(No Model.)

3 Sheets—Sheet 1.

S. H. SHORT.

ELECTRIC BRAKE.

No. 594,493. Patented Nov. 30, 1897.

Fig. 2.

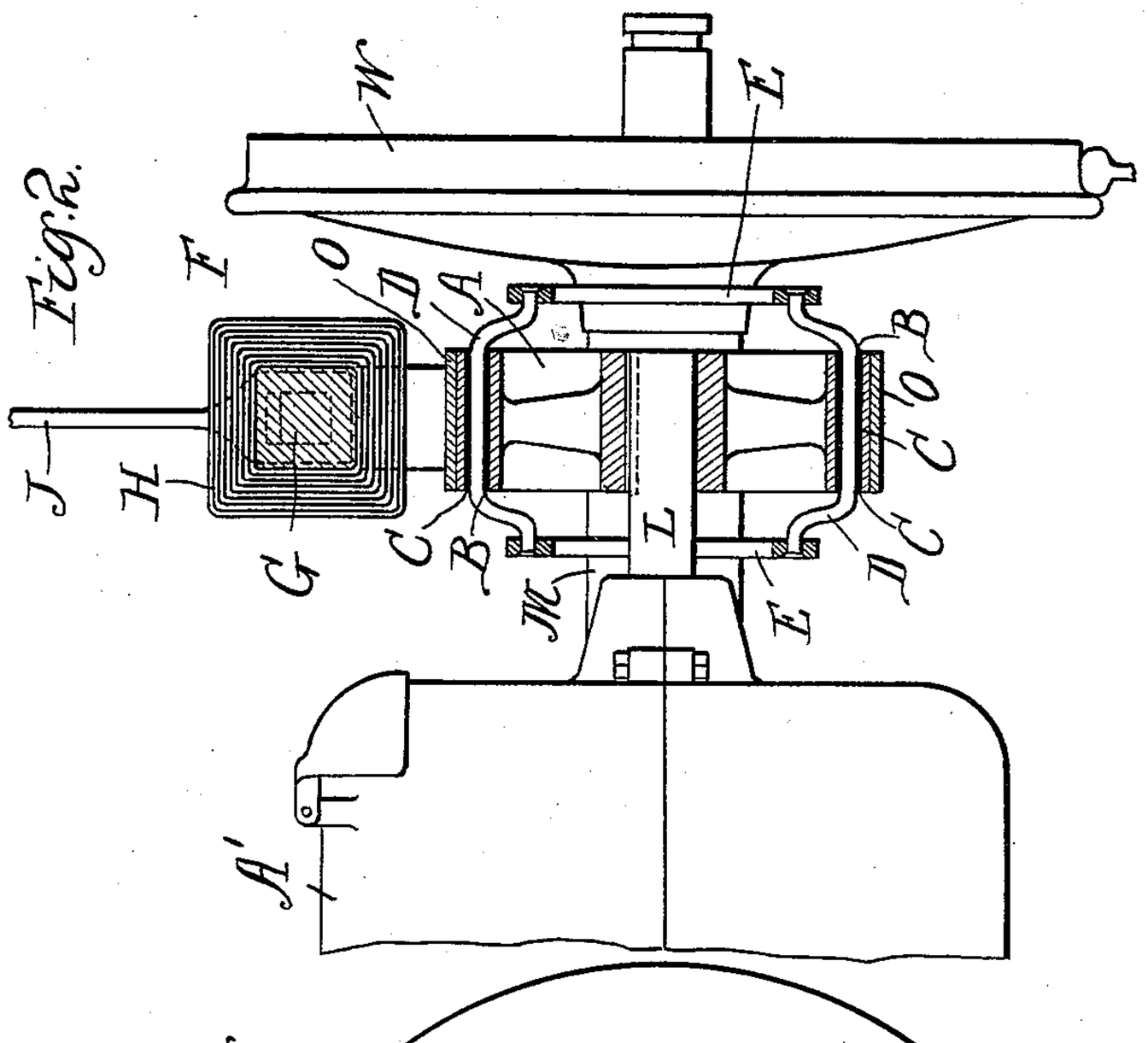
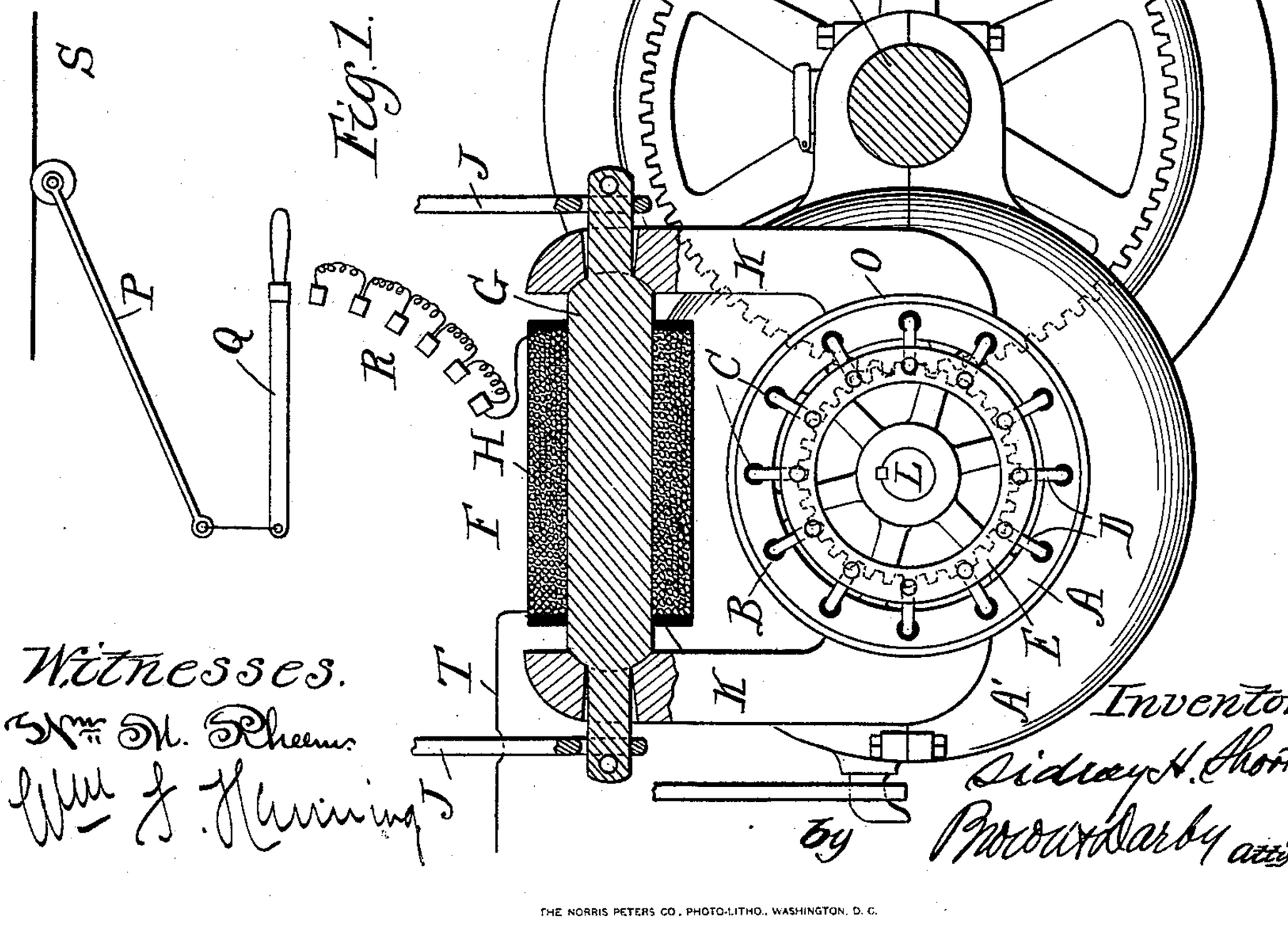


