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L. F. HOWARD & P. B. RICE.

INDUCTIVE BOND.

APPLICATION FILED MAR. 2, 1906.

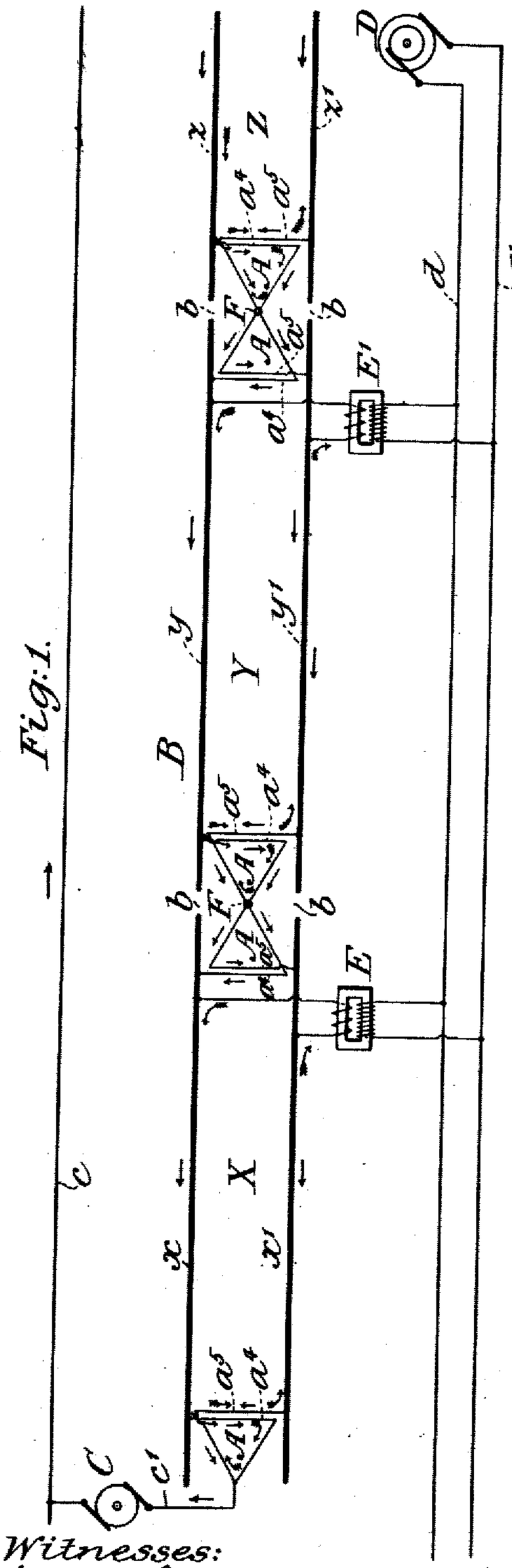

Fig. 1.

