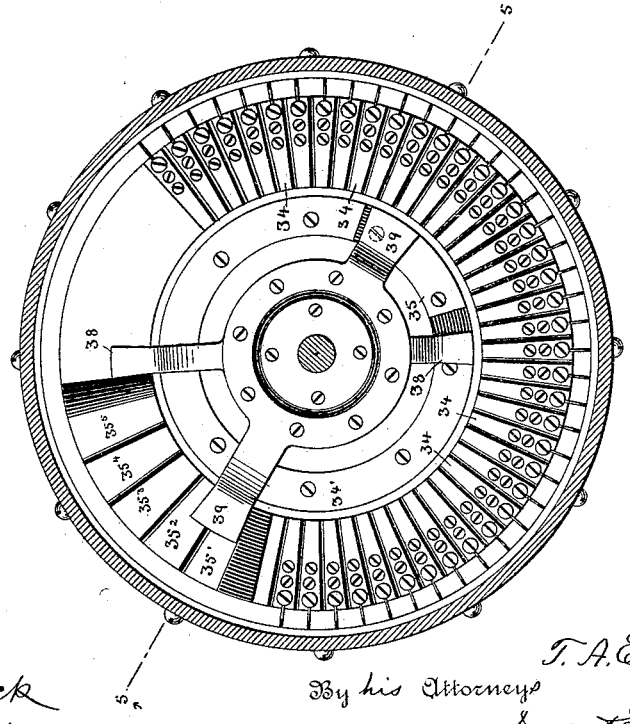

Fig. 7.

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Fig. 8.

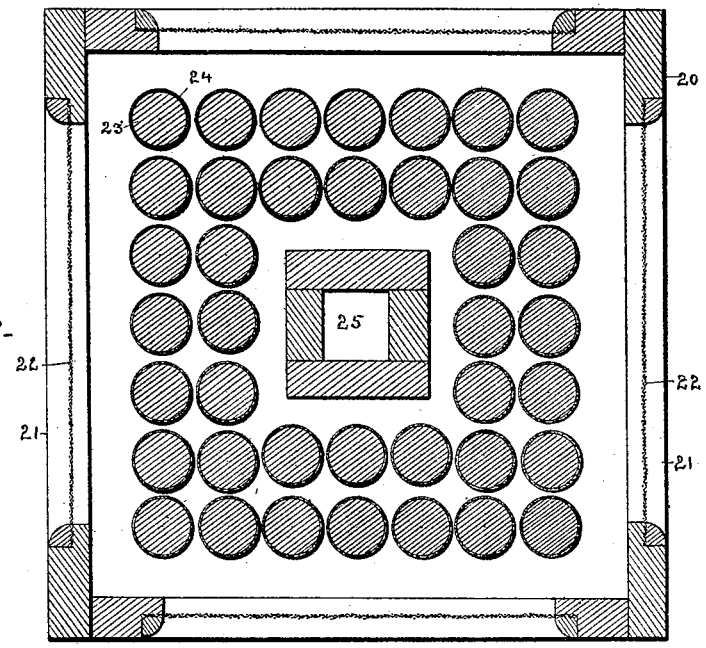

Fig. 9.

