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No. 672,712. Patented Apr. 23, 1901.

L. ROSENFELD, C. ZELENAY & J. DULAIT.

SYSTEM OF ELECTRODYNAMIC PROPULSION.

(Application filed Jan. 31, 1900.)

(No Model.) 2 Sheets—Sheet 1

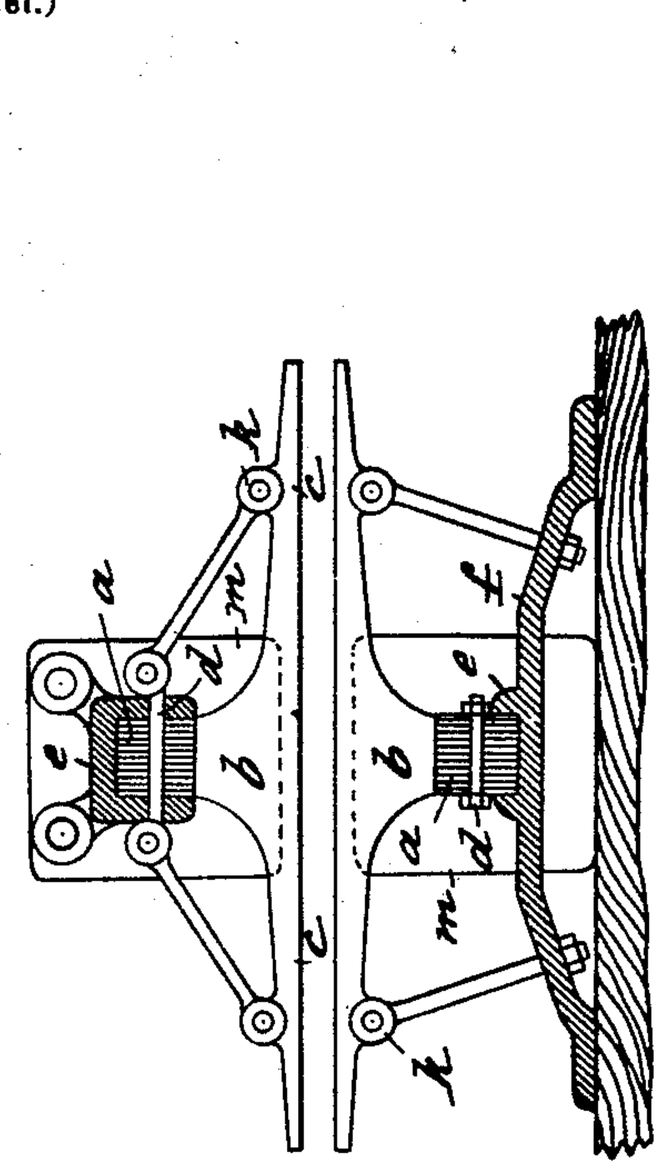

Fig. 2.

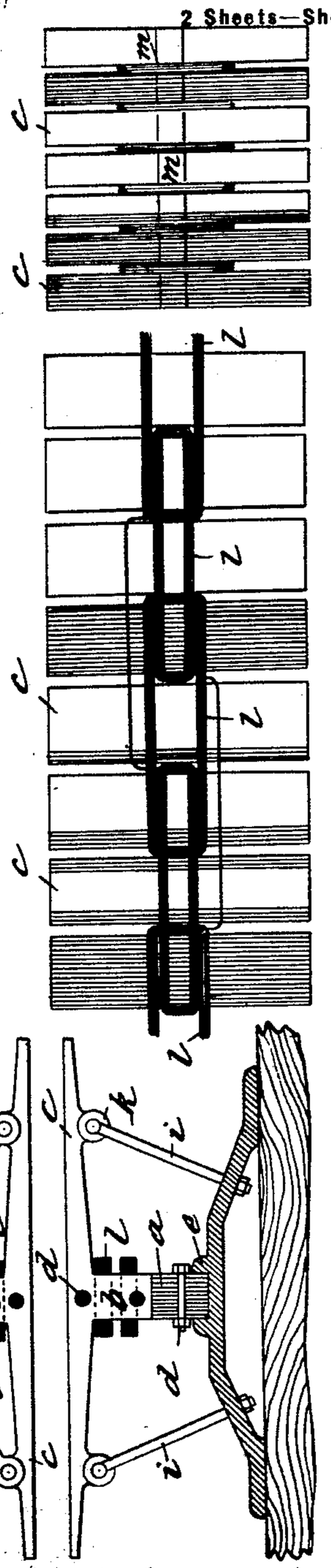

Fig. 3.

