(No Model.) 4 Sheets—Sheet 1.

# P. K. STERN.

## ELECTRICAL TRANSPORTATION SYSTEM.

No. 564,262. Patented July 21, 1896.

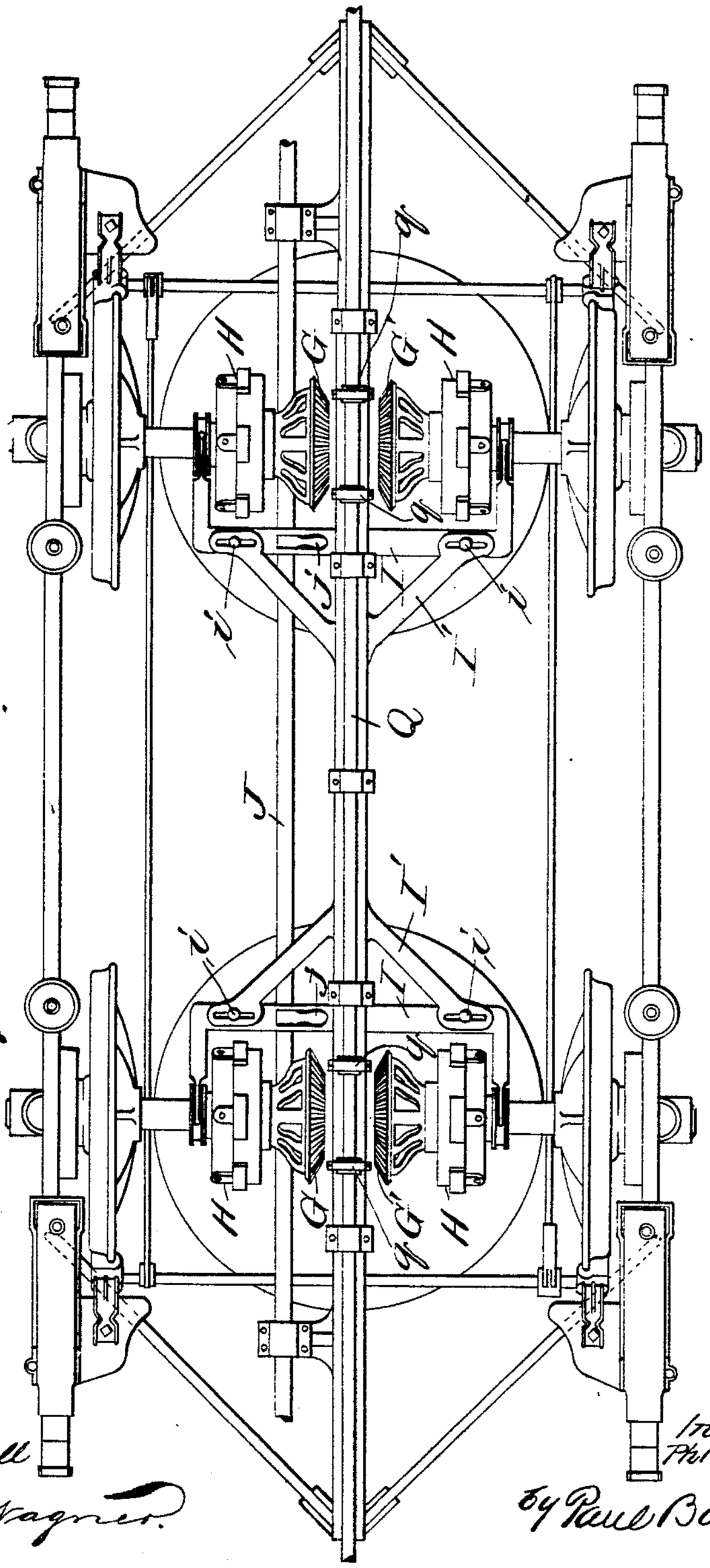


Fig. 1.

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By Paul Bakewell
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(No Model.) 4 Sheets—Sheet 2.

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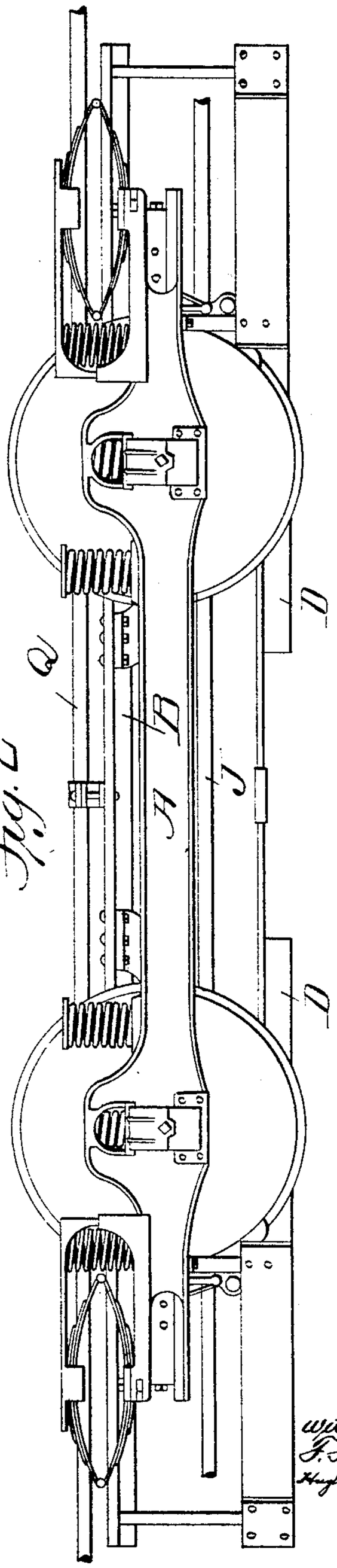