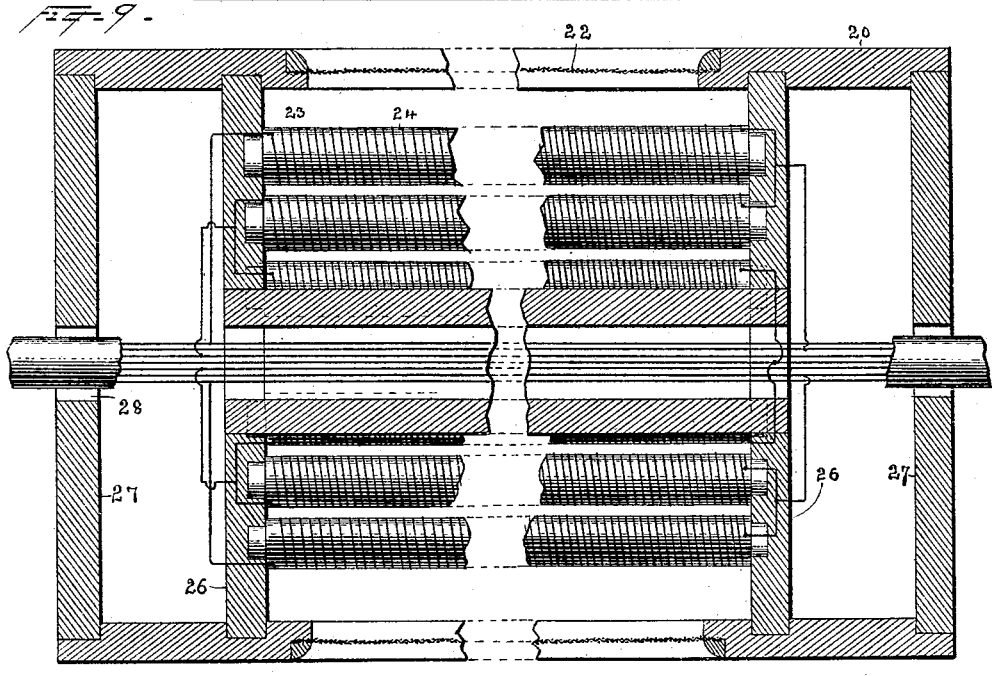

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Fig. 10.

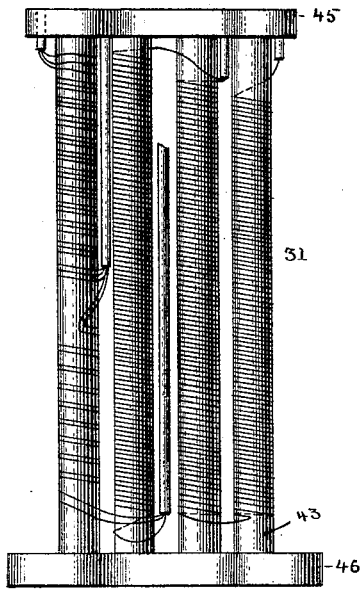


Fig. 13.

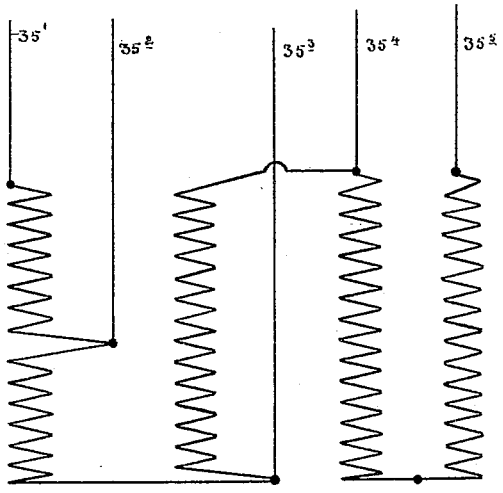


Fig. 11.

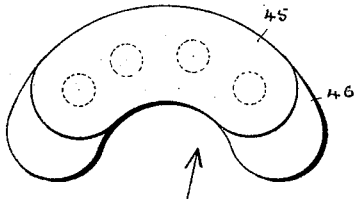
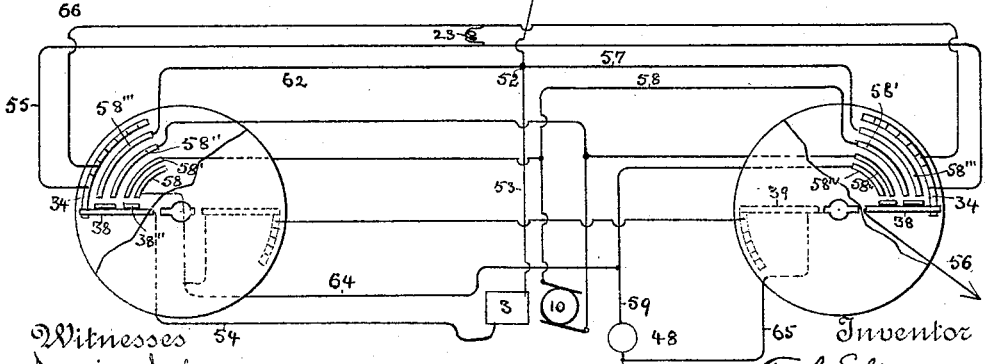