Fig. 1.



Witnesses.
Wm. H. Rheem.
Wm. F. Hunnings

Inventor
Sidney H. Short
By Brown & Darby Atty's.

(No Model.) 3 Sheets—Sheet 2.

S. H. SHORT.

ELECTRIC BRAKE.

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Fig. 3.

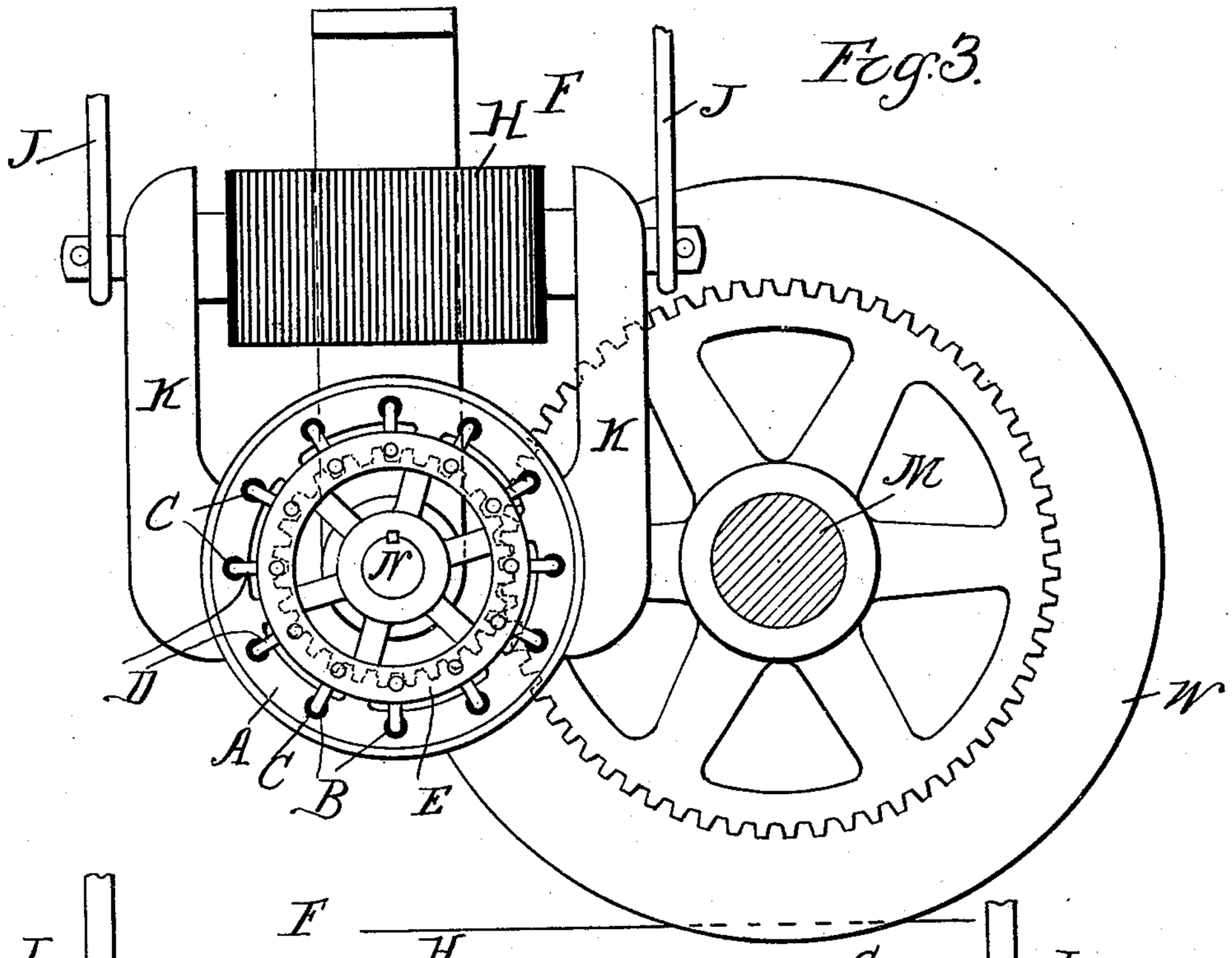