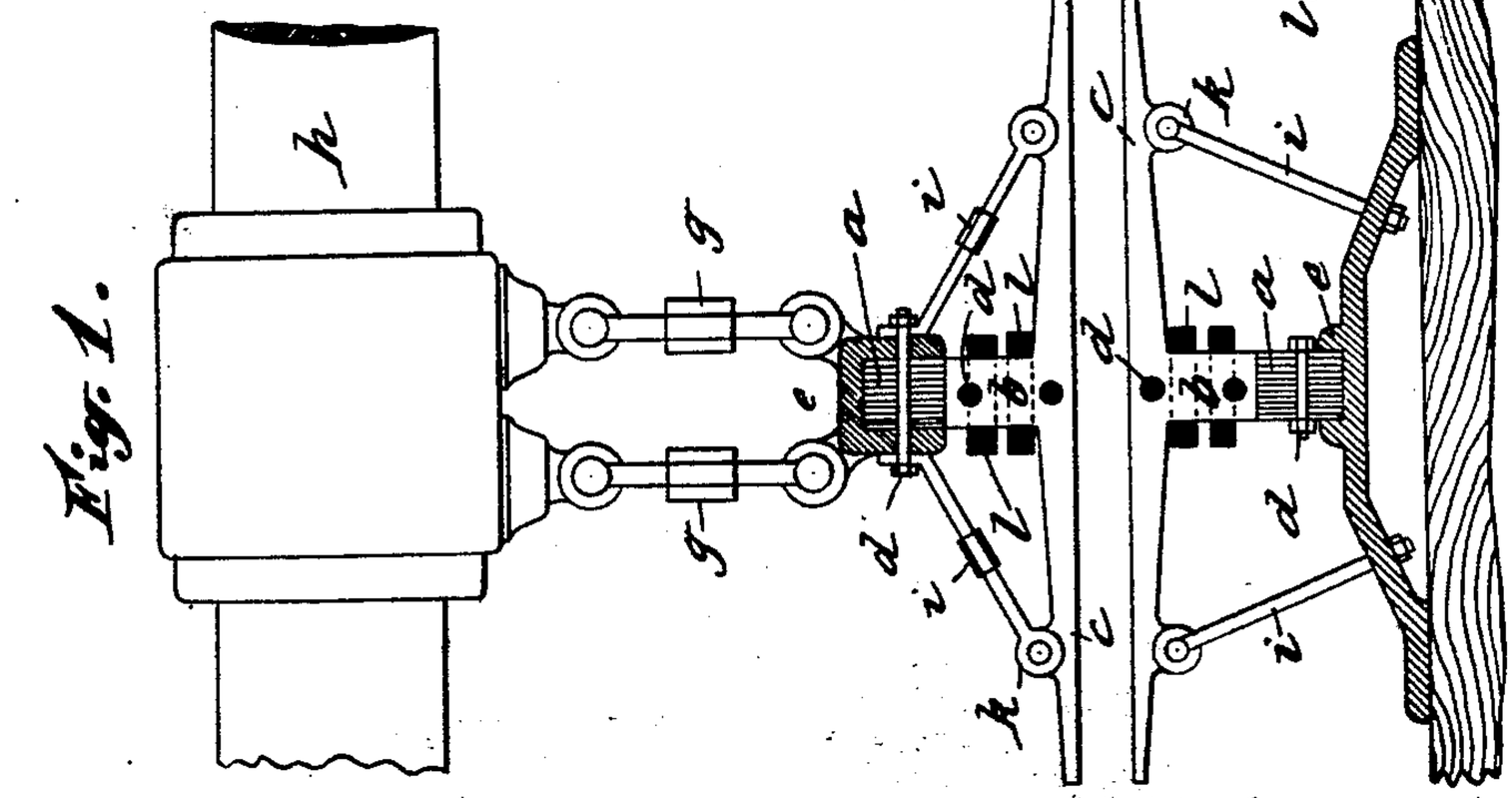

Fig. 1.

Witnesses:
P. F. Smith
J. Green

Inventors:
Leon Rosenfeld
Constantin Zelenay
Julien Dulait
by Foster & Freeman
Attys

[illegible]72. ELECTRIC MOTIVE POWER,
[illegible]

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Fig. 3a.