Fig. 12.

Fig. 15.



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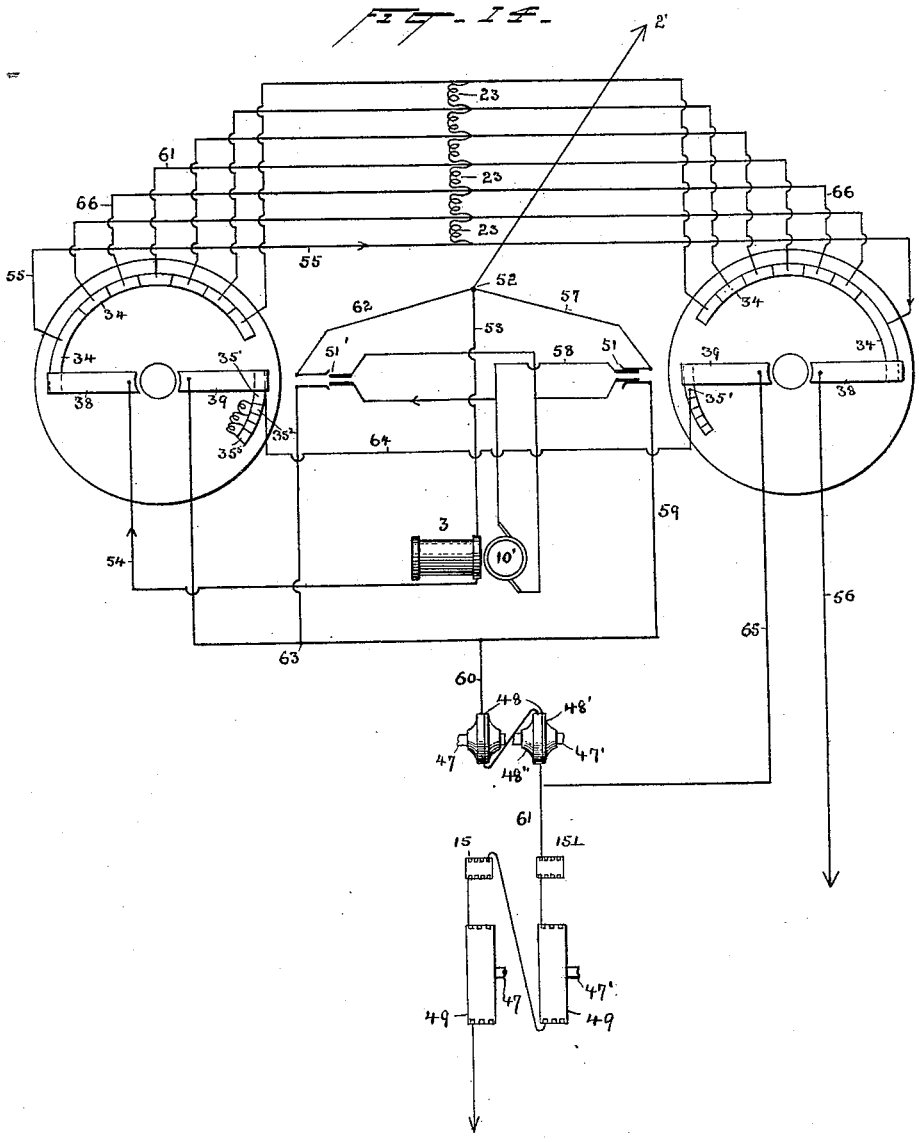
(No Model.) 8 Sheets—Sheet 7.