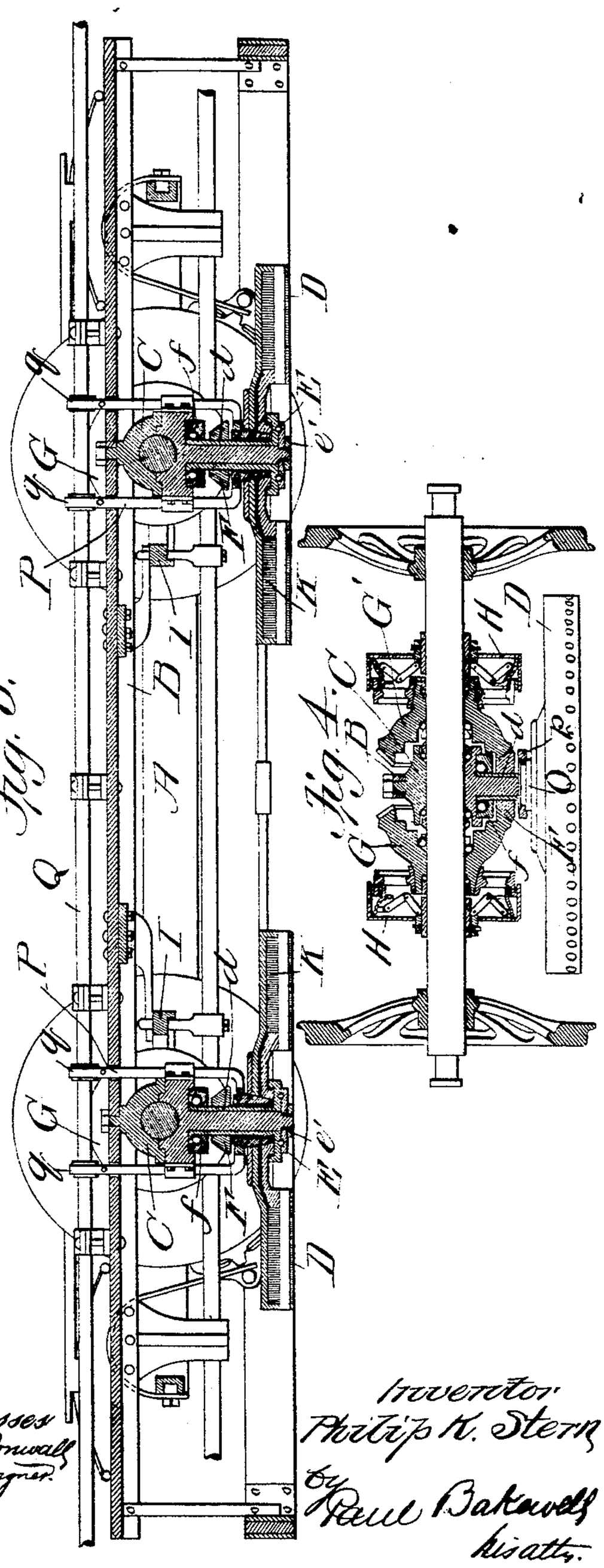


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## ELECTRICAL TRANSPORTATION SYSTEM.

No. 564,262. Patented July 21, 1896.