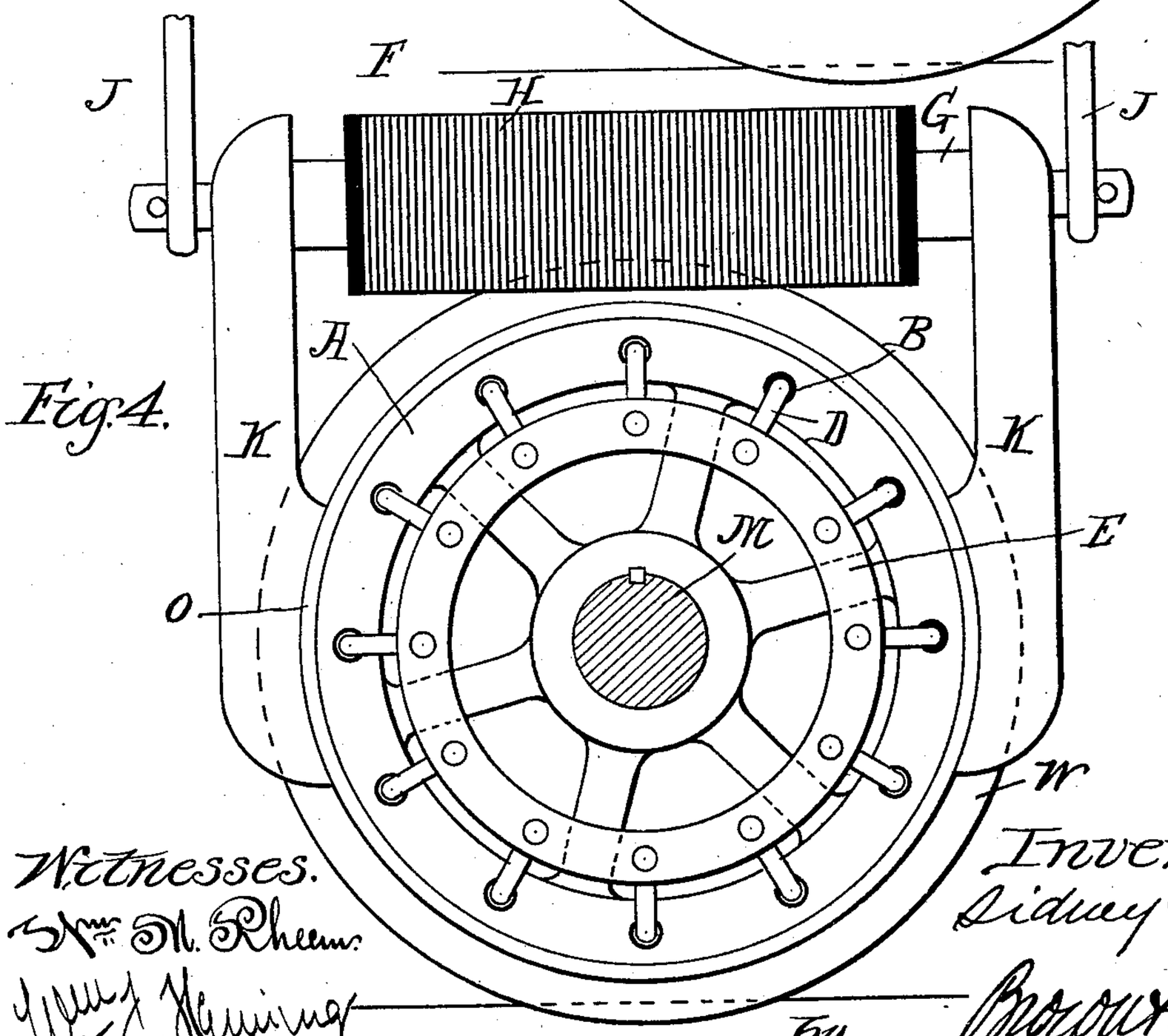


Fig. 4.



Witnesses.
Wm. N. Rheem.
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Inventor
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Atty's

(No Model.) 3 Sheets—Sheet 3.

S. H. SHORT.

ELECTRIC BRAKE.