T. A. EDISON.

ELECTRIC LOCOMOTIVE.

No. 493,425. Patented Mar. 14, 1893.



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(No Model.) 8 Sheets—Sheet 8.

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ELECTRIC LOCOMOTIVE.

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Fig. 16.

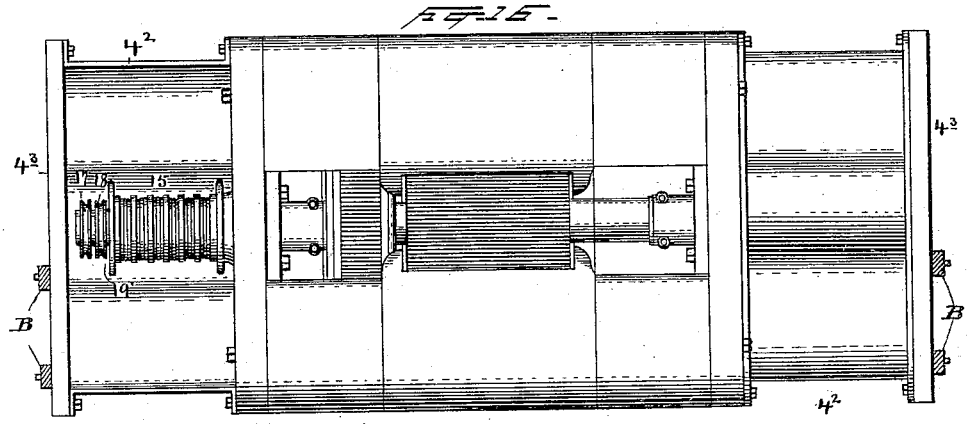


Fig. 18.

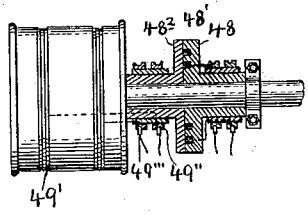
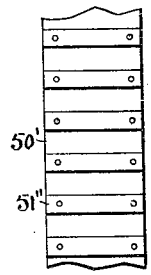


Fig. 17.



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UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

ELECTRIC LOCOMOTIVE.

SPECIFICATION forming part of Letters Patent No. 493,425, dated March 14, 1893.

Application filed January 19, 1891. Serial No. 378,253. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, county of Essex, and State of New Jersey, have invented a certain new and useful Improvement in Electrically-Propelled Vehicles and Means for Controlling the Same, (Case No. 904,) of which the following is a specification.

The present invention relates to electrically propelled cars or vehicles, and especially to the motor and means for connecting it to the car axles; and to switching and controlling apparatus for the motor and magnetic pulleys and clutches as hereinafter set forth.

The invention consists, first, in an improved construction of propelling motor; second, in the magnetic power transmitting mechanism between said motor and the car axles; third, in the improved switch for throwing resistance into or out of the car circuits; fourth, in a certain arrangement of circuits on the car embracing the propelling motor, magnetic pulleys and clutches; and the invention consists finally in certain other combinations and devices to be hereinafter set forth.

In the accompanying drawings which illustrate the invention, Figure 1 is a side view of a car partially in section. Fig. 2 is a central section of the motor which I prefer to use on the car. Fig. 3 is plan view of said motor. Fig. 4 is a cross section on the line 4—4 of Fig. 3. Fig. 4^a is an end view of the motor with a protecting shield partially surrounding the magnetic pulley. Fig. 5 is a central section of my switch on line 5—5 of Fig. 7. Fig. 6 is a plan of the box or casing in which the switch in mounted. Fig. 7 is a plan of the switch in the casing with the top of the casing removed. Fig. 8 is a section of the resistance box carrying the resistance which is placed in the field magnet circuit of the motor. Fig. 9 is a view of the same at right angles to Fig. 8. Fig. 10 is an elevation of the resistances which I use for controlling the magnetic clutches. Fig. 11 is a plan view thereof. Fig. 12 is a section of one of the rods on which the resistances are wound. Fig. 13 is a diagram illustrating the connection between the several resistance coils. Fig. 14 is a diagram illustrating the entire arrangement of circuits on the car; and Fig. 15 is a diagram showing a different arrangement of the armature circuit connections from that shown in Fig. 14. Fig. 16 is a view of the motor at right angles to Fig. 3 with the pulley shields in place. Fig. 17 shows one form of magnetic belt which may be used; and Fig. 18 shows one form of magnetic pulley and clutch.