Fig. 5

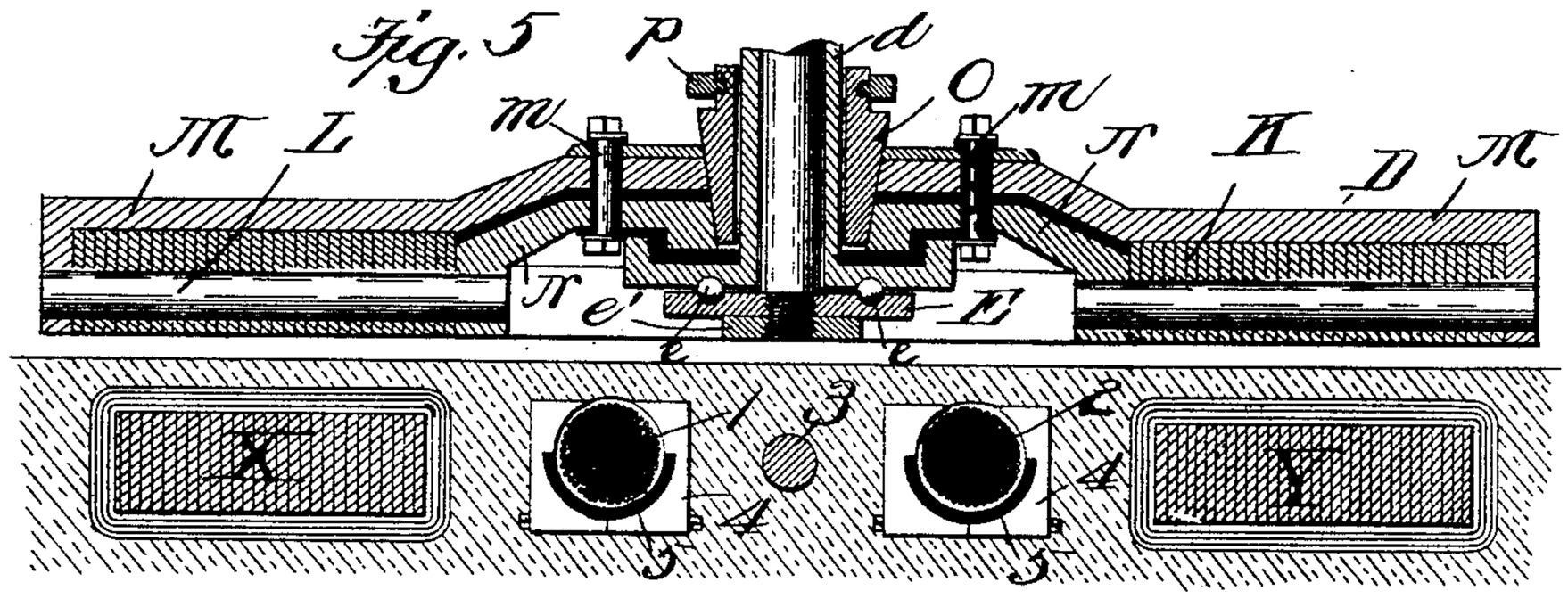
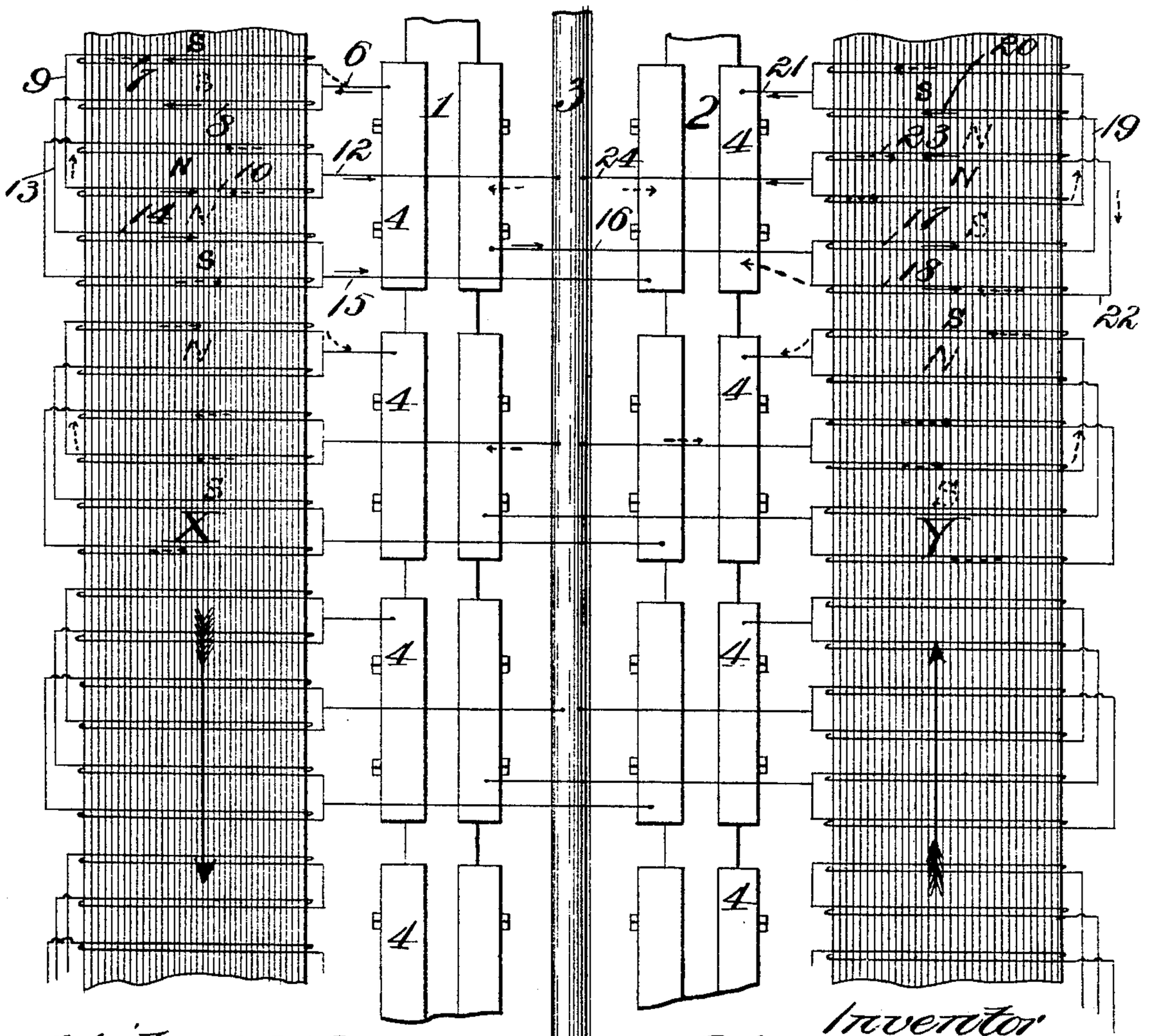



Fig. 6

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(No Model.) 4 Sheets—Sheet 4.