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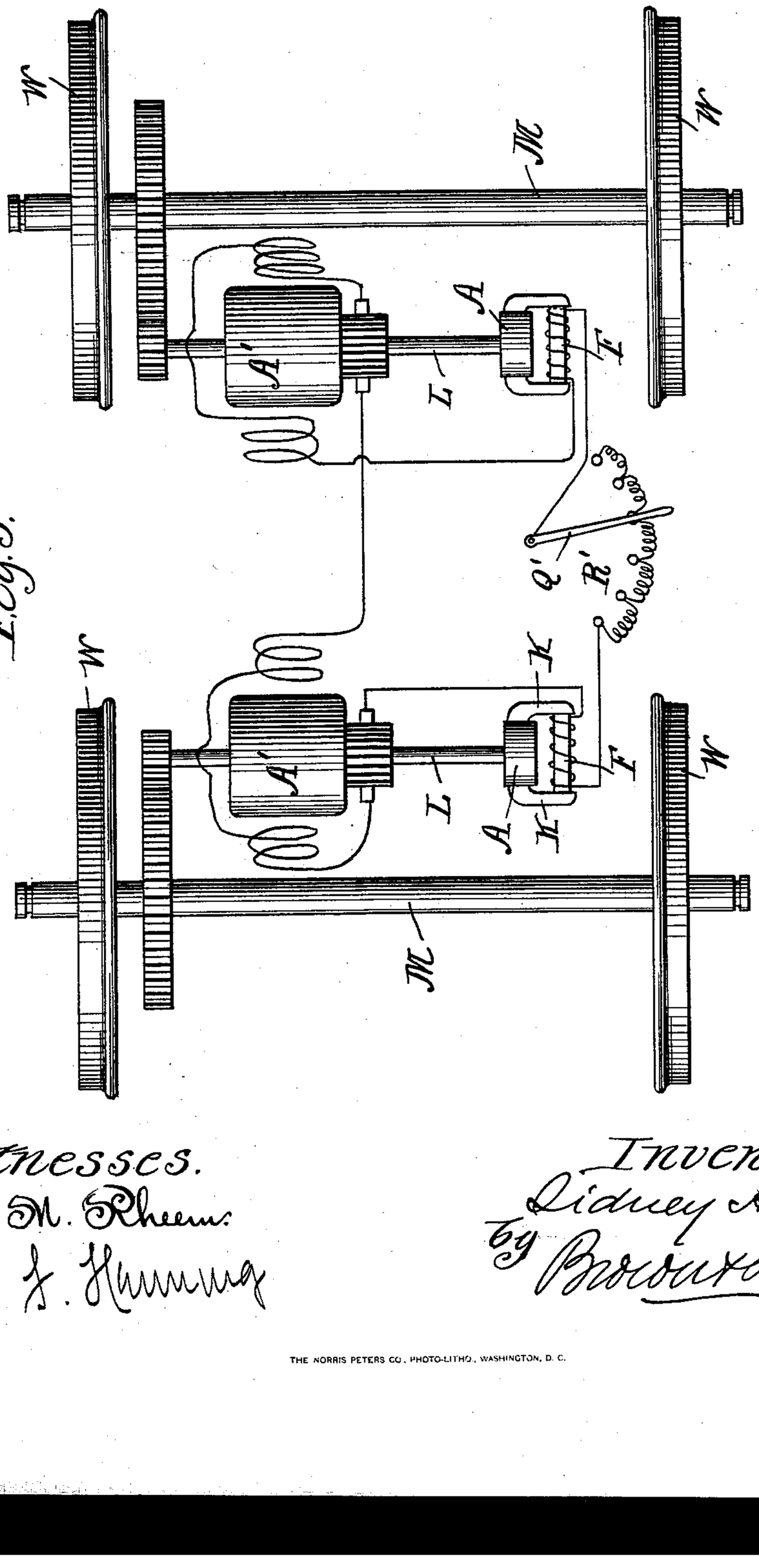

Fig. 5.

Witnesses.
Wm. M. Rheem.
Wm. F. Hunnig

Inventor.
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by Brown & Darby
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UNITED STATES PATENT OFFICE.

SIDNEY H. SHORT, OF CLEVELAND, OHIO.

ELECTRIC BRAKE.

SPECIFICATION forming part of Letters Patent No. 594,493, dated November 30, 1897.

Application filed May 10, 1897. Serial No. 635,865. (No model.)

To all whom it may concern:

Be it known that I, SIDNEY H. SHORT, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a new and useful Electric Brake, of which the following is a specification.

This invention relates to electric brakes.

The object of the invention is to provide an electrically-operated brake of simple and improved construction for efficiently braking shafts or axles.

The invention consists, substantially, in the construction, combination, location, and arrangement of parts, and mode of operation, all as will be more fully hereinafter set forth, as shown in the accompanying drawings, and finally specifically pointed out in the appended claims.

Referring to the accompanying drawings and to the various views and reference-signs appearing thereon, Figure 1 is a broken view, partly in end elevation, showing the application of a brake embodying my invention to the shaft of a motor geared to a car-axle, the brake-magnet being in longitudinal section and the car-axle in transverse section. Fig. 2 is a view in front elevation of the construction shown in Fig. 1, the brake-wheel being in longitudinal section and the brake-magnet in transverse section. Fig. 3 is a view similar to Fig. 1 showing the application of a brake embodying my invention to a countershaft suitably geared to the car-axle. Fig. 4 is a similar view showing the application of a brake embodying my invention as applied directly to the car-axle. Fig. 5 is a view in plan, somewhat diagrammatical, showing a form of application of my invention.

The same part is designated by the same reference-sign wherever it occurs throughout the several views of the drawings.

