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E. S. SHAW.

ELECTRIC LOCOMOTIVE.

No. 367,069. Patented July 26, 1887.

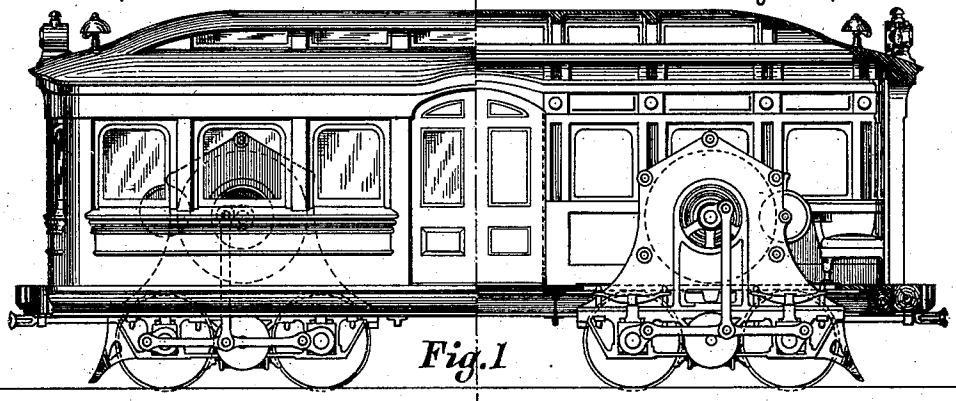

Fig. 1

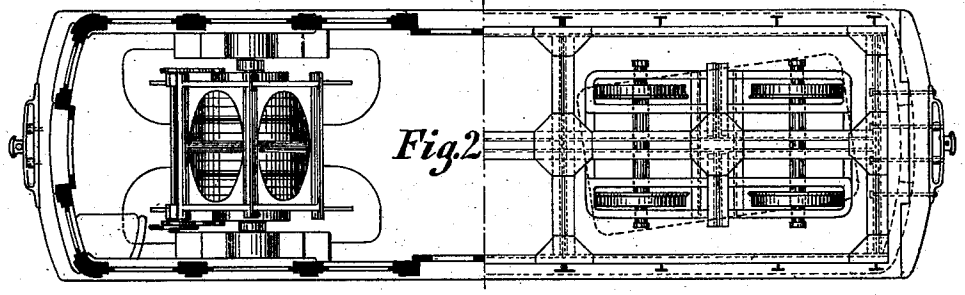

Fig. 2

Fig. 3

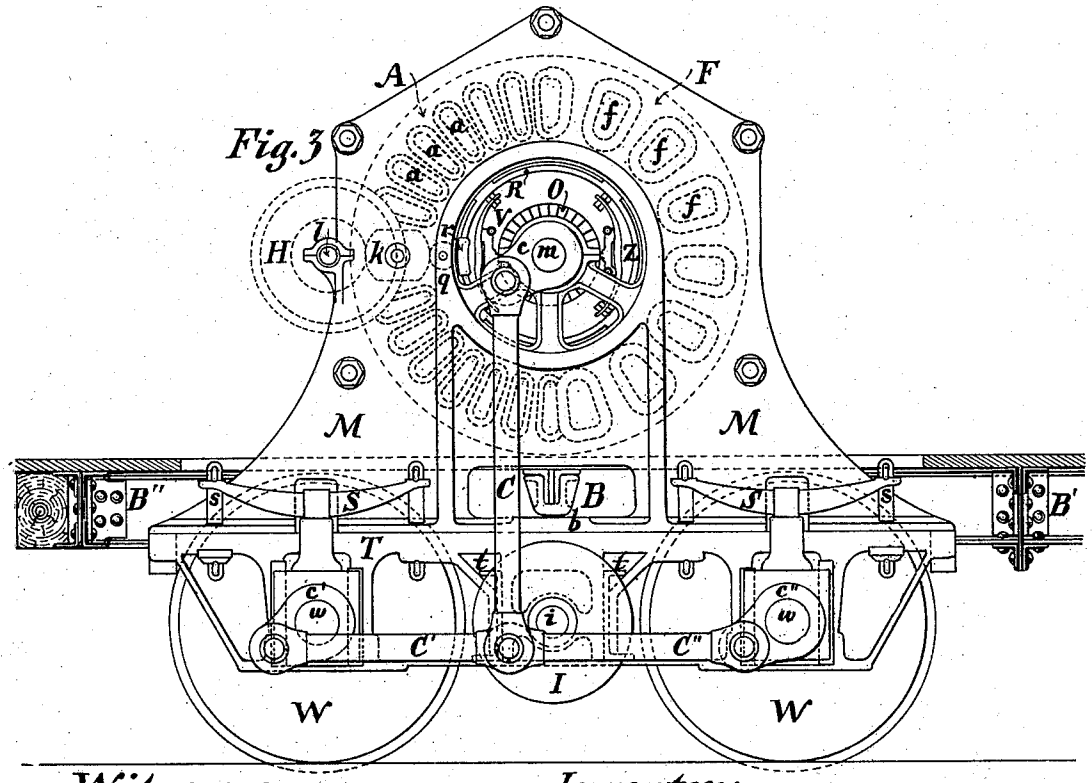