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## ELECTRICAL TRANSPORTATION SYSTEM.

No. 564,262. Patented July 21, 1896.

Fig. 7

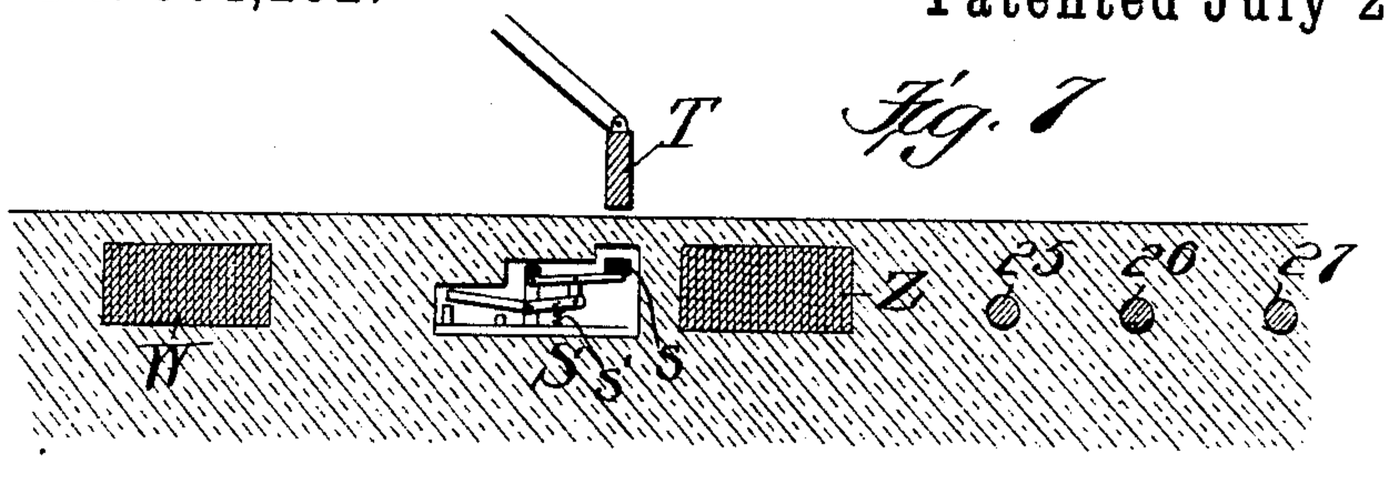



Fig. 8.