In carrying my invention into practical effect I induce in a strong magnetic field a very heavy alternating current in circuits short-circuited upon themselves. The strong magnetic field referred to may be produced in any suitable or convenient manner. In the particular form shown I form a closed magnetic circuit, and I arrange the means for generating the alternating current to revolve in a path so as to cut the magnetic lines of force in this magnetic circuit. By arranging the brake-shoes to close the magnetic circuit and by suitably energizing such magnetic circuit it will be seen that I secure a strong braking effort upon an application of the brakes to the revolving surface the speed of rotation of which is to be decreased.

I will first describe the construction of the brake-wheel and its accessory parts and the construction and arrangement thereof and will afterward point out and describe the manner of mounting the same and its relative arrangement with respect to the axle or shaft the speed of rotation of which is to be arrested.

In the drawings reference-sign A designates the brake-wheel. This wheel is provided with a heavy peripheral rim of cast iron or steel, having perforations extending through such rim at equally-spaced distances around the periphery thereof, said perforations extending in lines parallel with the axis of such wheel, as indicated at B. In these perforations I arrange suitable insulating-sleeves C, through which I pass heavy inducting-bars of copper or other suitable conducting material, and I electrically connect together the projecting ends of the bars D in any suitable or convenient manner, as by riveting or otherwise securing the projecting ends of said inductor-sections in rings E of copper or other suitable conducting material. Reference-sign F designates the brake-magnet employed for energizing the magnetic circuit above referred to. This magnet comprises a core G of suitable material, over which is slipped a coil H of fine wire and many turns. This magnet and core may be supported from the car-body, truck-frame, or from the motor or motor-casing in any suitable or convenient manner—as, for instance, by means of the hangers J.

Reference-sign K designates the brake-shoes. These shoes may be formed of any suitable material—such, for instance, as cast-iron—and are provided with a large area of surface suitably formed to embrace the surface of the periphery of brake-wheel A, as clearly shown, and may be supported in any suitable or convenient manner. I have shown a simple and convenient arrangement for supporting the brake-shoes K by loosely hanging

said brake-shoes upon extensions of the magnet-core G, as clearly shown in Fig. 1, whereby the braking or bearing surface of said shoes may be moved freely toward or from each other—*i. e.*, toward or from the surface of the brake-wheel against which said brake-shoes are adapted to bear. As will presently be more fully explained, these brake-shoes, with the brake-wheel A, are included in and form part of a magnetic circuit, which also includes the magnet-core G. It is desirable and important, therefore, that these brake-shoes may have a large area of contact with core G. In order to accomplish this result, I reduce the ends of said cores and suitably perforate the ends of the brake-shoes, and I slip said brake-shoes over the reduced ends of the core, whereby the brake-shoes bear against the shoulder or surface of the magnet-core formed by reducing the ends thereof, as clearly shown in Fig. 1, and in order to secure the desired degree of freedom of movement of the brake-shoes I reduce the ends of the core G, as clearly shown in Fig. 1, to a diameter smaller than the perforations in the brake-shoes.

From the foregoing description it will be seen that when the brake-magnet F is energized by a current of electricity traversing the coils H thereof a strong magnetic flux will take place through the closed magnetic circuit formed by the core G, the brake-shoes K, and the brake-wheel A, said brake-wheel completing such magnetic circuit between the bearing-surfaces of the brake-shoes. The magnetic flux induced by energizing the brake-magnet will cause the two brake-shoes to hug the brake-wheel very tightly, and a pressure of from fifty to one hundred pounds per square inch may be attained, depending upon the reluctance of the magnetic circuit. By relatively proportioning the area of contact between the brake-shoes and the periphery of the brake-wheel any desired degree of braking effort may be attained.

From the foregoing description it will be seen that the brake-wheel, with the inductor-sections D mounted therein, forms in effect an armature-core with the copper windings or inductor-bars short-circuited upon themselves, and which armature revolves in a strong magnetic field which is produced by the closed magnetic circuit described, the brake-shoes acting as pole-pieces for such armature. The effect of this arrangement is to produce a very heavy alternating current in the windings when such armature or brake-wheel is revolving at a high rate of speed. This alternating current will be set up in the inductors D as they cut the magnetic lines of force in the magnetic circuit above referred to, and which currents are short-circuited through the end connections E of such inductors. From this it will be seen that I not only get the frictional breaking effort upon the peripheral surface of the brake-wheel by reason of the brake-shoes hugging such surface, but these induced alternating currents tend to retard the revolution of the brake-wheel by consuming energy and radiating it from the brake-wheel in the form of heat. Thus the action of the inductors in cutting the lines of force through the revolutions of the brake-wheel is exactly the same as the action of an alternating dynamo which is short-circuited upon itself, as will be readily understood by persons skilled in the art.

In practice, as is well understood, it is desirable and usually the custom to initially apply the brakes while the cars are going at a high rate of speed. Under this condition, with the brake-wheel mounted on a revolving shaft geared to the axle, or directly upon the axle itself, and hence revolving at a high rate of speed, a very heavy braking effort is exerted on the shaft or axle when the brakes are first applied; but this braking effort decreases as the speed of the car and hence as the speed of rotation of the brake-wheel decreases, and when the car is finally stopped the braking effort caused by this consumption of energy, as above explained, by the induced current in the inductors D would entirely cease or disappear, leaving merely the frictional engagement of the brake-shoes against the surface of the brake-wheel as the sole braking effort applied, and this remaining braking effort remains applied so long as the brake-lever is in the "on" position. Therefore the braking effort at the beginning would be very great, being the sum of the friction of the brake-shoes upon the peripheral surface of the brake-wheel and the braking effort due to the absorption of energy by the heavy alternating currents in the inductor-sections. In other words, the electrical braking effort due to the alternating currents would decrease in proportion to the decrease in the speed of the car, and finally becomes zero when the car stops, while the frictional braking effort would remain constant as long as the brake-lever is left in the "on" position. Therefore by the above-described arrangement and mode of procedure I secure the advantage of only a small degree of frictional application of the brake-shoes to the peripheral surface of the brake-wheel, as the electrical braking effort is directly proportional to the speed at which the brake-wheel is rotating.