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Fig. 4

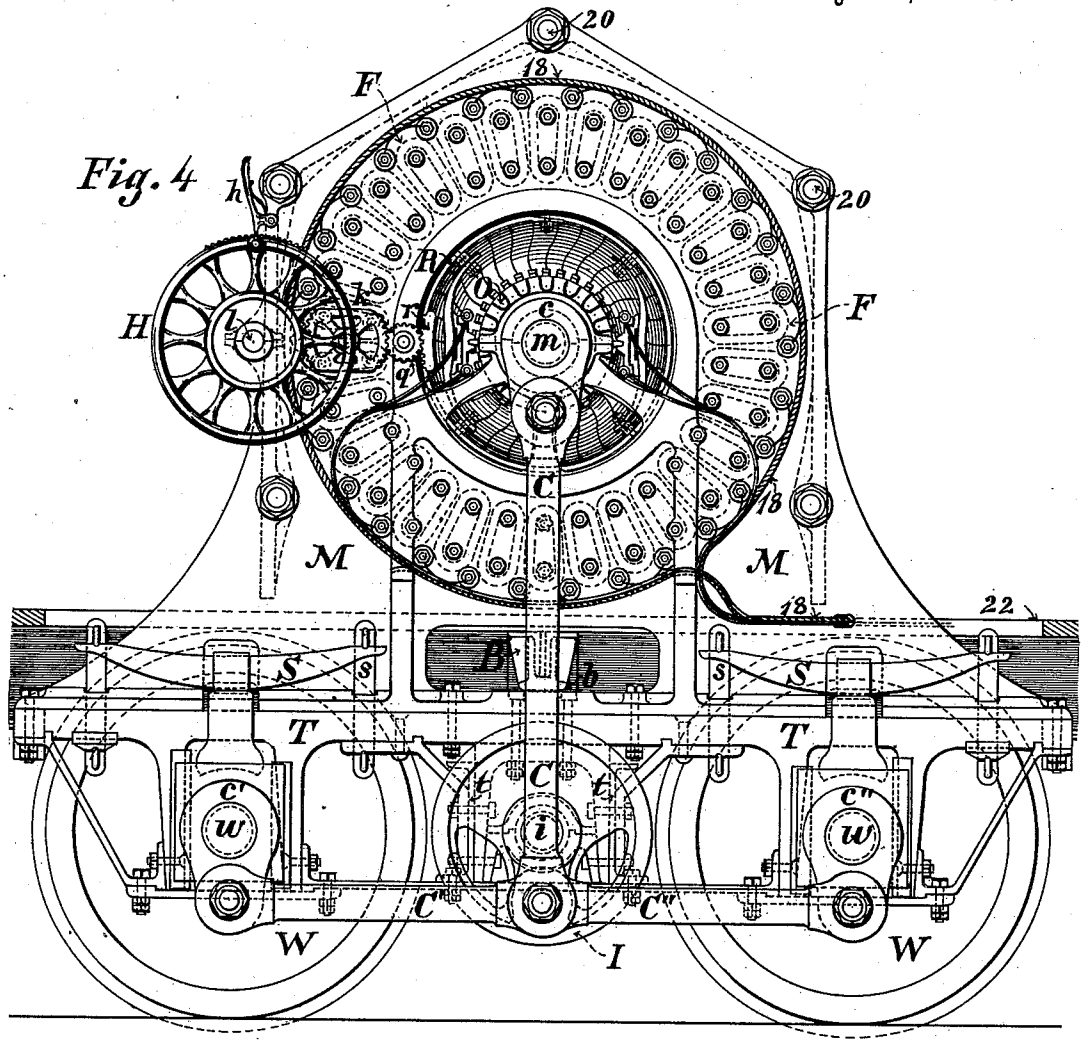
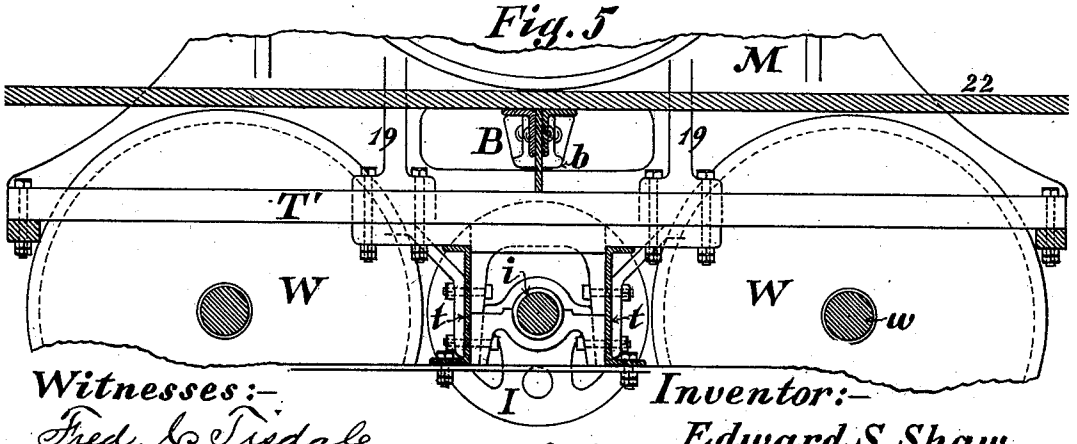


Fig. 5



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(No Model.) 6 Sheets—Sheet 3.