The current for propelling the car may be taken from any suitable conductor, shown in this case as an overhead conductor 1, against which a trolley 2 bears. The motor 3 is preferably supported on the car truck midway between two axles thereof. The motor is preferably constructed substantially as shown on Sheet 2.

4, 4 are end plates serving as yokes to connect the pole pieces 5, of which there are four arranged to surround the armature as clearly shown. Said armature consists of a hub 6 on the shaft 7, an insulating web 8 composed of several insulating rings placed on the hub and bolted together, the core 9, preferably consisting of oxidized iron wire, and an armature coil 10 wound on said core and connected by means of wires 11 to the commutator plates 12, against which the commutator brushes 13 bear in the ordinary manner. These commutator brushes are supported between the pole pieces and armature and the inner face of plate 4, and are insulated from said plate. By being thus supported they are inclosed and protected from mechanical injury. The axis or shaft of the armature is extended in both directions, as indicated at 14, 14′, and on each end of said shaft is placed a magnetic pulley 15, 15′ consisting of an iron cylinder having one or more grooves 16 around it, in which grooves are wound magnetizing coils.

17, 18 are metal rings insulated from the shaft by a bushing 19. One of said rings is connected to one end of the magnetizing coil of the pulley, and the other ring is connected to the opposite end thereof. When in use, a brush 19′ connected with the supply circuit rests in the groove in each of these rings.

In Fig. 4^a an iron or steel plate 4^3, bent into U shape, is shown bolted to the end plate or yoke 4 and surrounding the magnetic pulley 15 on three sides, the fourth side being left wholly or partially open for passage of the

belt. The shield at the opposite end of the motor shaft would be reversed in position to accommodate the second belt which extends to an axle on the opposite side of the motor. This arrangement is shown in Fig. 16.

As shown in Figs. 1 and 16, a plate 4^3, is placed over the outer end of the shield. Said plate is secured to the shield by bolts in the same manner as the shield is secured to the yoke of the motor (see Fig. 4^a). The plates 4^3, at each end of the motor are then bolted to the side beams B of the truck and thus support the motor.

At some convenient point on the car, preferably under the body as shown in Fig. 1, is placed a box or case 20 containing resistances which are used in regulating the car motor. This case and resistance device are preferably constructed as illustrated on Sheet 5.

In one or more sides of the box are openings 21, covering which are brass wire or other screens 22 for the purpose of admitting air to the resistance coils, keeping them thoroughly cool and at the same time protecting them from mechanical injury. The wires 23 constituting the resistance coils are wound on several rods 23′ of wood or other material, over each of which is placed a covering 24 of asbestus. See Fig. 8. Through the center of the box is a passage 25, through which the conductors may be carried. The ends of the box are preferably double, as shown in Fig. 9, the ends 26 supporting the rods 23′, and the ends 27 having an opening 28 through which the cable is carried to the switches 29, 29′ at either end of the car.

The switches just referred to are constructed as shown in Sheets 1, 3 and 4 of the drawings.

30 is a sheet metal stand resting on the platform of the car. Within said stand or case is the clutch resistance 31, the end of the cable 32 extending to the resistance box 20 and the switch contacts. On an insulating plate 33 within the stand or within a chamber in the top or cover of the stand the several contacts are secured.