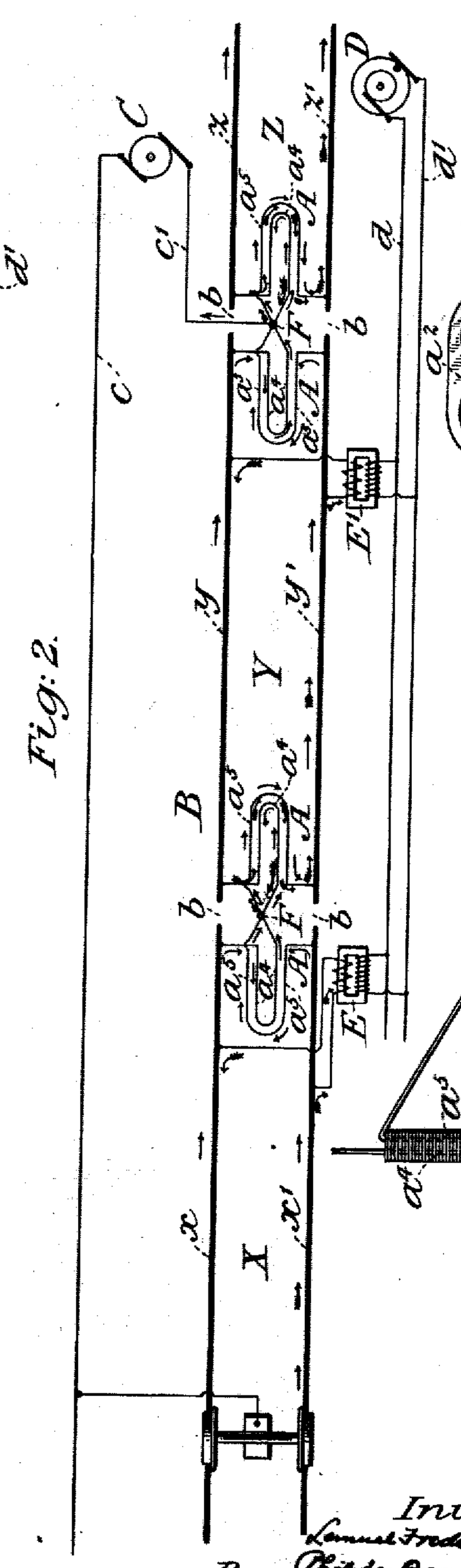

Fig. 2.

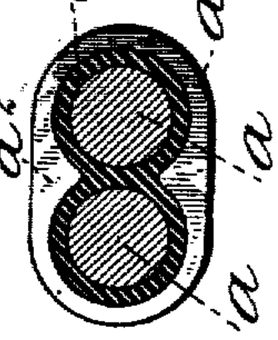

Fig. 4.

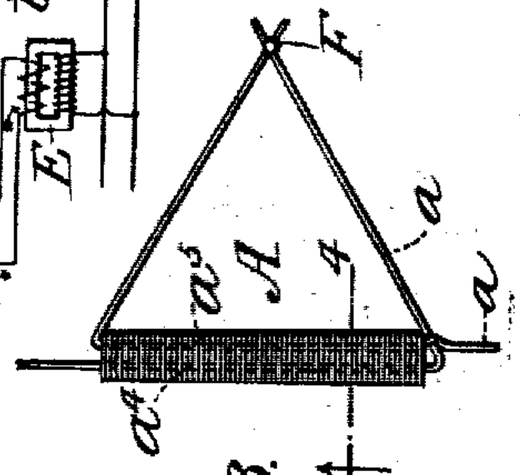

Fig. 3.

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UNITED STATES PATENT OFFICE.

LEMUEL FREDERIC HOWARD, OF EDGEWOOD, AND PHILIP BERNARD RICE, OF WILKINSBURG, PENNSYLVANIA, ASSIGNORS TO THE UNION SWITCH AND SIGNAL COMPANY, OF SWISSVALE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

INDUCTIVE BOND.

No. 825,538. Specification of Letters Patent. Patented July 10, 1906.

Application filed March 2, 1906. Serial No. 303,808.

To all whom it may concern:

Be it known that we, LEMUEL FREDERIC HOWARD, residing at Edgewood, and PHILIP BERNARD RICE, residing at Wilkinsburg, Allegheny county, Pennsylvania, citizens of the United States, have invented certain new and useful Improvements in Inductive Bonds, of which the following is a specification.

Our invention relates to inductive bonds.

Our invention also relates to electric railways the track-rails of which are divided by insulation to form block-sections and are used to form part of the return path or conductor for the car-propulsion current and in which inductive bonds are employed for conducting the car-propulsion current around insulation-points.

We will describe an inductive bond embodying our invention and an electric railway using inductive bonds in the trackway for the purposes stated, also embodying our invention, and then point out our invention in claims.

In the accompanying drawings, Figure 1 is a diagrammatical view of a portion of a railway, a portion of the power-circuit for the propulsion-current, and inductive bonds employed in the trackway and embodying our invention. Fig. 2 is a view similar to Fig. 1, but illustrating a different arrangement of the conductors of the inductive bonds. Fig. 3 is a diagrammatical plan view of an inductive bond embodying our invention. Fig. 4 is a detail vertical sectional view taken on the line 4 4 of Fig. 3 and drawn to a larger scale.