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Fig. 6

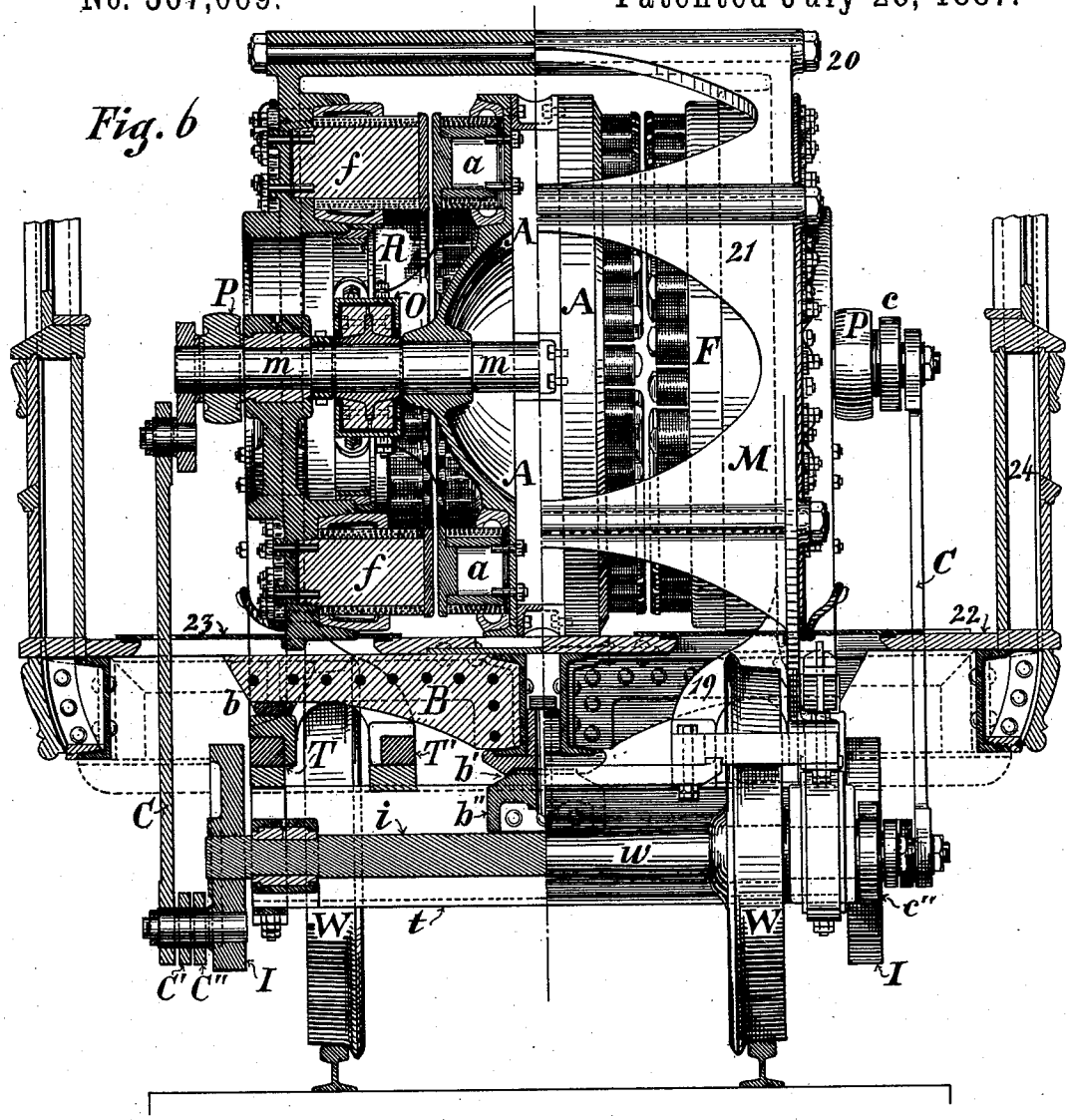

Fig. 7

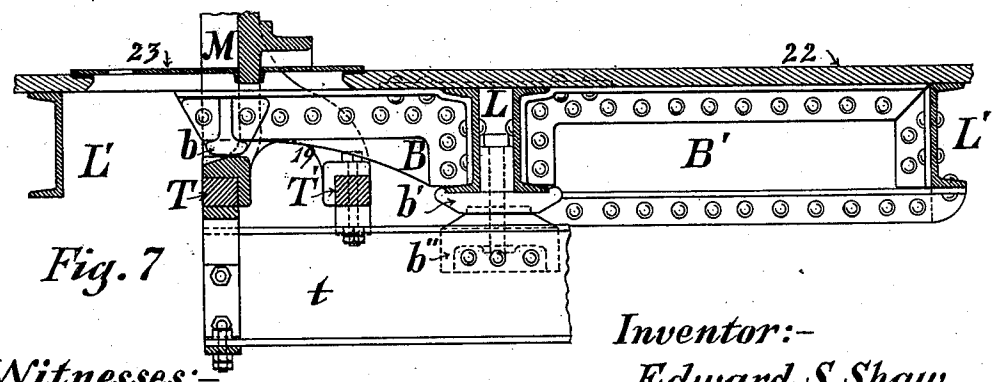

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Fig. 8

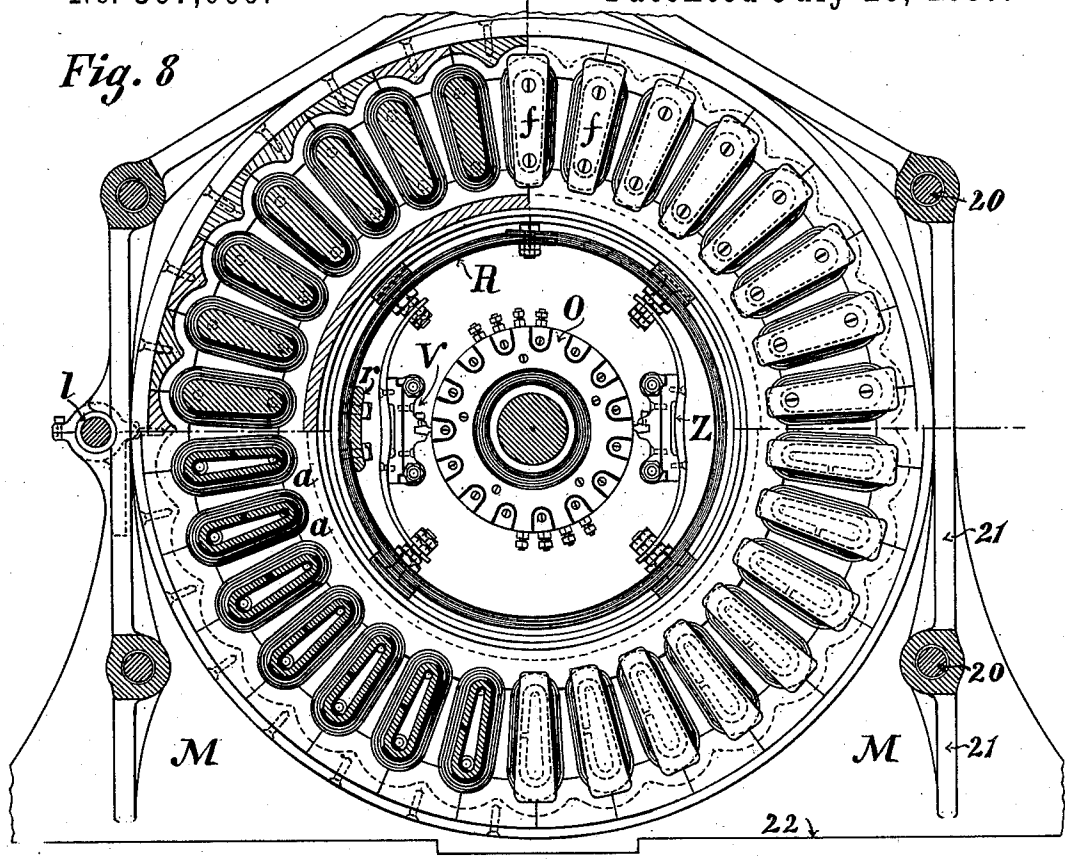

Fig. 9.