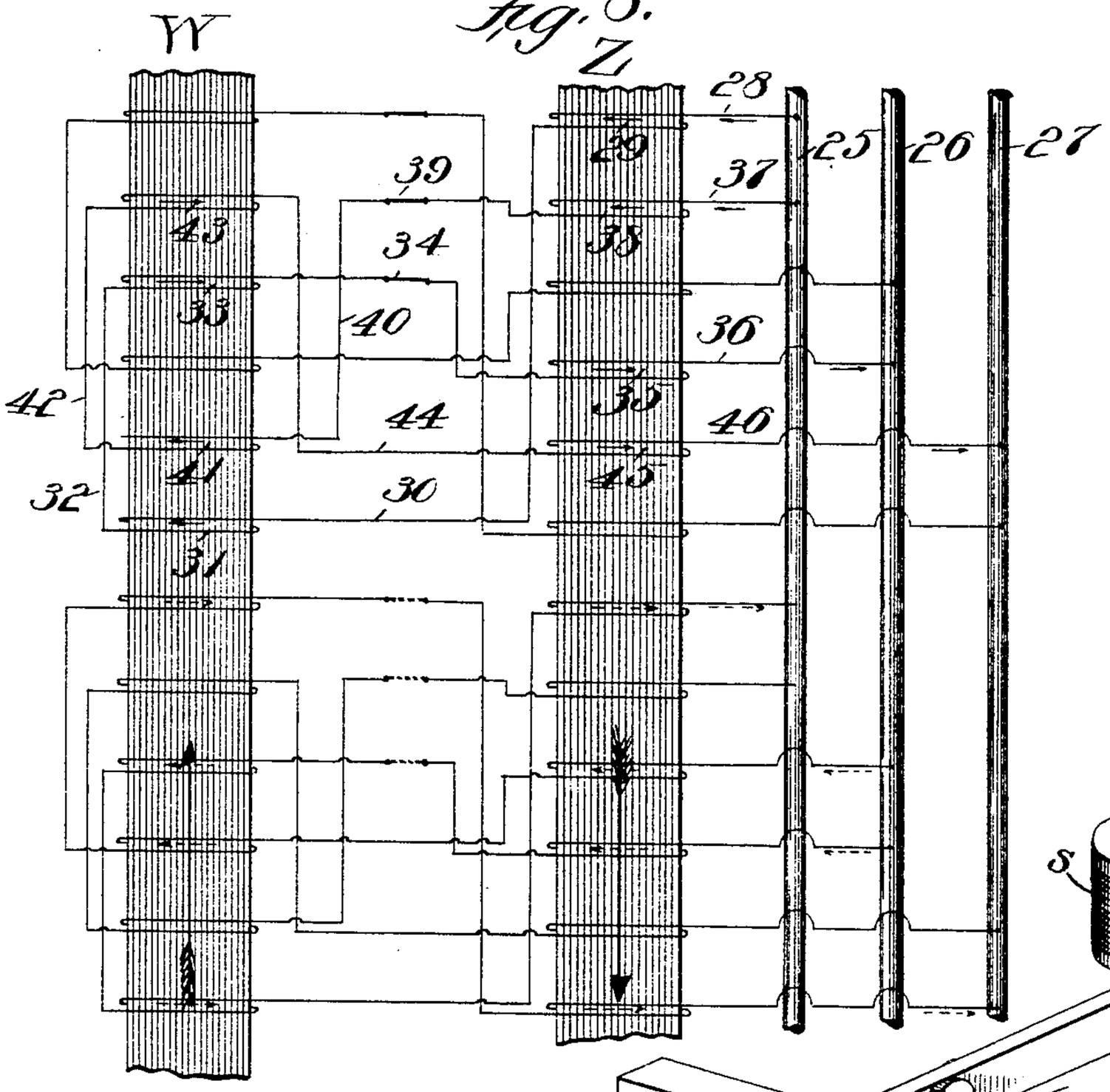
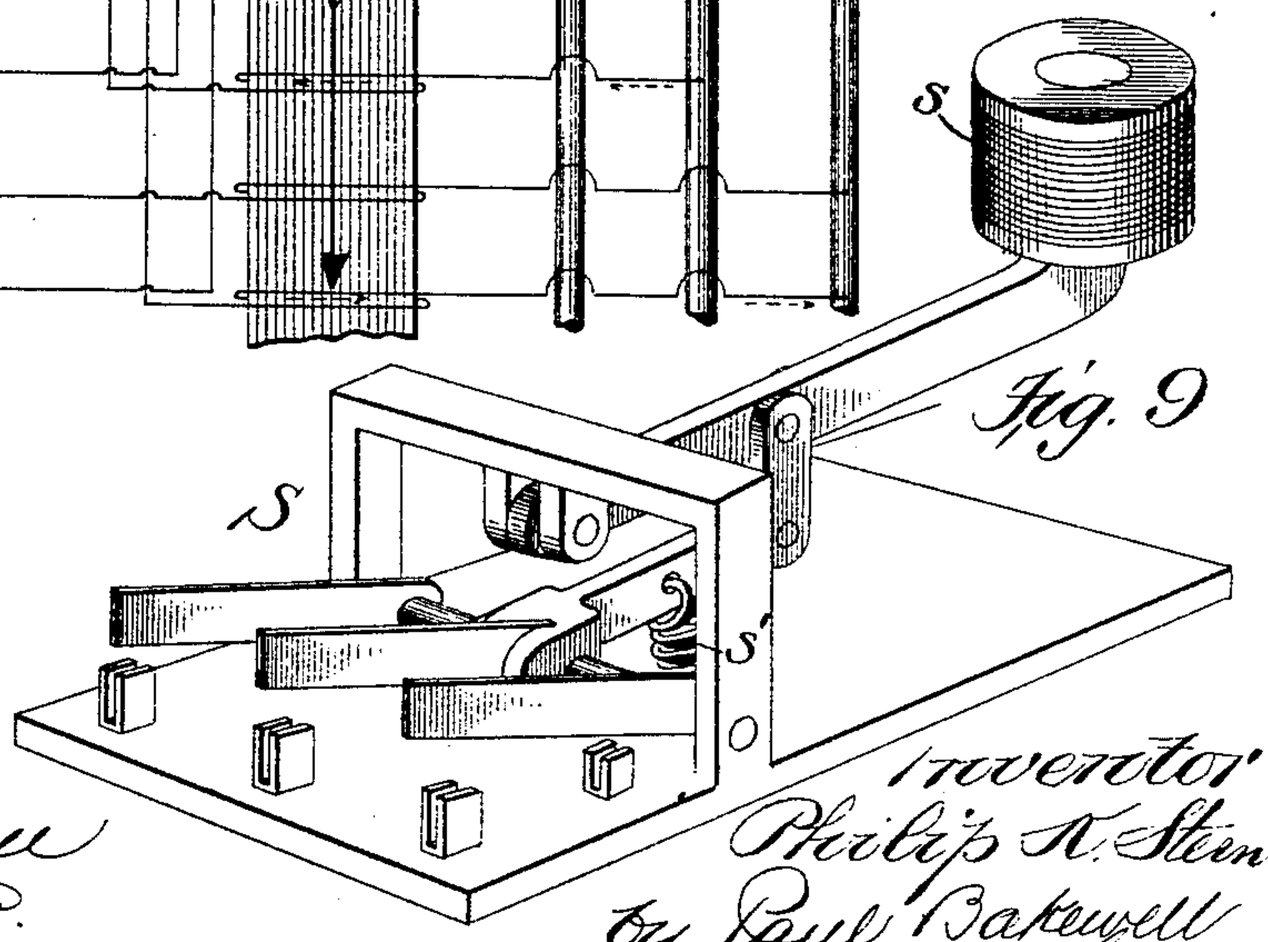



Fig. 9




Witnesses
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# UNITED STATES PATENT OFFICE.

PHILIP K. STERN, OF ST. LOUIS, MISSOURI, ASSIGNOR OF ONE-HALF TO H. W. KIRCHNER, OF SAME PLACE.

## ELECTRICAL TRANSPORTATION SYSTEM.

SPECIFICATION forming part of Letters Patent No. 564,262, dated July 21, 1896.

Application filed October 7, 1895. Serial No. 564,911. (No model.)