Similar reference characters designate corresponding parts in all of the figures.

An inductive bond A embodying our invention comprises a non-magnetic substance *a* and a magnetic substance *a'*, one inclosed by the other. Preferably the non-magnetic substance will be inclosed by the magnetic substance. More specifically speaking, a bond embodying our invention comprises a conductor of copper *a*, inclosed by a laminated iron sheath *a'*, suitable insulation *a²* being employed between the two materials and between parallel portions of the conductor *a*. The purpose of the laminated iron sheath, the sections of which are at right angles to the length of the conductor, is to afford a path of high permeability for the magnetic lines of force produced or generated by a current or currents flowing in the copper conductor *a*. The cross-section of the copper conductor is immaterial, and a magnetic material other than iron may be employed for the sheath.

If the bond embodying our invention is to be employed to conduct one character of current with a minimum impedance and simultaneously another or different character of current with a maximum of impedance, we so arrange portions of the copper conductor in parallel and close together with insulation between them and inclose these paralleled portions by the same metallic and laminated sheath and pass one character of current in opposite directions through the parallel portions of the copper conductor and the other or different character of current through the parallel portions in the same direction. In other words, we employ the well-known principle in the construction of our bond—to wit, that when a current of rapidly-varying value flows through two conductors laid parallel to each other in opposite directions the impedance offered to the current by the conductors is a minimum, while a current of rapidly-varying value flowing through the conductors in the same direction meets with maximum impedance. The laminated iron sheath common to both conductors affords a path of low reluctance for the magnetic lines of force produced by the current flowing in the conductors, and this path being of lower reluctance than air enables the lines of force to more readily combine or flow in the same direction or to oppose each other when flowing in opposite or reverse directions. The magnetic action of the propulsion-current on the sheath (either direct or alternating) is rendered small in the form of bond herein described by passing it through the parallel portions of the conductor in opposite directions, thus making it possible to take advantage of the full value of the permeability of the iron to give the maximum inductive resistance to the signaling-current flowing through the parallel parts of the conductor in the same direction.

A bond composed of the materials and con-

structed upon the lines hereinbefore set forth is of particular advantage on electric railways where the traffic-rails are divided by insulation to form block-sections and the track-rails of the railway form part of or are included in the return-path for the car-propulsion current. In this use the car-propulsion current flows in one direction along the track-rails in its return to the power-generator, while the signaling-current for each block section flows in opposite or reverse directions. The inductive bonds in this instance serve to conduct the car-propulsion current from the track-rails of one block-section to the track-rails of an adjacent block-section, and as it is connected across the track-rails of a block-section it has to offer considerable impedance to the flow through it of the signaling-current, which generally is an alternating current, and thereby avoiding a short circuit for the signaling-current of its block-section.

Referring now to Figs. 1 and 2, B designates a portion of an electric railway, both track-rails of which are divided at points by insulation *b* to form block-sections. X, Y, and Z designate three such block-sections, the track-rails thereof being designated by *x x'*, *y y'*, and *z z'*. C designates a generator for generating propulsion-current, (either direct or alternating current,) and *c* a feeder-conductor, trolley, or third rail extending along the line of the railway. One pole of the generator C is connected with the conductor *c* in the usual manner, and the other pole of the generator is connected with the track-rails of the railway in the usual manner. As shown, a conductor *c'* extends from the generator C to a middle point of the conductor of an inductive bond. D designates a generator of alternating signaling-current and *d d'* conductors of the feeder-circuit extending therefrom. E E', &c., designate step-down transformers, one being provided for each block-section to supply alternating signaling-current to the track-circuit thereof. This is all well understood in the art and will not be described further. Each track-circuit is provided with the usual track-relays, (not shown,) and the relays may control in any well-known or understood manner one or more of the circuits comprised in a signaling system which we have not deemed necessary to illustrate. The alternating signaling-current for each block-section is confined thereto by the insulations *b*, located at the ends of the track-rails of the block-sections. At each end of a block-section we locate an inductive bond—for example, an inductive bond of the general type hereinbefore described. The ends of a conductor of an inductive bond are electrically connected with the two track-rails of a block-section, and a suitable conductor F electrically connects the middle points of the conductors comprised in two adjacent inductive bonds. Instead of a conductor F the middle points of two adjacent conductors *a* or the middle points of the conductors may be otherwise electrically connected together. By means of this connection the propulsion-current is divided between the two halves of the conductor and flows in opposite or reverse directions.