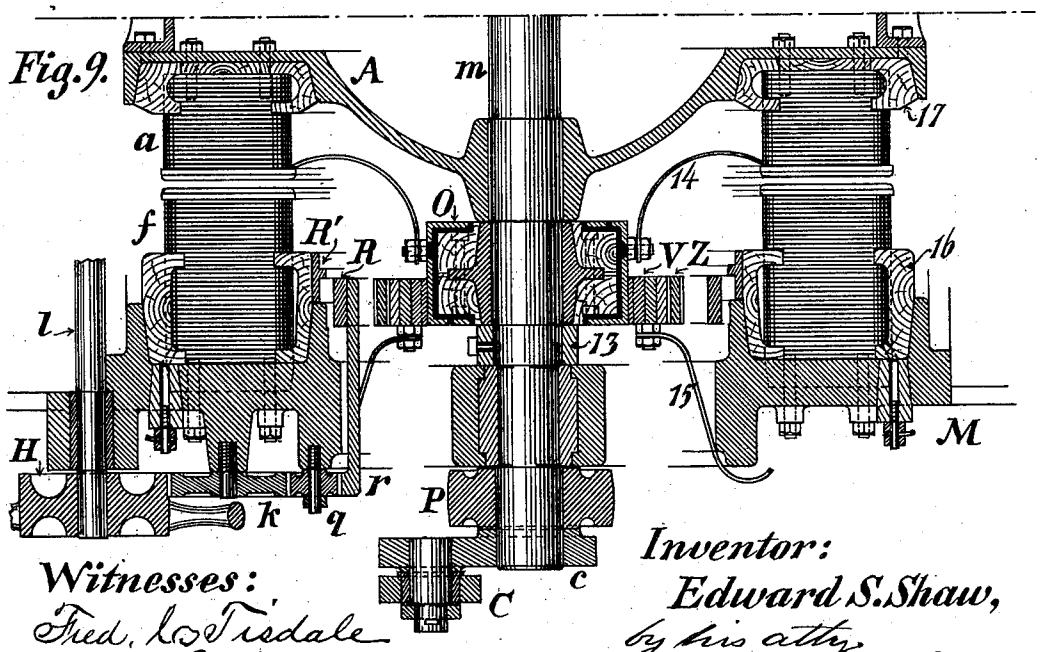

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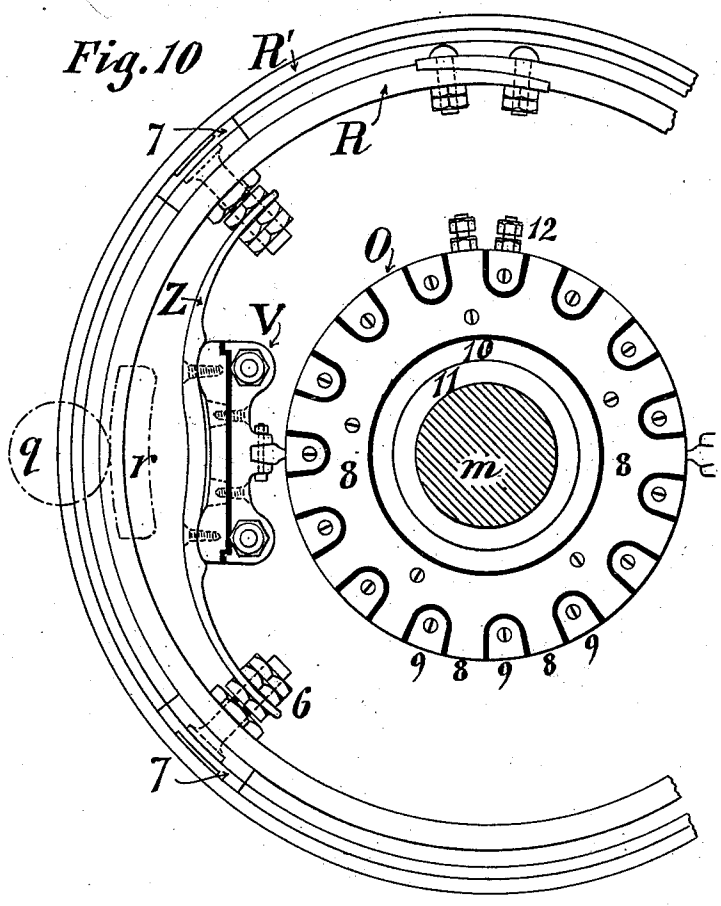
Fig. 10



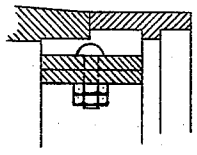
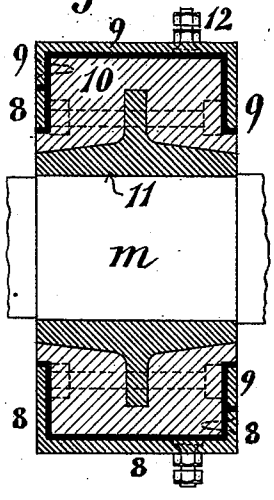
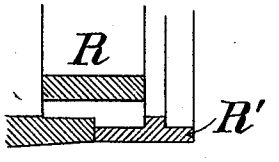


Fig. 11





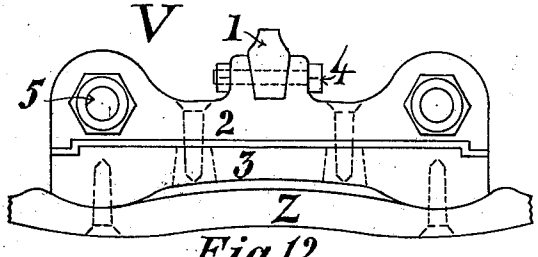
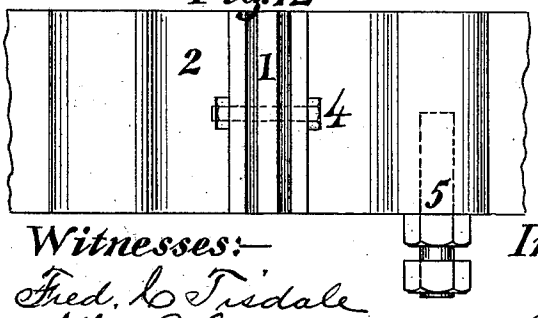


