(No Model.) 3 Sheets—Sheet 1.

G. F. CARD.

CIRCUIT SYSTEM FOR ELECTRIC BRAKES.

No. 372,598. Patented Nov. 1, 1887.

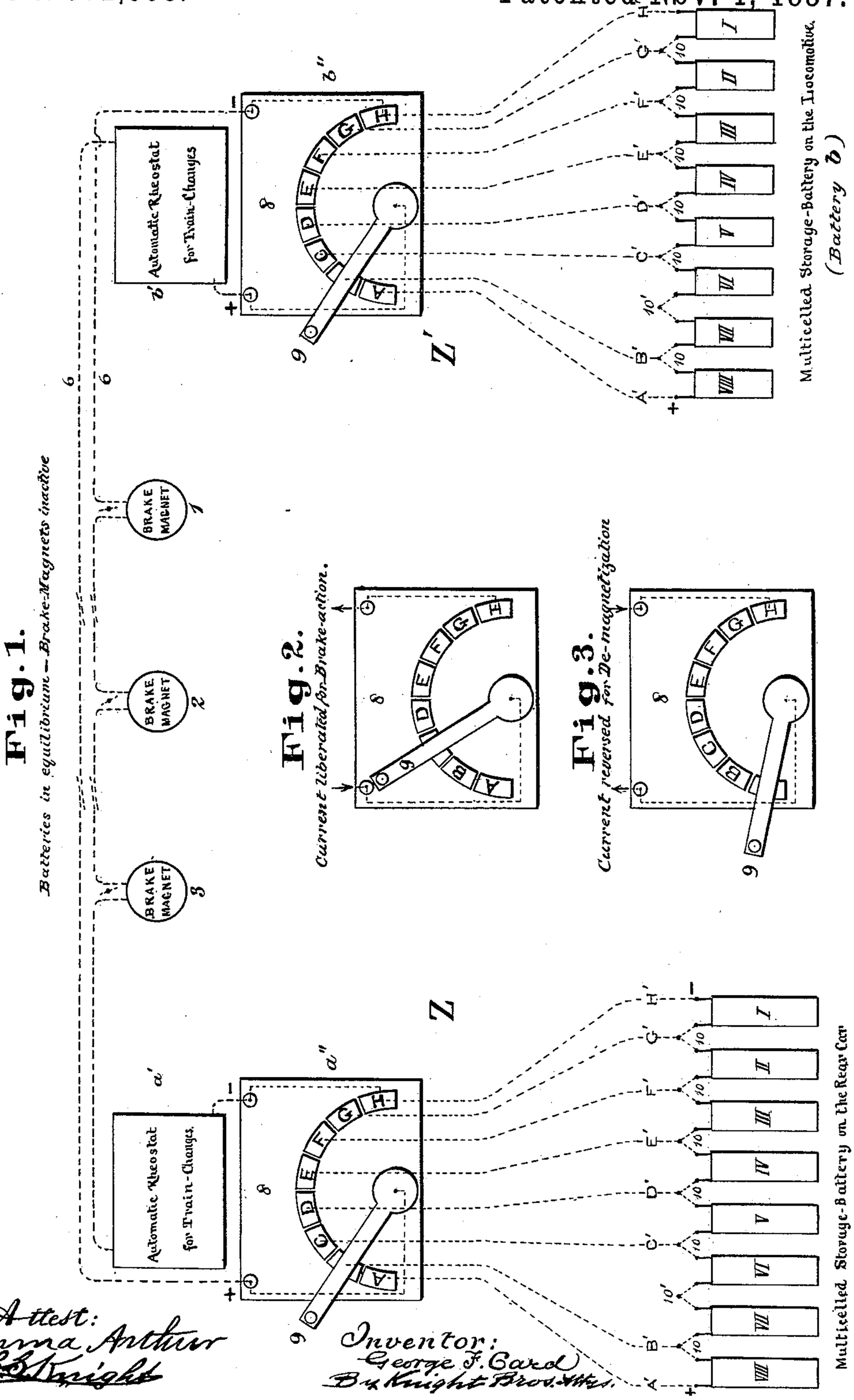