As hereinbefore stated, Figs. 1 and 2 illustrate different arrangements of the conductors of the inductive bonds. As shown, both diagrams illustrate bonds each of which has parallel portions of the conductor inclosed by the same metallic sheath. The direction of flow of the car-propulsion current along the track-rails and through the inductive bonds is indicated by the plain arrows, while the direction of flow of the alternating signaling-current along the track-rails of a block-section and through the conductors of the inductive bonds for the block-section is illustrated by the feathered arrows. The direction of flow of the alternating signaling-current in alternate block-sections may be same, if desired. This is immaterial, as is the arrangement of the transformer in the track-circuit and the form of relay employed.

It will be seen from an examination of Figs. 1 and 2 that the direction of flow of the propulsion-current through a conductor of a bond is in opposite or reverse directions through the two halves thereof, and especially is this true of the parallel portions, which in Figs. 1 and 2 I have designated a^4 a^5, thereby reducing to a minimum the impedance offered by the inductive bond to the propulsion-current. This is true irrespective of whether the propulsion-current be alternating or direct. The alternating signaling-current, however, such of it as flows through the conductor of an inductive bond flows in the same direction through the parallel portions, thereby offering the maximum impedance of the inductive bond to the flow of an alternating signaling-current through it.

What we claim as our invention is—

1. An inductive bond comprising a conductor having parallel portions and inclosed by a laminated magnetic material.

2. An inductive bond comprising a conductor having parallel portions, a laminated magnetic covering for said parallel conductor, the laminated magnetic covering along the parallel portions being common to both portions.

3. The combination with a railway, both track-rails of which are divided by insulation to form block-sections, of an inductive bond located at the end of each block-section, comprising a conductor and a laminated magnetic covering therefor, and an electrical connection between the middle points of adjacent conductors, each conductor having parallel portions and connected with the track-rails of a block-section to pass one character of current in opposite directions through

parallel portions and another character of current in the same direction through parallel portions.

4. The combination with a railway both track-rails of which are divided by insulation to form block-sections, of an inductive bond provided at each end of a block-section and adjacent bonds electrically connected together by a single connection, each inductive bond comprising a conductor and a laminated magnetic covering for the conductor, each conductor being connected with the track-rails of its block-section and having parallel portions through which current of one character passes in opposite directions and a current of a different character passes in the same direction.

5. The combination with a railway, the track-rails of which are divided by insulation to form block-sections, inductive bonds at insulation-points for passing propulsion-current and offering a path of high impedance to an alternating signaling-current, each of said inductive bonds comprising a conductor and a magnetic sheath, the conductor having parallel portions inclosed by the same metallic sheath, such conductor being connected with the track-rails to pass the propulsion-current in opposite directions through the parallel portions and the alternating signaling-current in the same directions through the parallel portions.

6. An inductive bond comprising a conductor having parallel portions inclosed by the same metallic sheath.

7. The combination with a railway, both track-rails of which are divided by insulation to form. block-sections, a power-circuit of which the traffic-rails form a part and conduct the power-current in one direction, an alternating signaling-current for each block-section and inductive bonds connected with the track-rails at or near insulation-points and adjacent bonds electrically connected together, each comprising a conductor having parallel portions inclosed by the same metallic sheath, the parallel portions being arranged to conduct the propulsion-current in opposite directions and the alternating signaling-current in the same directions.

In testimony whereof we have signed our names to this specification in the presence of two subscribed witnesses.

LEMUEL FREDERIC HOWARD.
PHILIP BERNARD RICE.

Witnesses:
D. J. McCarthy,
W. L. McDaniel.