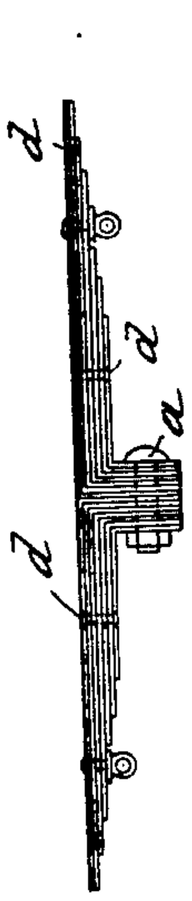


Fig. 3b.

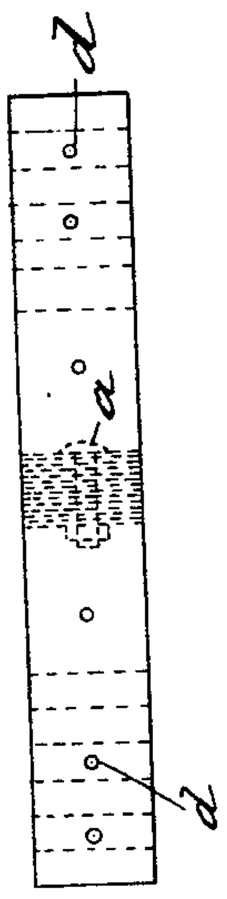
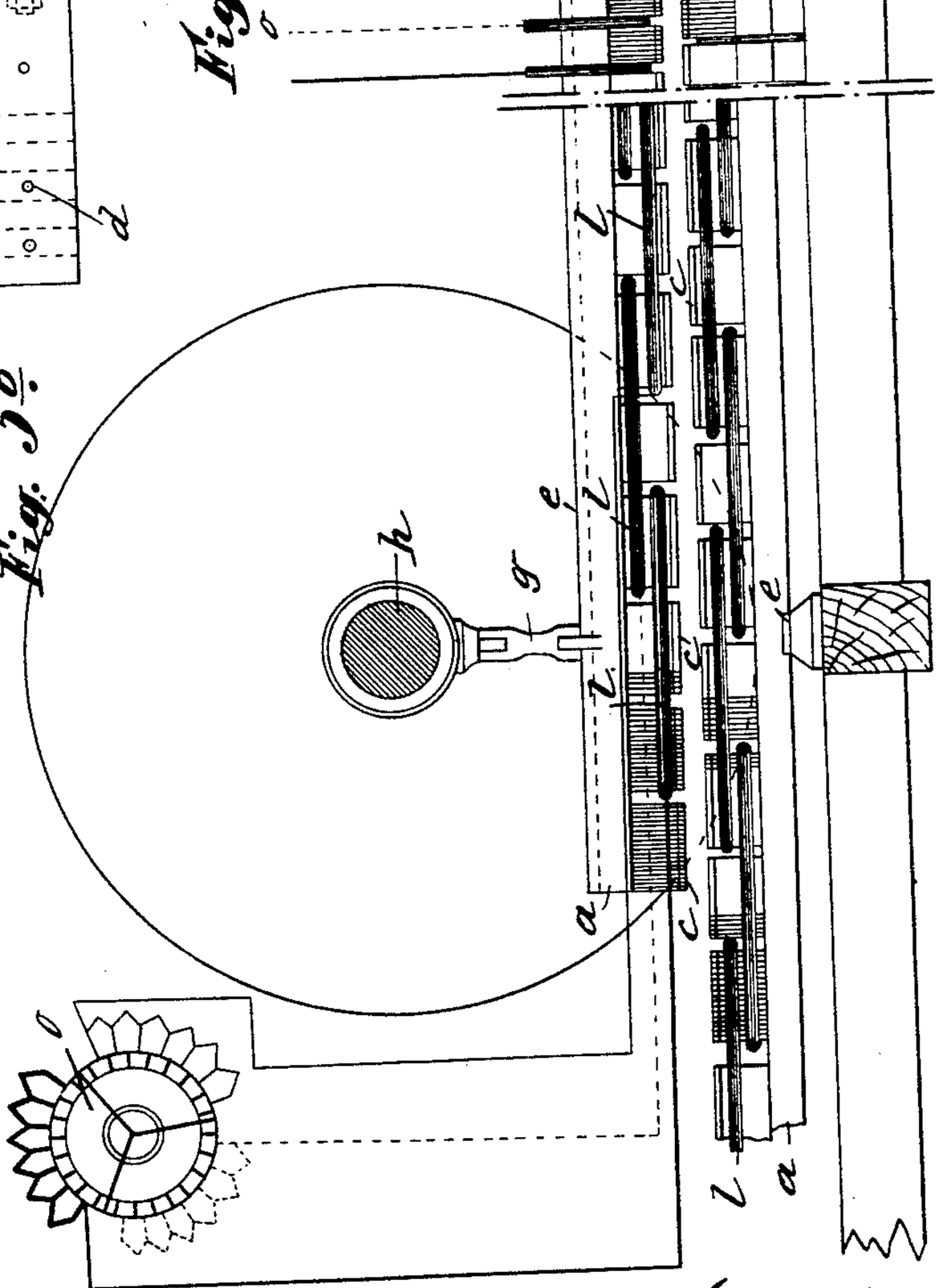