*To all whom it may concern:*

Be it known that I, PHILIP K. STERN, a citizen of the United States, residing at the city of St. Louis, State of Missouri, have invented a certain new and useful Improvement in an Electrical Transportation System, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification, wherein—

Figure 1 is a top plan view of an improved form of truck designed to be used in connection with my system. Fig. 2 is a side elevational view of the same. Fig. 3 is a longitudinal sectional view through the truck. Fig. 4 is a cross-sectional view through the truck-wheels and axle, showing the driving and clutch mechanism. Fig. 5 is an enlarged sectional view through the armature, which is mounted on the car, showing the primaries and feed-wires in the road-bed beneath. Fig. 6 is a schematic view of the primaries showing means for cutting in and cutting out sections thereof. Fig. 7 is a sectional view through a modified form of primaries, and means for cutting in and cutting out different sections thereof. Fig. 8 is a schematic view of the same. Fig. 9 is a detail view of the switch for the primary sections and its controlling medium.

This invention relates to a new and useful improvement in a system of electrical transportation; and it consists, generally stated, in arranging along a route or line of travel primary coils, which are energized by the passage of an undulatory or pulsatory current which influences a horizontally-rotatable armature arranged on the vehicle, adapted to travel along said route or line of travel. The passage of the aforementioned undulatory or pulsatory currents through the primary coils sets up a magnetic field, which, by the nature of the currents and the electrical connections, is constantly changing both in intensity and direction. The field thus set up acts by induction upon the armature or secondary coils carried by the vehicle, causing said armature or secondary coils to experience a couple or torque and rotate, thus propelling the vehicle.

It further consists in arranging parallel primary coils which are energized by the passage of undulatory or pulsatory currents in such manner that the armature or secondary coils on the vehicle is influenced on diametrically opposite sides of its pivotal point.

It further consists in providing means which are influenced by the passage of the vehicle along the track or line of travel to render certain sections of the primary coils operative or inoperative.

It further consists in providing means whereby the induced currents of the armature or secondary coil may be short-circuited or closed to control the rotation of said armature, and, finally, in the construction, arrangement, and combination of the several parts, all as will be hereinafter described, and afterward pointed out in the claims.

Referring to the drawings, wherein like symbols of reference refer to corresponding parts in the several figures of the drawings, A indicates a truck having the usual side bars, axles, track-wheels, brakes, springs, &c., as are common.

Depending from the center bar B of the truck and embracing the axle is a spindle-block C, upon the downwardly-projecting spindle of which is rotatably mounted the armature D, which is fixed to a sleeve *d*, surrounding said spindle. The lower end of this sleeve is provided with a flange which is grooved concentrically to receive balls *e*, which are supported by a plate E, secured to the lower end of the spindle and held in place by a jam-nut *e'*, as more clearly shown in the enlarged sectional view in Fig. 5. The upper end of the sleeve is also provided with a flange, beneath which are arranged balls supported by a cap *f*, as shown in Figs. 3 and 4.

Fixedly mounted upon the sleeve D is a gear-wheel F, which meshes with gears G and G', loosely mounted upon the truck-axle, and preferably provided with ball-bearings, as shown in Fig. 4.

Upon the hubs of gears G and G' are arranged one member of a clutch H, the other member of said clutch being slidingly arranged on the truck-axle through the medium of a feather or other like construction. The

axle members of this clutch are provided with grooved collars, in the grooves of which are seated fingers to slide said members, at the same time permitting their rotation. (See Fig. 4.) This means for operating the sliding members of the clutch extends from one clutch to the other on the same axle, as illustrated by the bar I, Fig. 1. This bar is preferably provided with pins *i*, which operate in slots in the ends of a frame I′, secured to the center bar B of the truck. By this arrangement the lateral movement of the sliding members of the clutch is limited or controlled.

To actuate the bar I, and through it the sliding members of the clutch, I extend up through a slot in said bar a rock arm or finger *j*, which is mounted or arranged on a rock-shaft J, journaled in suitable bearings depending from the center bars of the truck. At the ends of this rock-shaft J, I arrange any suitable means for partly rotating said shaft, which means may be in the form of a lever, miter-gears, &c.

The armature D in the construction shown in Figs. 1 to 5, inclusive, rotates horizontally on the spindle-block. This armature consists of a laminated body or core K, which is traversed by induction-rods L, preferably arranged radially in this form of armature, there being a number of said rods disposed through the laminated core. The ends of these rods are mounted in frame-plates M and N, the former being the outside plate and the latter the inside. These plates are suitably insulated from each other, as shown in Fig. 5, and preferably secured together by insulated bolts *m*. Plates M and N are provided with a central conically-shaped opening to receive a short-circuiting plug O, which is slidingly mounted upon the sleeve on the spindle. This plug, when it is raised out of contact from either of the plates, breaks the circuit between the plates or opens the secondary circuit, but when said plug is forced down it is wedged in the opening formed by the two plates, and in this manner short-circuits the induced currents of the armature or closes the secondary coils.

To operate the plug O, I groove the same near the top, in which groove fits an internal flange on a ring *p*, which ring is mounted upon arms P, guided in their vertical movements by suitable ways on the spindle-block. The upper ends of these arms embrace cams *q*, mounted on a rod Q, journaled in suitable bearings on the center bar of the truck. Suitable means are provided to rotate this cam-rod Q, which thereby raises and lowers the plug O of the armature.