It will be seen that in the resistance box 20 there are forty resistance coils. On the plate 33 there is an equal number of contacts 34, and each of these contacts is connected by a separate wire in the cable 32 to one of said coils. The first of these contacts 34 is quite long, as seen in Fig. 7, so that the arm 38 will not pass from said first contact onto the second contact until arm 39 has passed from 35′ over 35^5 for the purpose hereinafter indicated. In the clutch resistance shown on Sheet 6 there are five resistance coils, and on the switch there is an equal number of contact plates 35′, 35^2, 35^3, 35^4, 35^5. The connection between the several coils is shown in Fig. 13. It will be seen from Fig. 5 that the contacts 35′ &c. are on a higher plane than the contacts 34.

36 is a shank or pin rigidly secured to the insulating plate or block 37, which carries the switch arm 38 on its lower side, the two ends of which arm are adapted to bear on the contacts 34 and on the ring terminal 34′, and the switch-arm 39 on its upper side, the two ends of this arm being adapted to make contact with the plates 35′ &c. and the opposite plate 35.

40 is a handle which may be placed on the pin 36 for the purpose of turning the pin and the switch-arms. This handle is provided with lugs 41, 42 which fit corresponding slots in the top of the case, so that the handle must be inserted in the position shown in Fig. 6. In operating the switch, the handle is moved in the direction indicated by the arrow in Fig. 6, and thereby the speed of the car is regulated in accordance with the position of the handle as indicated by the words "Slow" "Fast" &c. on the cover. To speed down the car, the handle is moved in the reverse direction back to its original position.

The resistance 31 heretofore referred to as the clutch resistance is shown in detail on Sheet 6. On several rods 43, covered with asbestus or other heat resisting material 44, the resistance coils are wound, and are connected to the terminals 35′, 35^2 &c. in the manner indicated in Fig. 13. When the switch-arm 39 is on the first contact 35′, the opposite end being on the contact plate 35 which is connected to the clutch circuit, none of the resistance 31 is in circuit; when the switch is turned bringing 39 onto 35^2, the first section of the resistance is brought into the circuit; as the arm is moved still farther onto 35^3, the first two coils are brought into circuit; and so on for the other contacts and coils. It may be here stated that the resistances just described are thrown into or out of a circuit shunting the magnetic clutches, whereby the clutches are made to transmit more or less of the power from the motor to the car axles as hereinafter set forth. 45, 46 are end plates between which the rods carrying the resistance coils are supported.

On the two magnetic power transmitting mechanisms shown as axles 47 of the car I mount two magnetic clutches 48 and two magnetic pulleys 49, one clutch and pulley on the front axle 47 at one end, and one clutch and pulley on the rear axle at the opposite end (see Fig. 14), the magnetic pulleys 49 being in line with the two magnetic pulleys 15, 15′ on the armature shaft and said pulleys being connected by magnetic belts 50. These may be plain steel bands, or the belt may consist of steel bands 50′ on which are riveted cross-bars 50″ of soft iron. The magnetic pulleys 49 are constructed like the pulley 15 already described. The clutches 48 each consist of two plates facing each other, mounted on the axle 47, the plate 48′ being rigidly secured to its axle, and the part 48^2 being loose on said axle but forming a part of the magnetic pulley 49′ or being rigidly connected therewith, as set forth in my application Serial No. 374,760, filed December 15, 1890. The pulley

has circumferential grooves 49′ in which magnetizing coils are wound. The terminals are connected to the two insulated rings 49″, against which brushes 49‴, which are connected to the supply circuit, bear.

By the term "magnetic power transmitting mechanism" I mean a mechanism which when suitably magnetized by a current, or when put in proper working condition, serves to transmit power from the motor to the car axle, but when not magnetized or in such condition slips and fails to transmit the power. In the form of apparatus described the magnetic clutch and the pulley connected to one member of the clutch constitute this transmitting mechanism.