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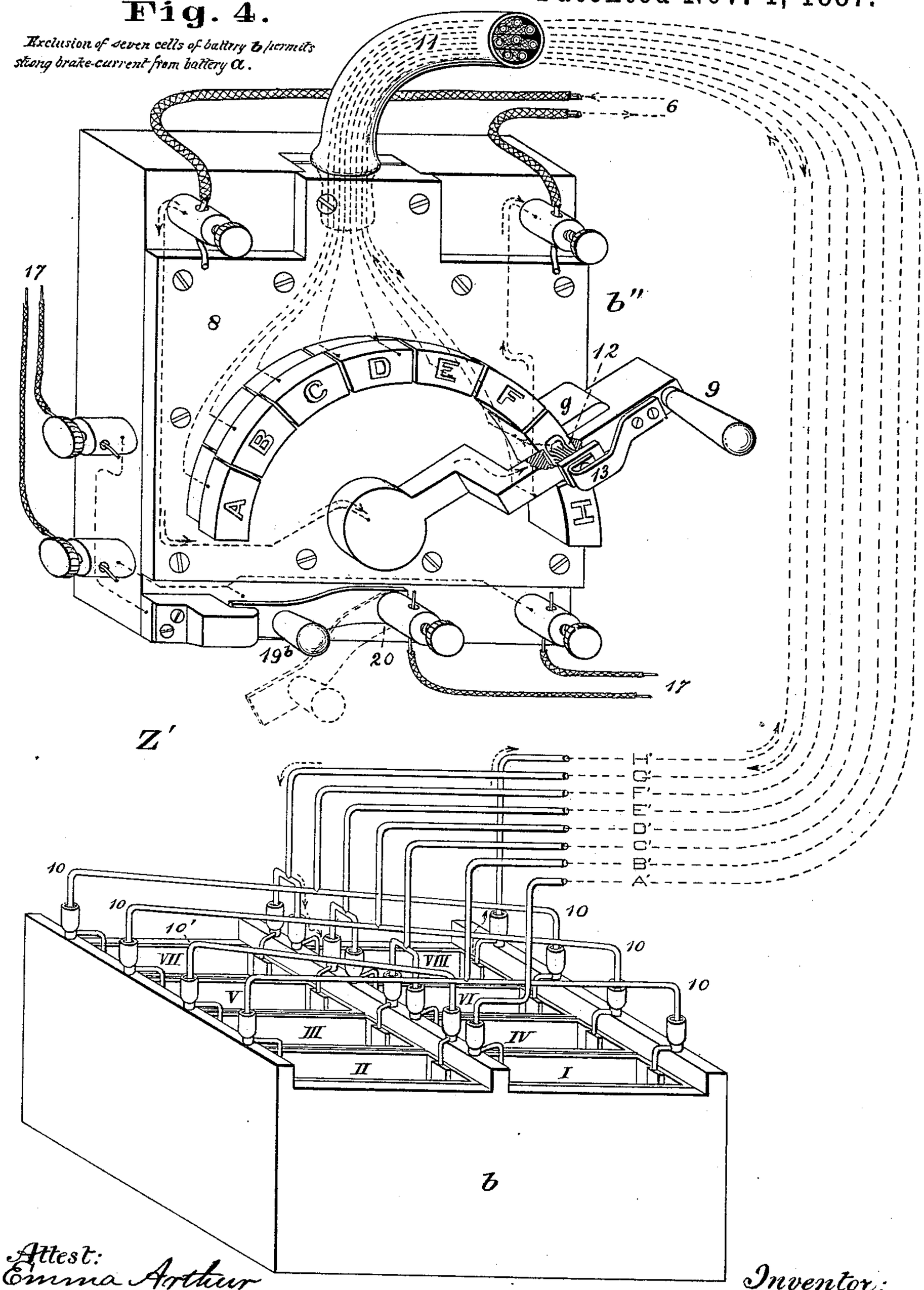
Fig. 4.

Exclusion of seven cells of battery b permits strong brake-current from battery a.