I will now describe the method of the application of an electric braking system or arrangement in accordance with the principles of my invention for street-car-motor work.

The brake-wheel and the brake-rigging, as above described, may be applied directly to the motor-shaft L, as shown in Figs. 1, 2, and 5, at either the commutator end or, if desired, outside of the gear-casing at the gear end or any other suitable or convenient location upon the armature-shaft, said brake-wheel being, as clearly shown, keyed to revolve with the armature-shaft. Instead, however, of mounting the brake-wheel upon

the shaft L of the motor said brake-wheel and its electrical appliances may be mounted upon a counter-shaft N, as shown in Fig. 3, in either case the armature-shaft or the counter-shaft N being geared to the car-axle M through suitable reduction-gearing, whereby I am enabled to secure the advantages of a high speed of rotation of the brake-wheel in order to utilize the electrical braking effort above described, and in such case, as will be readily understood, the braking effort is multiplied to the car-axle through the reduction-gearing. The construction shown in Fig. 3, wherein the brake-wheel and the brake-rigging referred to are mounted upon a counter-shaft geared to the car-axle through reduction-gearing, is particularly well adapted for use on trail-cars—*i. e.*, cars which do not carry a motor.

In Fig. 4 I have shown the brake-wheel as applied directly to the car-axle M. In such case, however, it is necessary to largely increase the diameter of the brake-wheel and also to correspondingly increase the area of the bearing-surface of the brake-shoes against the periphery of said wheel in order to secure the highest possible efficiency of the electrical braking effort. In the case of the mounting of the brake-wheel upon a counter-shaft or upon the motor-shaft the size of the brake-wheel may be greatly reduced, because the desired degree of speed of rotation of such brake-wheel in order to develop the electrical braking effort is secured by the increased speed of rotation of the brake-wheel in such cases.

If desired, and in order to reduce the wear on the peripheral surface of the brake-wheel to the lowest possible point, the peripheral flange of said wheel may be chilled. Instead of this, however, or, if desired, in addition thereto, I may provide a suitable band or ring O, which may be easily slipped over the wheel A and which may form the surface against which the brake-shoes bear. In this arrangement, as will be readily seen, when the ring O becomes worn it may be removed and thrown away and replaced by a new ring.

The current for energizing the brake-electromagnet F may be derived from any suitable or convenient source. In Fig. 1 I have shown a convenient arrangement wherein the current is taken from the overhead or supply conductor S through the trolley-pole P, the brake-lever Q, and resistance-box or rheostat R, through the coils H and conductor T to ground, in any suitable or convenient manner.

The operation of supplying current to the electromagnet F will be readily understood and is as follows: When the brake-lever Q is moved to complete the circuit above described between said lever and the first segment of the rheostat or resistance-box R, the entire current for energizing the electromagnet F is caused to traverse the entire resistance of such rheostat or resistance-box, and hence only a small degree of energization of such magnet is secured, and hence a small degree of braking effort of the brake-rigging is attained. As the lever Q moves over the segments of the rheostat, however, cutting out more and more of the resistance contained therein, the braking effort is increased, until finally, with all the resistance of the rheostat cut out of circuit, the full effort of the braking system is attained. The wire forming the coils H of the electromagnet F, though small in cross-sectional area, should be of sufficient size to enable the full current's strength to pass therethrough without unduly heating the same, and it is evident that only a small current is required to be passed through these coils, for the reason that the desired number of ampere-turns may be secured, owing to the large number of convolutions of wire, to attain the desired result.

Instead of supplying the electromagnet F with current as above described such current may be supplied in any other suitable or convenient manner. For instance, as is well understood by persons familiar with the art, when two or more motors are employed, by shutting off the current from the motors and reversing their fields or armature connections the motors become generators under the revolutions imparted to the armatures thereof by the movement of the car due to momentum through the gearing between the car-axle and the armature-shaft. I utilize this effect in an arrangement embodying my invention, as shown in Fig. 5, by coupling up such motors acting as generators, under the conditions named, in circuit with the electro brake-magnets F through a suitable brake-lever Q′ and a resistance-box or rheostat R′, similar in construction, arrangement, and relation to that above described with reference to the trolley-circuit, and thus I utilize the current generated by the motors acting as generators under the momentum of the car instead of drawing power from the supply-conductor S. This arrangement, however, while operative and practical, is not as desirable as that above described, for the reason that when the car stops the action of the motors acting as generators also stops, thereby requiring an application of the hand-brakes should it be desired to stop the car on grades, and hence, instead of employing the motors A′ as generators, I prefer to energize the brake-magnets from the feed or supply conductor S.

The motor A′ may be supported in any suitable manner upon the car-body or truck-frame, as by means of the supporting connection B′; but I desire it to be understood that the particular construction, arrangement, and manner of mounting the motor are immaterial to my present invention, and I do not desire, therefore, to be limited or restricted in regard thereto.