Fig. 12



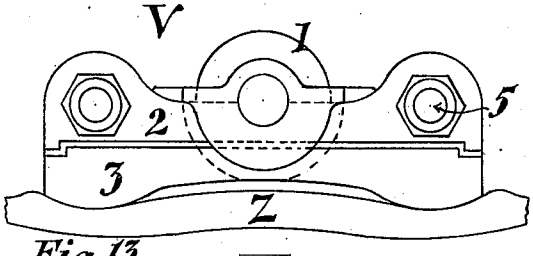
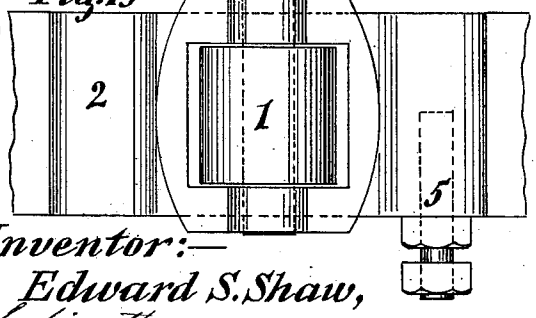


Fig. 13



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ELECTRIC LOCOMOTIVE.

No. 367,069. Patented July 26, 1887.

Fig. 14

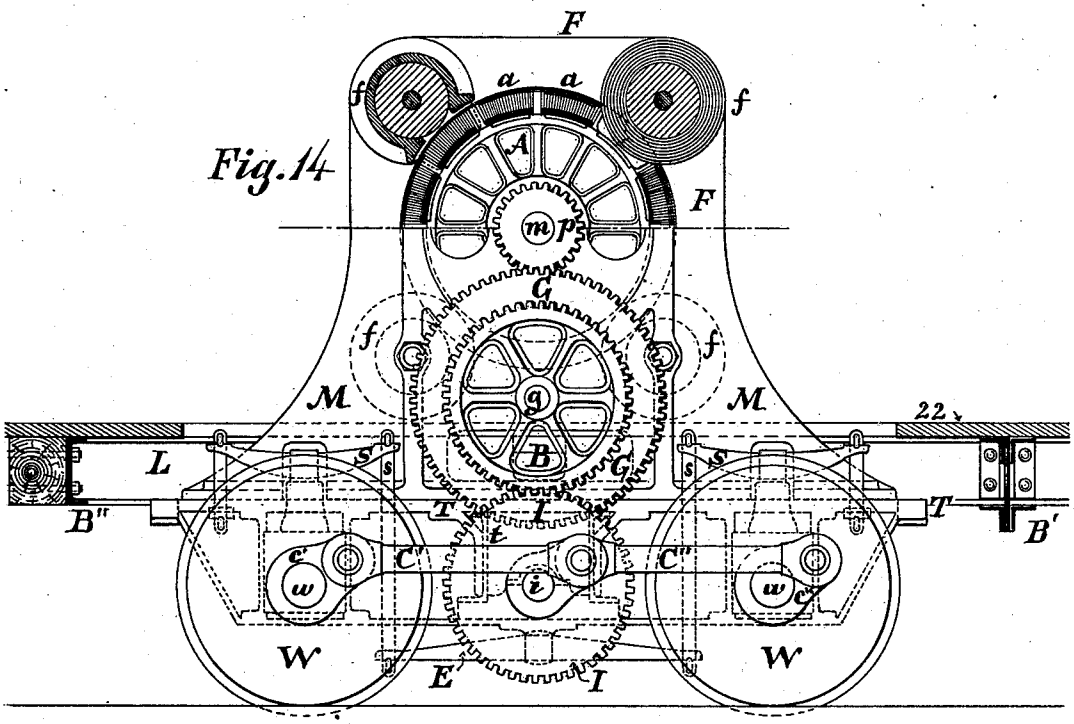
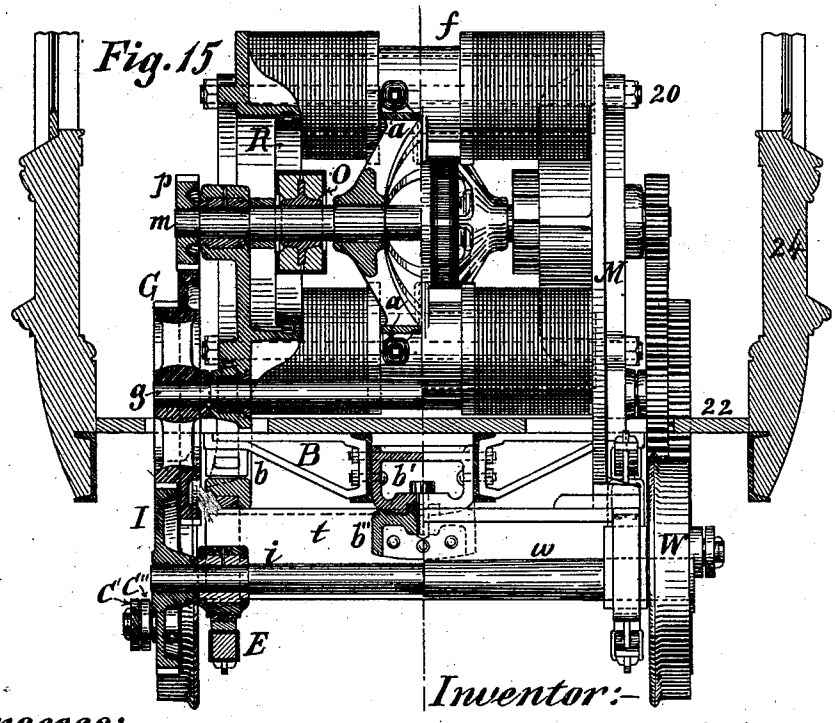


Fig. 15



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UNITED STATES PATENT OFFICE.

EDWARD S. SHAW, OF CAMBRIDGE, MASSACHUSETTS.

ELECTRIC LOCOMOTIVE.

SPECIFICATION forming part of Letters Patent No. 367,069, dated July 26, 1887.

Application filed June 3, 1886. Serial No. 204,105. (No model.)