The language of the above description is applicable to but one armature and its associate parts. I have shown two armatures mounted on the truck shown in Figs. 1, 2, and 3, which armatures, their plugs, and their clutches are operated from a common medium. It is obvious that, if desired, more armatures may be mounted upon the same truck and be operated from the same operating means, such, for instance, as mounting three armatures on a six-wheel truck.

Located in juxtaposition to the armatures or secondary conductors and along the route or line of travel of the vehicles are primaries, which, when energized, produce a field for the armatures. These primaries, as shown in Figs. 5, 6, 7, and 8, are composed of two parallel laminated cores which are embedded in the road-bed of the track, said road-bed consisting, preferably, of asphaltum or other like substance.

The cores illustrated in Figs. 5 and 6 are wound with coils at suitable distances apart, said coils being connected so as to be adapted to a three-phase alternating current generated at some suitable point and conducted through the line-wires 1, 2, and 3, which line-wires are tapped to feed the coils at suitable points. As shown, two of said line-wires are preferably in cable form, the cores of which are of iron, also of cable form. These cables are arranged within or have strung upon them at different points along their length split boxes 4, with which the cables are adapted to contact and make electrical connection during the presence of a magnet or an attracting medium, such as the armature D. Confined within these boxes or blocks and affording a seat for the cables are pieces of insulation 5, upon which the cables normally rest when they are not in contact with the boxes or blocks. Upon the approach of a magnet or during the presence of an attracting medium, such as the armature D, the iron cores of these cables are influenced and raised so as to enable the feed-cable to contact with the blocks and thus establish an electrical circuit through the wires and coils which are connected to said blocks and the remaining line-wires. The direction of such a circuit is illustrated in the upper part of Fig. 6, where we will assume for a given instant of time the cable 1 is the feed-cable, while the remaining cables 2 and 3 are return-cables. The current will pass from cable 1 to the blocks and through wire 6 to coils 7 and 8. From coil 7 it will go through wire 9 to coil 10 and wire 12 to cable or line-wire 3. From coil 8 it will go through wire 13, coil 14, wire 15 to block surrounding cable 2, to said cable. By this arrangement the primary at the left-hand side of Fig. 6, which is lettered X, will have established in it a magnetic field. (Indicated by the full-line letters N and S.) At the same instant that the current passes through wire 6 to coils 7 and 8, located at the upper portion of the left-hand section cut in, the current also passes from the block on the cable 1 through wire 16 to coils 17 and 18, located in the lower portion of the section cut in on primary at the right-hand side of the sheet. From coil 17 the current passes through wire 19 to coil 20 and through wire 21 to cable 2. From coil 18 the current passes through wire 22 to coil 23 and wire 24 to main line 3. By

this arrangement the primary at the right-hand side of the sheet has poles set up in it, as indicated by the full-line letters N and S. At the next instant, we will say, the cable 3 becomes the feed-cable and cables 1 and 2 the return line-wires or cables. In this event the current will pass to the left primary, to the coils to which it is connected, and from said coils through others, as indicated by the dotted arrows, finally returning to the return-cables 1 and 2. The current will pass to the primary at the right in the direction indicated by the dotted arrows. It will be noted in this connection that the poles will be shifted in the direction of the large arrows at the bottom of the figure, that is, in opposite directions, as indicated by the letters N and S. in dotted lines. At the next instant, when cable 2 becomes the feed-cable and 1 and 3 the return-cables, the current will pass in an opposite direction from that indicated by the full-line arrows, and will shift the poles again, this time the south pole being where the north pole was when cable 3 was a feed-cable, and the north pole being where the south pole was in that event. It will thus be seen that a shifting magnetic field is set up in each of the primaries, the poles of which are being shifted constantly and successively in the direction indicated by the large arrows, or in opposite directions.

It will be understood that the current only sets up a magnetic field around that portion of the cores and conductors which are connected to the blocks or block with which the cables 1 and 2 are in contact. Upon the passage of the vehicle over the sections so energized the cables fall by gravity out of contact, and such sections behind the vehicle are cut out. In this manner the cross-section of the feed-cables may be greatly reduced.

In Figs. 7 and 8 I have shown a slightly-modified form of primary winding, in which 25, 26, and 27 indicate the feed-wires and W and Z the two primaries. Instead of depending upon the elevation of one of the feed-cables to make the contact for certain sections, I arrange within a "section," as I have termed it, a switch S, which preferably has three blades or arms, making and breaking circuits with as many terminals. These switches are operated by an arm pivoted in a suitable framework, which arm has arranged upon its end a magnet *s*, the magnets of the several switches being, preferably, in series and constantly energized. To operate the switches, I suspend from the vehicle an iron bar or rod T, which may be lowered or raised by means of the arm or arms upon which it is hung. Upon the approach and during the presence of this arm T in proximity to the magnet *s* said magnet is elevated, forcing the blades of the switch to make contact with the terminals which they control, thus completing the circuits through the section in which said switch may be located. When the vehicle, upon which the iron bar T is mounted, passes on, the switch-blades are elevated, so as to break the circuit in that section in which it is located, said elevation being accomplished by a spring *s'*.