It is evident that where several cars equipped with a braking system embodying my invention are employed in the same train such braking apparatus may be connected up in parallel or in series in any suitable or convenient manner, as will be readily understood.

Having thus set forth the object and nature of my invention and the method of its application and a construction and arrangement embodying the principles thereof, I desire it to be understood that I do not limit or confine myself to the exact details of construction as shown and described, as many variations therefrom and changes therein would readily suggest themselves to persons skilled in the art and still fall within the spirit and scope of my invention; but

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

1. In a braking system, the combination with circuits closed upon themselves in a closed magnetic field, of means for inducing heavy currents in said closed circuits, as and for the purpose set forth.

2. In a braking system, brakes arranged to form part of a closed magnetic field, in combination with electrical circuits closed upon themselves and means for inducing therein heavy currents, as and for the purpose set forth.

3. In a braking system, a closed circuit, means for creating a large magnetic field therein, circuits closed upon themselves and arranged in said field and means for inducing alternating currents in said last-mentioned circuits, as and for the purpose set forth.

4. In a braking system, a closed magnetic circuit including a brake-wheel, brake-shoes, and an electromagnet, and inductors carried by said brake-wheel and arranged to move across or transverse to said magnetic circuit, as and for the purpose set forth.

5. In a braking system, a brake-wheel, brake-shoes arranged to bear against the surface of said wheel, said shoes and wheel forming part of a closed magnetic circuit, in combination with inductors carried by said brake-wheel and arranged to cut the lines of force of said magnetic circuit, and means for energizing said circuit, as and for the purpose set forth.

6. In a braking system, a brake-wheel, brake-shoes arranged to bear thereagainst, said brake wheel and shoes included in a closed magnetic circuit, an electromagnet for energizing said circuit, and means for controlling the current through said magnet, in combination with inductors carried by said brake-wheel and arranged to cut the lines of force of said magnetic circuit, as and for the purpose set forth.

7. In a braking system, a brake-wheel, inductors carried thereby, said inductors being short-circuited upon themselves, brake-shoes arranged to bear against said wheel, said brake shoes and wheel forming part of a closed magnetic circuit, as and for the purpose set forth.

8. In a braking system, a brake-wheel, inductors mounted thereon but insulated therefrom, said inductors being short-circuited upon themselves, brake-shoes arranged to bear against said wheel, said shoes and wheel forming part of a closed magnetic circuit, as and for the purpose set forth.

9. In a braking system, a brake-wheel, inductors carried thereby, means for electrically connecting said inductors, brake-shoes arranged to bear against said brake-wheel, said shoes and wheel included in a magnetic circuit, as and for the purpose set forth.

10. In a braking system, a brake-wheel, inductors carried thereby, means for electrically connecting the ends of said inductors, brake-shoes arranged to bear against said wheel, said wheel and shoes included in a magnetic circuit, as and for the purpose set forth.

11. In a braking system, a brake-wheel, inductors carried thereby, means for electrically connecting the ends of said inductors, brake-shoes arranged to bear against the said wheel, said wheel and shoes forming part of a magnetic circuit, and means for energizing said circuit, as and for the purpose set forth.

12. In a braking system, a brake-wheel, inductor-sections mounted in the periphery thereof, said inductor-sections forming circuits closed upon each other, brake-shoes arranged to bear against said wheel, said wheel and shoes forming part of a magnetic circuit, as and for the purpose set forth.

13. In a braking system, a brake-wheel perforated in the peripheral rim thereof, inductor-sections mounted in said perforations, means for electrically connecting said sections, brake-shoes arranged to bear against said wheel, said wheel and shoes forming part of a magnetic circuit, as and for the purpose set forth.

14. In a braking system, a brake-wheel having perforations arranged in the periphery thereof, insulating-sleeves mounted in said perforations, inductor-sections mounted in said insulating-sleeves, said sections being electrically connected together, brake-shoes arranged to bear against said wheel, said brake shoes and wheel included in a magnetic circuit, as and for the purpose set forth.

15. In a braking system, a brake-wheel, inductor-sections carried thereby, conducting-rings connecting the ends of said sections, brake-shoes arranged to bear against said wheel, said shoes and wheel included in a magnetic circuit, as and for the purpose set forth.

16. In a braking system, a brake-wheel, brake-shoes loosely supported and arranged to bear against said wheel, said shoes and wheel forming part of a closed magnetic cir-

cuit, in combination with inductors carried by said wheel and arranged to move across said circuit, as and for the purpose set forth.

17. In a braking system, an electromagnet and a brake-wheel, and brake-shoes respectively arranged to bear against said wheel and the core of said magnet, thereby forming a closed magnetic circuit, in combination with inductors carried by said wheel and arranged to move across said circuit, as and for the purpose set forth.

18. In a braking system, a brake-wheel, means for magnetically applying thereto a frictional braking effort comprising an electric magnet and brake-shoes forming the pole-pieces of said magnet, in combination with means for developing a coincident electrical braking effort, and means for varying the amount of current through said electromagnet, whereby the magnetic braking effort may be varied, as and for the purpose set forth.

19. In a braking system, a brake-wheel, an electromagnet, pole-pieces loosely mounted at the ends thereof in magnetic relation to the core of said magnet, and arranged to bear against said brake-wheel, thereby forming a closed magnetic circuit, said brake-wheel comprising an armature adapted to revolve in a direction to cut the lines of force of said magnetic circuit, whereby, when said electromagnet is energized, a magnetic and a coincident electric braking effort is secured, as and for the purpose set forth.