In Fig. 14, 51, 51′ are switches for closing the circuit in one direction or the other through the motor armature 10′. These switches are preferably so arranged as to be closed by the handle 40 heretofore described and to be positively opened by removal of said handle, but they may be separately operated switches adjacent to those operated by handle 40. In either case the arrangement is such that the circuit through the armature cannot be reversed without opening the switch at one end of the car and closing a corresponding switch at the opposite end of the car. This renders it impossible for an operator to reverse the current through the motor before it has had time to slow down.

In the diagram Fig. 14 the several parts are designated by the same numerals as in the other figures so far as possible. For simplicity only a few resistance coils 23, and a corresponding number of contacts 34, are shown in said figure, and instead of the contacts 35, 34′ of Fig. 7, the wires to which the said contact plates are connected in practice are shown in the diagram connected directly to the switch-arms.

2′, Fig. 14, is the wire leading from the trolley to the car circuits. At the point 52 the current divides into three branches, one branch 53 extending through the field magnet of the motor 3 by wire 54 to switch-arm 38 through said arm to the first contact 34 by wire 55 to the first contact 34 at the opposite switch to the arm 38 to wire 56 and to ground through the car wheels or otherwise. The second branch 57 leads to the switch 51 shown closed, thence to wire 58, through the armature 10′ of the car motor, to the opposite side of switch 51, to wire 59, to wire 60, through the magnetizing coils of the two clutches 48, thence by wire 61, through the magnetizing coils of the magnetic pulleys 15, 15′ and 49, and thence to earth, the armature, the clutch coils and the magnetic pulley coils thus being in series. The third branch 62 leads to the switch 51′ shown open; at the point 63 the line 59 branches to the switch-arm 39 (or plate 35) thence to the contact 35′, thence by wire 64 to the corresponding contact 35′ at the opposite switch, arm 39, wire 65, to wire 61 between the clutches 48 and the magnetic pulleys. This branch as just traced constitutes a circuit of low resistance, that is, a short circuit around the magnetic clutches.

66 are wires leading from the contacts 34 of one switch to the corresponding contacts of the opposite switch and connected to the several resistance coils 23 in the manner indicated in Fig. 14.

In Fig. 15 is illustrated an arrangement in which the motor armature circuit is controlled simultaneously with the field magnet and clutch resistances. The terminals of the armature circuit are connected at the right switch to conductors 58′, 58″, which are adjacent to conductors 58‴, 58^{IV}, the latter conductors being connected to wires 57 and 59, 62 and 64 respectively. At the left switch the armature is connected to conductors 58′, 58″, but said conductors are transposed. The switch-arms 38 each carry two conducting springs or blocks 38″ adapted to connect the conductors 58′, 58‴ &c. in pairs as shown. The blocks 38″ are normally just out of contact with 58′, 58‴ &c., but when the switch handle 40 (Fig. 5) is inserted and turned slightly the armature circuit is closed. If the handle is inserted at one switch the armature circuit is closed in one direction, and if the handle is inserted at the other switch the circuit is closed in the opposite direction. Since the handle cannot be removed without turning it back to its initial position, the armature circuit will necessarily be opened by the act of taking out the handle.

The apparatus and circuits having thus been described, the method of operating the car will now be set forth. When the car is on the track and in operation, the motor circuit is continuously closed and the armature is continuously rotating. Suppose the switch apparatus to be in the position indicated by the diagram; the circuit through the motor would be complete but the car would be stationary owing to the complete short circuit around the magnetizing coils of the clutches 48 through which motion is transmitted from the armature shaft to the car axles. When it is desired to start the car, the switch is turned (by means of handle 40) carrying the arm 39 over the contacts 35^2, 35^3 &c., thereby gradually energizing the magnetic power transmitting mechanism and starting the car. As the arm 39 moves over said contacts, the arm 38 moves over the first contact 34 without varying the amount of resistance in the field magnet circuit. As the switch-arm 39 passes from the last contact 35^5 the switch-arm 38 passes onto the second contact 34, thereby throwing the first resistance coil 23 into the field magnet circuit. As said arm is moved along to the next contact, the second resistance coil is thrown into the field magnet circuit, and so on successively for all the coils, thereby gradually weakening the strength of the field magnet and increasing the speed of

the motor armature. To slow down the car, the movement of the switch-arms 38, 39 would be reversed as heretofore stated.