Assuming the upper section in Fig. 8 to have been cut in, and that for a given instant of time the feed is through wire 25, while lines 26 and 27 act as return-cables, the current will pass through wire 28, coil 29, located in the upper portion of the section on primary Z, wire 30, coil 31, located in the lower portion of the section on primary W, wire 32, coil 33, through the switch terminals 34, coil 35, through wire 36 to line-wire 26. At the same instant the current will pass from main line 25 through wire 27 to coil 38, switch terminals 39, wire 40, coil 41, wire 42, coil 43, wire 44, coil 45, and through wire 46 to the feed-wire 27. When the other main lines 26 and 27 energize the coils through their respective circuits for their given instant of time, there will be established in the primaries W and Z a succession of polar waves, substantially the same as those developed in primaries X and V.

In the above description I have assumed that the directions of the primary currents are in the nature of a continuous current interrupted and reëstablished in the order given; but it is well understood that three alternating currents differing in their phase angles of one hundred and twenty degrees, or two alternating currents having their phase relations of one hundred and eighty degrees, (which would necessitate a slight change in connections,) would accomplish practically the same results, that is, the shifting of the poles already described would be propagated along the primaries.

I am aware that many minor changes in the construction, arrangement, and combination of the several parts of my invention may be made and substituted for those herein shown and described without in the least departing from the nature and principle of my invention.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. An electric transportation system, consisting of a route or line of travel, a vehicle which is adapted to travel along said route, a horizontally-rotatable armature on the vehicle for propelling the same, and a primary arranged along the route for influencing said armature; substantially as described.

2. An electric transportation system, consisting of a route or line of travel, a vehicle which is adapted to travel along said route, a horizontally-rotatable armature on the vehicle for propelling the same, and parallel primaries arranged along the route upon each side of the axis of the armature; substantially as described.

3. An electric transportation system, consisting of a route or line of travel, a vehicle which is adapted to travel along said route,

a horizontally-rotatable armature on the vehicle for propelling the same, a primary or primaries arranged along said route for rotating the armature by induction, and means on the vehicle for short-circuiting or controlling the induced currents of the armature; substantially as described.

4. The combination with a primary element which is energized by alternating currents of different phases, of a laminated armature located in proximity thereto, said armature being adapted to be rotated by induction, induced-current conductors in the armature, and a plug slidingly mounted upon the armature-shaft, which plug normally short-circuits the induced-current conductors, said plug, when withdrawn, breaking the circuits through the induced-current conductors, and causing the armature to cease rotating; substantially as described.

5. The combination with a truck, of an armature mounted on the axle thereof but rotating at an angle to said axle, and means for driving said axle in either direction from the armature; substantially as described.

6. The combination with a truck, of an armature mounted on a spindle dependent from the axle, a gear on the armature, gears on the axle which mesh with the armature-gear, and clutches for engaging or disengaging said axle-gears with or from the axle; substantially as described.

7. The combination with a truck, of an armature mounted on the axle thereof and rotating at an angle to said axle, means for driving the axle from the armature, clutches for controlling said means, a rod for operating the clutches, a plug for short-circuiting the armature and a cam-rod for operating the plug; substantially as described.

8. In a system of electric transportation, the combination with a plurality of primaries located in a route or line of travel and through which are propagated alternating electric currents of different phases, of a vehicle adapted to travel along said route, and a rotatory secondary member arranged in inductive relation to the said primaries and adapted to engage with the propelling mechanism of said vehicle, said primaries and secondary being so disposed that the secondary shall experience a couple or torque which will rotate the same; substantially as described.

9. In a system of electrical transportation, the combination with a plurality of primaries located in a route or line of travel and through which are propagated alternating currents of different phases, of a vehicle adapted to travel along said route, a horizontally-rotatable secondary member mounted upon the vehicle and arranged in inductive relationship to the primaries, said primaries being located on opposite sides of the axis of the secondary member; substantially as described.

10. An armature which is adapted to be rotated by an induced current, said armature consisting of a laminated core through which are arranged radially-disposed induced-current conductors, an outer inclosing plate in which one end of said conductors are received, an inner plate for receiving the other ends of the conductors, and a slidable plug for short-circuiting the two plates; substantially as described.

11. An electric transportation system, consisting of a route or line of travel, a vehicle which is adapted to travel along said route, a horizontally-rotatable armature on the vehicle for propelling the same, a primary arranged along the route for influencing the armature, and means for energizing the primary during the presence of the vehicle only; substantially as described.

12. An electric transportation system, consisting of a route or line of travel, a vehicle which is adapted to travel along said route, a horizontally-rotatable armature or secondary member on the vehicle, and a primary arranged along said route in inductive relationship to the armature or secondary member on the vehicle, said primary being composed of parallel cores which are divided into sections, terminals in said sections which are normally out of contact with the feed-wires, and means for cutting in said sections during the proximity of the vehicle, said sections being automatically cut out upon the departure of the vehicle; substantially as described.

13. In a system of electric transportation, the combination with a plurality of primaries located in a route or line of travel and through which are propagated alternating electric currents of different phases, of a vehicle adapted to travel along said route, and a rotatory secondary member arranged in inductive relation to the said primaries and adapted to engage with the propelling mechanism of said vehicle, said primaries and secondary being so disposed that the secondary shall experience a couple or torque which will rotate the same, and means for cutting in sections of the primaries during the presence of the vehicle only; substantially as described.

In testimony whereof I hereunto affix my signature, in presence of two witnesses, this 27th day of September, 1895.

PHILIP K. STERN.

Witnesses:
F. R. CORNWALL,
HUGH K. WAGNER.