20. In a braking system, a magnetic circuit, a brake-wheel and brake-shoes included in said circuit, an electromagnet for energizing said magnetic circuit, and a circuit for said electromagnet including a brake-lever and a rheostat, whereby the magnetic circuit may be gradually energized, in combination with inductor-sections carried by said wheel and arranged to cut said circuit transversely, as and for the purpose set forth.

21. In a braking system, a brake-wheel, comprising an armature of closed circuits, in combination with an electromagnet and loosely-mounted pole-pieces therefor, said pole-pieces forming brake-shoes, as and for the purpose set forth.

22. In a braking system, a brake-wheel, an electromagnet, brake-shoes loosely supported upon the core of said magnet and arranged to bear against said brake-wheel, in combination with inductors carried by said wheel and arranged to move across the magnetic circuit formed by said parts, as and for the purpose set forth.

23. In a braking system, a brake-wheel, brake-shoes perforated at one end thereof and arranged to bear against said wheel at the other end thereof, an electromagnet, the perforations in said shoes adapted to receive the core of said magnet, the core, shoes and wheel forming a closed magnetic circuit in combination with inductors carried by said wheel and arranged to transversely cut said circuit, as and for the purpose set forth.

24. In a braking system, a brake-wheel, an electromagnet, brake-shoes arranged to contact at the respective ends thereof against the core of said magnet and said wheel, and inductor-sections short-circuited upon themselves carried by said brake-wheel, as and for the purpose set forth.

25. In a braking system, an electromagnet, a brake-wheel, brake-shoes contacting at the respective ends thereof with the core of said magnet and the surface of said wheel, thereby forming a closed magnetic circuit, a circuit for said electromagnet, and means for controlling the current through said circuit, in combination with inductor-sections carried by said wheel and arranged to cut the lines of force of said circuit, as and for the purpose set forth.

26. In a braking system, a brake-wheel, an electromagnet, brake-shoes contacting at the respective ends thereof with the core of said magnet and the surface of said wheel, a circuit for said magnet, and a rheostat arranged in said circuit for controlling the same, in combination with inductor-sections carried by said wheel, as and for the purpose set forth.

27. In a braking system, an axle, a shaft geared thereto through reduction-gearing, a brake-wheel mounted on said shaft, brake-shoes arranged to bear against said wheel, said brake-shoes and wheel forming part of a magnetic circuit, and inductors short-circuited upon themselves carried by said brake-wheel, as and for the purpose set forth.

28. In a braking system, an axle, a motor having the shaft thereof geared thereto through reduction-gearing, a brake-wheel mounted on the shaft of said motor, brake-shoes contacting with said brake-wheel, said shoes and wheel forming part of a magnetic circuit, and inductor-sections short-circuited upon each other carried by said wheel, as and for the purpose set forth.

29. In a braking system, an axle, a shaft geared thereto, a brake-wheel mounted on said shaft, inductor-sections electrically connected together mounted on said wheel and a magnetic circuit in which said wheel is adapted to revolve, as and for the purpose set forth.

30. In a braking system, a brake-wheel, inductor-sections electrically coupled together and carried by said wheel, and means for creating a magnetic field in which said brake-wheel is adapted to revolve, as and for the purpose set forth.

31. In a braking system, the combination with an axle and a shaft geared thereto, of a brake-wheel mounted on said shaft, brake-shoes arranged to contact with said wheel, said shoes and wheel forming part of a closed magnetic circuit, and means for energizing said circuit, in combination with inductors carried by said wheel, as and for the purpose set forth.

32. In a braking system, an electromagnet,

means for supporting the same, brake-shoes loosely suspended from the core of said magnet, a brake-wheel, said shoes bearing against said wheel, and means for controlling the energizing-circuit of said magnet, in combination with inductors carried by said wheel, as and for the purpose set forth.

33. In a braking system, a brake-wheel, a removable ring mounted on the periphery thereof, brake-shoes arranged to bear against said ring, said shoes and wheel forming part of a closed magnetic circuit, and means for energizing said circuit, in combination with inductors carried by said wheel, as and for the purpose set forth.

34. In a braking system, an armature comprising insulated inductor-sections electrically connected together, brake-shoes arranged to bear against said armature and forming magnetic pole-pieces, and means for energizing said shoes at will, as and for the purpose set forth.

35. In a braking system, an axle, a brake-wheel rotatively connected therewith and carrying insulated, closed electric circuits, in combination with an electromagnet having pole-pieces arranged to frictionally engage said brake-wheel, as and for the purpose set forth.

36. In a braking system, a rotating brake-wheel, an electromagnet having pole-pieces arranged to frictionally engage said brake-wheel, in combination with electrical devices carried by said wheel for developing an electrical braking effort coincident with the application of said pole-pieces, as and for the purpose set forth.

37. In a braking system, a rotating brake-wheel, means for magnetically applying a frictional braking effort thereto, in combination with means carried by said rotating brake-wheel and dependent upon the speed of rotation thereof for coincidently developing an electrical braking effort, as and for the purpose set forth.

38. In a braking system, a rotating brake-wheel, means for magnetically applying a frictional braking effort thereto, in combination with electrically-connected conductors carried by said wheel for developing a coincident electrical braking effort, whereby as the speed of rotation of said wheel decreases said electrical braking effort decreases, while the frictional braking effort remains constant, as and for the purpose set forth.

In witness whereof I have hereunto set my hand, this 6th day of May, 1897, in the presence of the subscribing witnesses.

SIDNEY H. SHORT.

Attest:

M. A. KENSINGER,

JOHN J. BEVER.