In practice I prefer to have the armature revolve at a speed sufficient to propel the car about four miles an hour when the clutch is completely magnetized and when none of the resistance coils are in the field magnet circuit. To regulate the speed below four miles an hour, the clutch is allowed to slip more or less by adjusting the resistance in the clutch shunt circuit. To regulate the speed above four miles an hour, the resistance of the field magnet circuit is adjusted as above described.

Having thus described the invention, what I claim is—

1. The combination, in an electrically propelled vehicle, of a motor, pulleys on the motor shaft, magnetic pulleys on two of the vehicle axles, magnetic belts between said motor shaft and pulleys on the axles, and magnetic clutches between the axles and the magnetic pulleys, substantially as described.

2. The combination of a vehicle, a motor, a shaft for the motor having one or more pulleys, a shield for each of said pulleys and a connection between the shield and the vehicle for supporting the motor, substantially as described.

3. The combination, in a switch, of a plate or block and means for turning it, said plate carrying two switch-arms at an angle to each other and in different planes, one of said arms co-operating with one series of contacts, and the other of said arms co-operating with a second series of contacts, substantially as described.

4. The combination of a vehicle, a motor for propelling it, a switch at each end of the vehicle for controlling the speed thereof, a switch at one end of the vehicle for closing the circuit through the motor in one direction only, and a switch at the opposite end of the vehicle for closing the circuit through the motor in the opposite direction only, substantially as described.

5. The combination of a vehicle, a motor for propelling it, a switch at each end of the vehicle for controlling the speed thereof, a switch at one end of the vehicle for closing the circuit through the motor in one direction only, and a switch at the opposite end of the vehicle for closing the circuit through the motor in the opposite direction only, and means for operating either of said switches at will, substantially as described.

6. The combination of a magnetic clutch, a coil for magnetizing the same, a shunt around said coil, independent of the motor circuit and a switch for controlling the shunt, whereby the condition of the shunt can be varied without affecting the speed of the motor, substantially as described.

7. The combination with a vehicle and a motor for propelling it, of a magnetic clutch between the motor shaft and an axle of the vehicle, a shunt around said magnetic clutch, independent of the motor branch, and a switch for varying the resistance in said shunt, substantially as described.

8. The combination of a motor, a magnetic clutch, a shunt around the clutch, a resistance, a switch having two switch-arms or devices, contacts for each of the arms, one of the arms serving to throw resistance into or out of said shunt circuit, thereby varying the speed of the driven shaft without varying the speed of the motor, the other switch-arm serving to regulate the speed of the motor after all of said resistance has been successively thrown into the shunt circuit, substantially as described.

9. The combination of a vehicle, a motor for propelling it, switches comprising circuit contacts and co-operating switch arms on opposite ends of the vehicle, a regulating resistance for the motor supported on the vehicle, connections from said resistance to the two switches, and means for throwing said resistance into or out of the motor circuit, substantially as described.

10. The combination of a vehicle, a propelling motor in which the field magnet and armature are in multiple arc, a single resistance box supported on the vehicle and connected to switches at both ends of the vehicle, and means at said switches for throwing said resistance into or out of the field magnet circuit, substantially as described.

11. The combination of the box or case having double ends, the rods supported between the inner walls of the ends, the resistance coils on said rods, and a passage through the resistance device for the conductors, substantially as described.

12. The combination, in a resistance device, of an inclosing case, insulated rods in said case supported between plates as described, coils on said rods, and a passage through the resistance device for the conductors, substantially as described.

This specification signed and witnessed this 20th day of December, 1890.

THOS. A. EDISON.

Witnesses:
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RICHD. N. DYER.