Fig. 4.



Witnesses:
P. F. Tomek.
J. Green

Inventors
Léon Rosenfeld
Constantin Zelenay.
Julien Dulait
by Munn & Co
Attys

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UNITED STATES PATENT OFFICE.

LEON ROSENFELD, CONSTANTIN ZELENAY, AND JULIEN DULAIT, OF CHARLEROI, BELGIUM.

SYSTEM OF ELECTRODYNAMIC PROPULSION.

SPECIFICATION forming part of Letters Patent No. 672,712, dated April 23, 1901.

Application filed January 31, 1900. Serial No. 3,504. (No model.)

To all whom it may concern:

Be it known that we, LEON ROSENFELD, CONSTANTIN ZELENAY, and JULIEN DULAIT, engineers, of Charleroi, in the Kingdom of Belgium, have invented a certain new and useful Improved System of Electrodynamic Propulsion; and we do hereby declare that the following is a full, clear, and exact description of the same.

The object of this invention is to provide an improved construction of the inducing and induced elements in the polyphase-current system of electrodynamic propulsion, in which the induced element or armature suspended from the vehicle is influenced parallel to the inducing element or field-magnet without any other correlation thereto than the energy produced in the inter-air-space, the said improved construction being intended to obviate the chief disadvantage of the system, which lies in the insufficiency of the inter-air-space, by rendering it much more adequate without diminishing the effect of the magnetic flux to be applied to the armature by which the vehicle is propelled. Hitherto the minimum adequacy of the inter-air-space has been indispensable for obtaining, with a given weight of copper for the ampere-turns of the field-magnet a magnetic flux applying sufficient energy to the armature for the propulsion of the vehicle, as with the existing arrangements it was not possible to increase the "value" of the inter-air-space without diminishing its energy in the same proportion, so that in order in this case to maintain the same energy of the magnetic flux a considerable increase in the weight of the copper would be suggested as necessary. As, moreover, the very little value of the inter-air-space renders this system of propulsion, if not impossible, at least very difficult in practice, as in consequence of the jolting of the vehicle it might even happen that contact would be established between the field-magnet and armature, with all its possible disastrous consequences, it becomes necessary to increase the value of the inter-air-space considerably. Now this increase of the actual value of the inter-air-space, which is about three millimeters, to nearly four times its value—say to twelve millimeters—without increasing the weight of the copper, while preserving an energy equal to the magnetic flux, is realizable by means of a special arrangement of the pole-pieces of the armature and of the field-magnet, as illustrated in the accompanying drawings.

Figure 1 is a transverse section of the new construction of the armature and of the field-magnet, the copper being applied in drum, as in the Siemens system. Fig. 2 is a similar section with the copper applied in annular winding, as in the Gramme system. Fig. 3 is a plan view showing partly drum and partly annular coils. Figs. 3^a and 3^b show in section and plan view another construction of armature. Fig. 4 is a side elevation showing diagrammatically the rheostat for starting in connection with the armature.

The realization of the invention—that is to say, maintaining the same energy in an inter-air-space four times larger than the ordinary—is chiefly due to the enlarging of the pole-surfaces without increasing the section of the iron portion which carries the copper winding in order to excite the radiation of lines of force in the direction of the width, so as to compensate for the loss of force experienced in the direction of the height of the inter-air-space by its extension in width.

In practice the arrangement carried out in conformity with the particulars given above can be suitably effected in the following manner: The magnetic metal or iron in the field-magnet, as well as in the armature, consists, preferably, of thin plates or laminæ of sheet-iron joined together and is applied in two parts, the one part *a* being composed of a series of thin longitudinal plates, either in the form of a continuous rectangular bar or in interrupted sections throughout its course, and on which the series of consecutive pole-pieces *b*, which form the other part, are placed. These likewise constitute a collection of thin plates joined together, but cut out in T form, the side extensions *c c* of which are considerably widened, while the vertical part has only a sufficient section for the passage of the magnetic flux corresponding to suitable induction. The plates of the longi-

tudinal bar *a*, as well as those of the pole-pieces *b*, are joined together by means of rivets or bolts.