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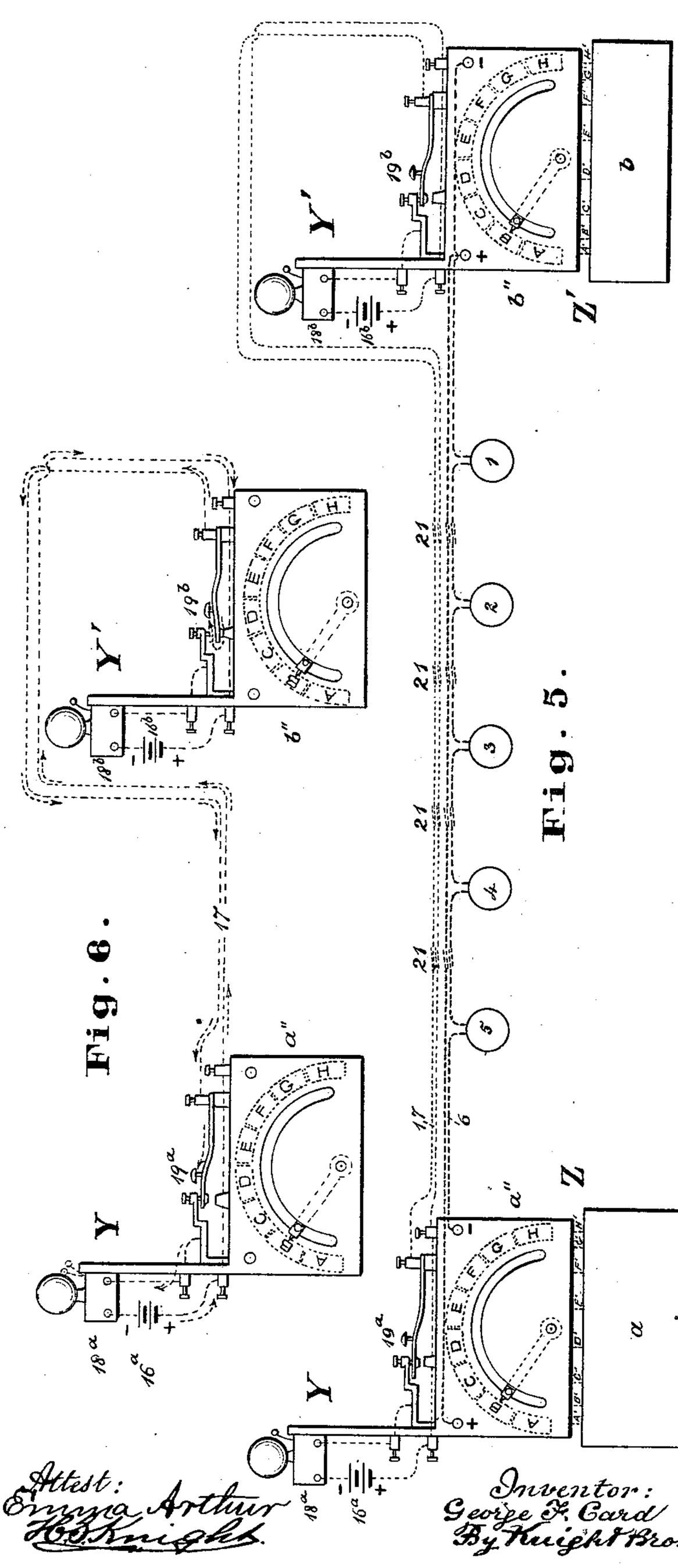

Fig. 5.

Fig. 6.

Fig. 7.

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UNITED STATES PATENT OFFICE.

GEORGE F. CARD, OF COVINGTON, KENTUCKY, ASSIGNOR TO HENRY K. LINDSEY, OF CINCINNATI, OHIO.

CIRCUIT SYSTEM FOR ELECTRIC BRAKES.

SPECIFICATION forming part of Letters Patent No. 372,598, dated November 1, 1887.

Application filed January 17, 1887. Serial No. 224,591. (No model.)

To all whom it may concern:

Be it known that I, GEORGE F. CARD, of Covington, Kenton county, Kentucky, have invented a new and useful Circuit System for Electric Brakes, of which the following is a specification.