To all whom it may concern:

Be it known that I, EDWARD S. SHAW, a citizen of the United States, residing at Cambridge, in the county of Middlesex and State of Massachusetts, have invented a new and useful Electric Locomotive, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to the class of electric locomotives in which the electromotor propelling the locomotive or car is carried upon and supported by a bogie or pivoted truck, so as to allow the vehicle to pass around a curve of short radius with ease.

Heretofore in bogie-trucks the motor has usually been attached to the truck or axles below the floor of the car and between the wheels. This position is objectionable on account of the difficulty of inspecting, cleaning, and repairing the motor, and on account of injury from dust or mud, snow or ice, obstructions on the track, &c.

The objects of my invention are, first, to so combine an electromotor of relatively large size and power with the frames of the truck and floor of an electrically-propelled vehicle, that, while the motor may be carried above the floor of the vehicle and its weight and power may be equally distributed among and exercised upon the several driving-wheels, the truck and motor shall be free to turn laterally about a center bearing or pivot, while traveling over curves in the track, and, second, to construct and arrange the mechanism by which the power of the motor is transmitted to the driving-wheels so that while the power of the motor may be equally distributed among and exercised upon the driving-wheels the axles shall be free to move vertically in spring-bearings, so as to conform to irregularities in the track, variations of load, and vibrations of the springs.

I attain the above objects by the methods of construction and the combinations illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation and longitudinal section of a double-truck locomotive exemplifying my invention. Fig. 2 is a plan and horizontal section of the same. Fig. 3 is a side elevation of the truck and motor, with a longitudinal section of a portion of the floor of the locomotive or car. Fig. 4 is a side elevation of the motor and truck in greater detail. Fig. 5 is a longitudinal section through floor and trucks between the wheels. Fig. 6 is an end elevation and transverse section of motor and truck, the section being taken on and near the center line or axis. Fig. 7 is a transverse section through floor and trucks, that on the left-hand side being taken on and near the center line of the trucks, and on the right-hand side near the transverse floor-beam B'. Fig. 8 is a longitudinal section through the motor, showing the arrangement of the field-magnet and armature-coils, the commutator and brushes. Fig. 9 is a horizontal section through the axial line of the motor. Fig. 10 is an elevation of the commutator, brush, and regulator-ring. Fig. 12 contains views of the brush on a larger scale, while Fig. 13 shows a modification of the brush. Figs. 8 to 13, inclusive, are introduced in order to more fully describe and illustrate the form of motor used in exemplifying my invention, and are not referred to in my claims. Fig. 14 is a side elevation and longitudinal section showing a variation in the form of motor and in the method of transmitting its power to the driving-wheels, not specifically claimed in this application. Fig. 15 is an end elevation and transverse section of the same.

In all of the figures the same letters or numbers are used to denote similar parts.

Referring to Figs. 1 and 2, it will be seen that the locomotive there illustrated consists of a pair of four-wheeled trucks, each combined with and supporting a rotary motor whose shaft or axis of rotation is parallel with and midway between the driving-wheel axles, and at a sufficient distance above the floor of the vehicle to allow an armature of relatively large size to revolve upon the shaft entirely above the floor. The trucks are attached to and connected together by a substantial floor-frame, preferably of iron or steel, through and by means of center bearings or pivots, allowing the trucks to turn laterally when passing over curves in the track, as shown by the dotted lines at the right hand of Fig. 2.

The locomotive should be covered by a neat and substantial housing to protect its contents from the weather. The floor-space between the motors may be utilized for storage-batter-

ies or baggage, the end spaces being reserved for the engine-men.

By omitting the motor upon one of the trucks and using the space thus obtained for passengers or baggage I have a locomotive-car whose motor-truck is constructed in accordance with my claims.

In Figs. 3, 4, 6, 14, and 15 the driving-wheels W are connected transversely by axles *w*, journaled in boxes which are allowed a slight vertical motion in pedestals or guides when subjected to impacts or variations of load, being restrained by the springs S, to which the truck-frames are suspended by means of hangers *s*, the inner pair of which may be connected by an equalizing-bar, E, Figs. 14 and 15. The truck-frames T may be of iron or steel, or of a combination of wood and metal. They may be placed outside of the wheels, as in Figs. 4 and 6, or inside, as in Figs. 14 and 15. When placed outside, a supplemental inner truck-bar, T′, Figs. 5, 6, and 7, may be used, to which the motor-frames M may be braced by brackets 19, Figs. 5, 6, and 7, and to which axle-guards may be attached.

The specific mechanical construction and electrical arrangement of the electromotor are not claimed as a part of this invention, and may be varied. I would, however, prefer to employ one of the two types shown in my drawings, and which may be constructively classified together as consisting of a shaft or axis carrying one or more annular or radial bobbin-armatures of large size, field-magnets parallel with and equidistant from the shaft and at right angles to the plane of the armature, and a pair of supporting-frames situated in planes parallel to the plane of the armature and at right angles to the axes of the magnets. These frames are supported directly upon and attached to the side frames of the truck, a strip of elastic material being preferably interposed, and should be spread longitudinally at their base to give greater stability.

At the center of each motor-frame is a pillow-block or bearing carrying the motor-shaft *m*, upon which the armature rings or wheels A and commutators O are concentrically attached. Surrounding the motor-shaft, parallel with and equidistant from it, are the field-magnets *f*. These may consist of a large number of comparatively small electro or permanent magnets, as in Figs. 3, 4, 6, 8, and 9, set in a circle or ring, F, formed upon the motor-frame, or there may be fewer magnets of larger size connected across from frame to frame, as in Figs. 14 and 15. The armatures may consist of a large number of coils wound upon bobbins whose axes are parallel to and equidistant from the motor-shaft, as in Figs. 3, 4, 6, 8, and 9, or they may be of the well-known Gramme or Pacinotti type, as in Figs. 14 and 15. In either case a double ring or circle of coils may be used, and the poles of one armature may have a lead or angular advance upon those of the other to obviate dead-points.

In all of the figures *f f* are the field-magnets, F is the field-magnet ring or portion of the motor-frame to which they are attached, *a a* are the armature-coils, and A is the wheel or ring to which they are attached and by which they are connected with the motor-shaft.