The longitudinal parts *a* of the field-magnet and of the armature are fitted into braces *e*, of which that belonging to the field-magnet forms part of the foot *f*, placed crosswise, while those belonging to the armature are suspended, by means of adjustable rods *g*, to a sleeve or box on the axle *h* of the vehicle. The pole-pieces are bound very tightly to the longitudinal bars, and thus solidly combined therewith and retained, on the one hand, in the braces *e* by adjustable tie-rods *i* and, on the other, against the pole-pieces by lugs *k*, cast in one piece with the plates and serving at the same time for binding the extremities of these together.

Instead of making the pole-pieces *b* of a collection of thin plates cut out in T form and vertically joined together side by side, as shown in Figs. 1, 2, and 3, they may be made also by superposition of two collections of thin rectangular plates *b*, of variable length, being bent at right angles and suitably joined together by bolts or rivets *d*, as shown in Figs. 3^a and 3^b, thus constituting a more economical mode of construction. In this arrangement the longitudinal bars *a*, in the form of joined plates, chiefly serve to facilitate the passage of the lines of force produced by the current running through the copper windings, which may be in either of the so-called "drum" and "ring" forms, as preferred.

In Fig. 1 the winding *l* is formed as a drum, and in this case the copper surrounds the feet of the pole-pieces, while in Fig. 2 the winding is represented in ring form, in which case the copper is wound on the longitudinal bar. The windings are situated in both cases in the spaces formed by the gaps between the pole-pieces, where they are arranged flat, as shown in Fig. 3.

The armature, closely connected with the vehicle, may be made in a single piece; but it is preferably constructed in several by reason of the special advantages accruing from this arrangement in its application to tractional purposes.

The control of the vehicle—that is to say, the starting, relaxation of speed, and stopping, in other words the putting into action or the suspension of the action of the magnetic flux—is carried out in the manner generally adopted in connection with polyphase motors—that is to say, through the medium of a rheostat *o*, the coils of which are connected with windings of the armature belonging to the system, as shown diagrammatically in Fig. 4, for a triple-phase system, for example, in which the rheostat-wires, as well as the windings of the armature and of the field-magnet, are shown in full lines, according to the position given by the conductor to the rheostat elements, the arrangements for which may be selected from the numerous known varieties of these apparatuses with a view to securing the desired effect. The current induced in the windings *l* or *m* of the sectioned propeller will be powerful or feeble or absolutely void in conformity with the motion to be applied to the vehicle. Based on these conditions the system of polyphase-current propulsion, which has the great advantage of dispensing with all connecting parts between the propeller and the inducing-conductor, meets all the requirements of satisfactory working without presenting any of the disadvantages which have hitherto rendered this system impracticable, and it may without any further hesitation be brought into practical use.

From the effects above described in the system of tangential traction by the arrangement of widened pole-pieces it follows that this system may be employed with corresponding advantages to alternating-current motors, with the view of increasing their power without the addition of copper windings.

What we claim, and desire to secure by Letters Patent, is—

1. In an electric-traction system with polyphase currents, having no connection other than the sliding magnetic field between the induction element suspended on the vehicle and the inductor extending on the track; the construction of the inductor and the induced element respectively with pole-pieces in T form extended laterally in relation to the diameter of the magnetic core, as described.

2. In an electric-traction system with polyphase currents and sliding magnetic field; having an induction element suspended on the vehicle and an inductor extending along the track; the combination of a series of pole-pieces composed of bundles of plates united in T shape, with very wide extension laterally to the track, beyond the diameter of the magnetic core; a laminated longitudinal bar to which the shanks of such pole-pieces are connected and suitable braces and tie-rods by which the longitudinal bars and pole-pieces are firmly connected to the supporting-foot of the field-magnet and the hangers upon the axles respectively.

3. The pole-pieces consisting of two series of slender plates of unequal length, bent at right angles, suitably superimposed and joined together by rivets or bolts, substantially as shown and described.

In witness whereof we have hereunto set our hands in presence of two witnesses.

LEON ROSENFELD.
CONSTANTIN ZELENAY.
JULIEN DULAIT.

Witnesses:
AUG. GREBISSEE,
GREGORY PHELAN.