My present is one of a series of inventions such as described in patents granted to me, (for example, patents numbered, respectively, 334,637, January 19, 1886; 357,976, February 15, 1887; 357,576, February 15, 1887; 357,760, February 15, 1887, to which reference may be made for specific description of details appropriate to the present device, notably to Patent No. 357,576, February 15, 1887, for details of the brake-magnet, and to No. 357,760, February 15, 1887, for details of the automatic rheostat for train changes. As stated in one of said applications, my said inventions belong to the class of train-regulating devices in which a series of electro-magnets in a metallic circuit coterminous with the train (or with so much of it as it may for the time being be desired to include in the brake-circuit) and under control of an officer thereof is employed to liberate for action the system of brake-chain windlasses commonly employed to utilize the train's own momentum to retard or stop it.

While applicable to all railway-trains, my invention is more particularly designed for and is here represented for use on freight-trains.

Description of the device in its special adaptation for passenger-trains is reserved for a subsequent application.

While the expressions "rear" car and "caboose," as employed in this specification, will generally mean the car at the rear extremity of the train, it will not of necessity mean other than that car which for the time being contains the train-battery and switch board, and which may occasionally have one or more cars attached to the rear of it. Such cars may be either included in or omitted from the brake-circuit, as fully explained in my said Patent No. 357,976, February 15, 1887.

My present application, in common with my aforesaid Patent No. 357,760, February 15, 1887, comprises the following features, to wit: first, a normally-closed metallic circuit whose couplings between the several component vehicles of the train are such as when joined to present insulated conduits for the outgoing and the returning currents, respectively, and such as when separated to automatically complete the circuit at the point of rupture on each separated portion; second, said circuit further includes two distinct storage-batteries, whose electro-motive forces are opposite and (in the normal condition of the circuit) are equal and consequently inert; third, a provision on each vehicle included in the circuit of a suitable electro-magnetic apparatus—for example, such as described in patent No 357,576, February 15, 1887—adapted to dominate the brake mechanism proper of such vehicle; fourth, a provision near each battery of a resistance-box or rheostat that automatically accomodates itself to train changes, so as to maintain a uniform current force whatever be the number of brakes added to or taken from the circuit.

As in my aforesaid patent, current is initiated and brake action reached by a disturbance of the normal equilibrium; but in my present system the current force heretofore expended in resistance-coils is made to traverse one or more cells of the (for the time being) diminished battery, whose internal resistances and counter electro-motive forces are thereby utilized as resistances, while the dominant current is utilized to recharge the cells of the diminished battery thus traversed by it. With this object in view each battery is made to consist of a given number of cells, which are coupled up in series and have loop-connections with corresponding plates of the switch-board. The batteries being in opposition and of equal electro-motive force, it follows that so long as each has the same number of cells in series no current-flow is possible; but should one or more cells of one battery be cut out of circuit current immediately flows from the other battery through the remaining cells of the thus-weakened battery, which cells, as already stated, will be thus utilized for resistances, and while so acting will become recharged.

In the practical use of my present system it is expected that by far the greater portion of the general braking will be done by the engine-

man, and hence that, by the action already explained, his battery will be maintained at full charge by the current from the train-battery. In view of this and that space is much more restricted on the locomotive than on the caboose the cells of the locomotive-battery may be relatively much smaller than those in the caboose.

The mechanism hereinafter described enables a predetermined number of cells of each battery to be placed normally out of circuit. With the mechanism so arranged the momentary cutting into circuit of one or more such cells of one battery will, by producing current-flow in reverse to that which caused brake action, operate to disperse the residual magnetism and cause a prompt release of the brakes.

In the accompanying drawings, Figure 1 is a diagrammatic representation of a circuit system embodying my present improvement, the apparatus being shown in its normal or inactive condition. Figs. 2 and 3 represent two conditions of the switch-arm, hereinafter explained. Fig. 4 represents the engine-man's battery and its accompanying switch-board. Fig. 5 is a diagrammatic representation of my brake circuit and of an associated signaling-circuit, both circuits being represented in their normal or inactive condition. Fig. 6 is a diagram showing the signal-circuit employed to send a message from front to rear of the train. Fig. 7 is a diagram showing both circuits automatically set in operation on both portions of a ruptured train.