Referring to Figs. 1 to 7, inclusive, and Figs. 14 and 15, it will be noticed that the truck-frames T are connected together transversely by means of a pair of beams or transoms, *t*, having attached to their central portion a center bearing or pivot-plate, *b″*, which supports an upper center bearing, *b′*, attached to the inner longitudinal beams of the floor L. Projecting laterally on either side of the center bearings, and attached to the beams L, are a pair of transverse cantalevers or brackets, B, having attached to or formed upon their ends the side bearings, *b*. The brackets B pass through elongated openings in the motor-frames, and each bearing *b* is placed nearly in contact with a smooth horizontal surface formed upon the motor-frame or on the side frame of the truck. The side framing and housing 24 of the vehicle is supported upon the outer longitudinal floor-beams, L′, and its weight, with that of the outer portion of the floor and load borne by the beams L′, is transferred to the inside floor-beams, L, and thence to the center bearings and trucks by means of the transverse floor-beams B′ B″, situated without the limits of the truck-frames. Longitudinal slots or openings are cut in the floor-planking 22 to allow the passage and lateral movement of the motor-frames and connections, these openings being covered and guarded by metallic plates 23, attached to the motor-frames so as to slide over the surface of the floor, or by a flexible covering composed of interwoven metallic links or chain-cloth covered with canvas, &c.

Referring to Figs. 3, 4, and 6, it will be seen that the motor-shaft *m* carries upon its extremities a pair of cranks, *c*. The pulleys P upon the motor-shaft are for an object not a part of this invention—viz., the driving of a fan, blower, air-pump, &c., by means of a belt passing around the pulley. To the cranks *c* are attached, by means of crank-pins, a pair of vertical connecting-rods or eye-bars C, which have their lower ends journaled upon pins fixed eccentrically in wheels I, centered upon the ends of a transverse intermediate or auxiliary shaft, *i*, which turns in bearings supported upon and between the truck-transoms *t*. The wheel I is connected with the driving-wheels W, or with their axles *w*, by means of coupling rods or bars C′ C″, journaled upon pins in cranks *c′ c″*, fixed upon the ends of the driving-axles, or in the driving-wheels themselves, where inside frames are used, as in Figs. 14, 15.

By the above-described method of connecting the motor-shaft with the driving-wheels the power and rotary motion of the one is transmitted to the other by a reliable and

noiseless mechanism, and the driving-wheels are allowed to move vertically in their guides without imparting any vertical thrust to the shafts *i* or *m*.

It is evident that the motor-shaft might be connected directly with one or both of the driving-axles by means of inclined connecting-rods journaled upon the cranks *c c' c''*, and such an arrangement has been shown in English Patent No. 12,300 of 1834. In this arrangement, however, there would be in certain positions of the cranks and rods a tendency to obstruct the play or vertical movement of the drivers, and thus create a transverse or bending stress in the shaft, axles, or cranks. This method is therefore objectionable.

In certain circumstances it may occur that the driving-wheels ordinarily move at a low rate of speed, and as a motor connected with them as above set forth must necessarily make the same number of revolutions in a given time as the driving-wheels its speed in this case may not be great enough for the generation of a sufficiently high counter electro-motive force to insure the most economical operation of the motor. With these conditions I should prefer to connect the motor-shaft *m* with the intermediate shaft, *i*, by the mechanism shown in Figs. 14 and 15, in which *p* is a small gear or pinion upon the end of the motor-shaft. G is a larger gear, which may have a single or double circle of teeth fixed upon a counter shaft or axle, *g*, and I is a gear-wheel upon the end of the intermediate shaft, *i*. This mechanism may form the subject of a future application for Letters Patent.

In order to make the illustration and exemplification of my locomotive full and complete, I have shown, Figs. 8 to 13, inclusive, the form of motor and method of commutating and regulating the currents which I would preferably adopt. These particulars are not claimed in the present application, but may form the subjects of future ones.

The motor is of the class known as "multipolar," and consists of a number—in the present example thirty—in each ring, of radially-elongated field-magnets *f f*, having preferably soft-iron cores, separate from the motor-frame but fixed in and attached to the same, as shown. The armatures consist each of a metallic ring or wheel, A, provided with radial slots to prevent circulating currents, or built up of a number of sectors insulated from one another and firmly bolted together. The ring A carries near its periphery a number of radially-elongated coils, *a a*, wound upon hollow wrought-iron cores or bobbins, which are attached to the ring and insulated from it by the backing 17. The number of coils in each armature circle may be equal to or double the number of field-magnet coils in one circle. Where the number of coils in the armature is the same as that of the field-magnets, the coils in one armature-ring should have a lead or advance upon those of the other ring equal to about one-half of the pitch or distance between them, and their respective commutators or brushes should have the same lead upon one another.

The commutator O consists of a pair of metallic rings, 8 and 9, Figs. 10 and 11, attached to the parallel ends of a cylinder, 10, of hard and fine grained wood or other suitable material. Each of these rings is provided with a series of projecting parallel strips or denticulations, passing across the curved surface of the cylinder, to whose shape they conform, being bent over and attached to the opposite end of the cylinder. The denticulations or circumference strips of the ring 8 alternate and interlock with and are insulated from those of the ring 9, and the opposite rings, 8 and 9, are insulated from one another and from the motor-shaft *m*. Connected with the circumferential strips or divisions of the commutator are binding screws 12, to which the terminal wires 14 of the armature-coils are attached. There are two brushes, V, for each commutator, each brush consisting of the contact point or wheel 1, Figs. 12 and 13, the metallic frame or holder 2, and the backing 3, which is preferably of wood, separated from the holder 2 by a strip of insulating material. Binding-screws 5 serve for the attachment of the conductors 15, conveying the current, both of the conductors attached to the same brush being of the same kind—that is, either positive or negative. The field-magnets being wound so as to present poles of alternate north and south polarity, the armature-coils should, in any given position, have poles of alternate polarity. The number of divisions in the commutator should equal that of the field-magnets in one ring, and should be the double of an odd number, so that the opposite brushes may always be in contact with opposite sets of commutator divisions.

The armature-coils may be connected with all of the divisions of the commutator, so as to be in multiple arc, one end of each coil being attached to a positive, the other to a negative binding-screw, or any convenient number of armature-coils may be connected in series, the terminals of the group being attached to positive and negative binding-screws, and by varying these connections a number of different combinations of series and multiple or parallel circuit may be effected. In any case the direction of the current in any given coil will be changed during each revolution as many times as there are divisions in the commutator, and by moving the brushes circumferentially about the commutator, through an angle equal to that of one of its divisions, the point of reversal of the current may be changed from the position of a given armature-coil opposite the pole of any given magnet to a position opposite the pole of the adjacent one, and the direction and speed of rotation thus controlled. Each brush is attached, by means of screws or other suitable insulated fastening, to the

brush-spring Z, which is secured at each end to the regulator-ring R by means of screw-bolts and nuts 6, allowing an adjustment. The regulator-ring R is situated a short distance within and parallel to a retaining or guide ring, R′, secured to the frame of the motor concentric with its axis, or forming a part of that frame.

Blocks of anti-friction metal 7, sufficiently lubricated, confine the regulator-ring in place, while they allow a circumferential motion in either direction, this motion being effected by means of the hand-wheel H, Figs. 3, 4, and 9, the intermediate or idle gear *k*, the pinion *q*, and rack *r*. As there would usually be a pair of commutators with their respective brushes situated upon opposite sides of the motor, I would connect them by a lateral shaft, *l*, provided with similar gearing at either end, so that both sets of brushes may be operated from the same wheel H. The regulating-gear of two motors upon the same locomotive may be connected so as to be operated from the same point.

The electric current by which the motors are actuated may be generated by dynamo-machines, and transmitted to the locomotive through the rails, or through an insulated conductor parallel with them, or it may be derived in whole or in part from storage or secondary batteries carried upon the locomotive or train. It may be conveyed to the field-magnet coils by means of the insulated cable 18, Fig. 4, having branches connected with the brushes, the field-magnet and armature-conductors being connected with one another, and with the supply-conductor by a suitable switch or commutator controlled by the engine-man. The methods of generating, transforming, conveying, and controlling the actuating-current which I would preferably adopt do not form a part of this invention, but may form the subject of an application for a patent for an electric railway system.

I do not claim, broadly, as my invention, the position of the axis or shaft of the electromoter, parallel with and midway between the driving-wheels and above the floor of the vehicle; neither do I claim, generally, the combination and dynamical connection of the motor-shaft with the driving-wheel axles by means of reciprocating coupling-rods; nor, in general, the combination of an intermediate or auxiliary shaft situated between the driving-wheel axles, with a motor situated above it.

What I do claim as my invention, and desire to secure by Letters Patent of the United States, is—

1. An electric locomotive or electrically-propelled railway-vehicle provided with one or more rotary electromotors, each mounted upon and supported by a four-wheeled bogie or centrally-pivoted truck, each motor containing a central shaft or axis of rotation parallel to and midway between the driving-wheel axles and above the floor of the vehicle, one or more revolving armatures fixed concentrically upon the said shaft, field-magnets parallel with and equidistant from the said shaft, and a pair of frames supporting the said shaft and field-magnets and situated in vertical planes above and parallel with the side frames of the truck, substantially as and for the purposes set forth.

2. In an electric locomotive, the combination of a four-wheeled bogie or pivoted truck with an electromotor whose field-magnets and armatures are situated above the floor of the containing-vehicle and within its housing, and are symmetrically disposed with regard to the wheels and truck-frames, substantially as set forth.

3. In an electric locomotive, the combination of a four-wheeled bogie or pivoted truck with an electromotor whose field-magnets and armatures are supported by a pair of frames situated in vertical planes parallel with and above the side frames of the truck, substantially as set forth.

4. In an electric locomotive, the combination of a bogie or pivoted truck, a floor-frame and flooring supported upon the center pivot and side bearings of the truck, and an electromotor whose supporting-frames are carried upon the side frames of the truck and pass through guarded openings in the flooring, arranged so as to allow the motor to turn horizontally about the vertical axis or pivot of the truck, substantially as and for the purposes herein set forth.

5. In an electric locomotive, the combination of a bogie or pivoted truck, an electromotor provided with vertical longitudinal frames placed over and supported upon the side frames of the truck, and a floor-frame consisting of a pair of inner longitudinal beams or girders, L L, a pair of outer longitudinal beams, L′ L′, a pair of transverse beams or girders, B′ B″, situated outside of the limits of the truck-frames, and a pair of cantalevers or brackets, B B, projecting transversely from the center bearing, *b′*, and supported at their ends *b b* upon the frames of the truck or motor, substantially as shown and described.

6. In an electric locomotive, the combination, with the frames of the motor M F and the floor of the vehicle 22, of guard-plates 23, attached to the frames of the motor so as to slide laterally over the floor of the vehicle and cover the openings therein, substantially as specified.

7. In an electric locomotive, the combination of a four-wheeled truck whose axles are allowed a vertical motion in spring-restrained bearings, an electromotor whose armature shaft or axis is parallel with, midway between, and above the driving-wheel axles, an auxiliary or intermediate shaft parallel with and midway between the driving-axles and beneath the motor-shaft, reciprocating coupling-rods connecting the intermediate shaft with the driving wheels or axles, and a device or mechanism connecting the motor-shaft with the interme-

diate shaft, whereby the power of the motor is transmitted to the driving-wheels, substantially as set forth.

8. In an electric locomotive, the combination of a four-wheeled truck whose axles are allowed a vertical motion in spring-restrained bearings, an electromotor whose armature shaft or axis is parallel with, midway between, and above the driving-wheel axles, an intermediate shaft parallel with and midway between the driving-axles and beneath the motor-shaft, reciprocating coupling-rods connecting the intermediate shaft with the driving wheels or axles, and reciprocating coupling-rods connecting the intermediate shaft with the motor-shaft, whereby the power of the motor is transmitted to the driving-wheels, substantially as set forth.

9. In an electric locomotive, the combination of the motor-shaft *m*, cranks *c*, coupling-rods C, crank or counterbalance wheels I, auxiliary or intermediate shaft, *i*, coupling-rods C′ C″, and driving-wheels W W, substantially as herein shown and described.

10. In an electric locomotive, the combination of the motor-shaft M, cranks *c*, coupling-rods C, crank or counterbalance wheels I, and intermediate shaft, *i*, substantially as set forth.

In testimony whereof I hereunto set my hand in the presence of two subscribing witnesses.

EDWARD S. SHAW.

Witnesses:
C. N. GOODRICH,
ALEX. L. HAYES.