The small circles 1 2 3 4 5 may indicate the locations in the circuit of the electro-magnetic mechanism of as many vehicle trucks included in a circuit whose line-wires are represented by dotted lines 6.

a' b' may represent automatic rheostats identical in form and function to those described in my Patent No. 357,760, February 15, 1887.

Located, respectively, upon the caboose and the locomotive are two similar storage-batteries, *a b*, each composed of the same number of cells connected in series. The said batteries are so placed in the circuit 6 as to present their poles of same sense in opposition, so that when each battery has the same number of cells included in circuit, as represented in Fig. 1, the two sets of electro-motive forces are in equilibrium, and there is no current-flow. In the drawings the consecutive cells of each battery are marked by Roman ordinals I, II, III, IV, V, VI, VII, and VIII, arranged in the direction of the electro-motive force.

Associated with the batteries *a* and *b*, respectively, are switch mechanisms *a''* and *b''*, of which each comprises a switch-board, 8, and a switch-arm, 9, and, concentric with said arm's center of oscillation, a series of relatively-insulated contact-plates, A, B, C, D, E, F, G, and H, whose number is preferably that of the battery-cells, as here shown. Adequate contact between the switch-arm 9 and the respective plates of the switch-board is secured by any suitable means, such as a spring-slide, *g*, similar to that in my Patent No. 357,760, February 15, 1887, and a wire brush, 12, which is held against the faces of the plates by a spring, 13. Each battery has, preferably, as many extraneous wires as cells, which wires are here indicated at A', B', C', D', E', F', G', and H', respectively. Of these wires A' connects the positive pole of the battery with plate A. Wires B', C', D', E', F', and G' connect the several cell-couplings 10 with plates B, C, D, E, F, and G, respectively. Wire H' connects the negative pole of the battery with plate H. The blind coupling 10' between cells VI and VII having no direct communication with any contact-plate, it follows that a shift of switch-arm 9 from plate B to plate C operates to cut out of circuit two cells at once for effective initiation of the brake action.

The group of electro-magnetic brake-operating instrumentalities upon the caboose (shown to the left in Fig. 1) and the corresponding group of instrumentalities upon the engine (shown in Fig. 4 and to the right in Fig. 1) may be spoken of as distinct entities, and will in this specification be respectively known as organisms Z and Z'. All the wire-connections have insulating-coverings, and when they occur in groups, as is the case between the switch-board and battery and at the couplings between the consecutive vehicles, they are additionally protected by being inclosed in rubber tubes.

It will be the duty of those in charge of a train furnished with the above-described system to have the two batteries normally in equilibrium. This will be accomplished by the engine-man and the train-man habitually maintaining their respective switch-arms on similar contact-plates—as, for example, both on plate A or both on plate B. The preferred normal position is shown in Fig. 1—namely, with each switch-arm on contact-plate B of its respective switch-board, because this position leaves in each battery a cell (cut out of circuit) in reserve for momentary reversal of current for prompt obliteration of residual magnetism after terminating brake action, in order to secure liberation of the brakes the instant that their service is no longer required.

The operation of my said electro-magnetic-brake system is as follows: The train being in motion and both switch-arms being in contact with two predetermined similar plates—say plates B, as in Fig. 1—let it be supposed that the engine-man desires to prepare for brake action. His first act will be to shift his brake-arm from plate B to plate C. This action reduces by two the number of cells in battery *b* included in circuit, and gives a sufficient preponderance of electro-motive force to battery *a* to initiate a current whose magnetizing energy just serves to quickly take up the slack of the brake-windlass chain. Further advance now of the switch-arm—say to plate D or plate E—produces instantly a moderate brake

action. Still further advance—as, for example, to plate G, as represented in Fig. 4—produces a very powerful brake action. For securing a very sudden halt, a movement of the switch-arm to the extreme right-hand plate H, by cutting all the cells of battery *b* out of circuit, liberates a current whose effect is to bring the brakes to bear with their utmost promptitude and stress. Finally, the condition "off brakes" is obtained by retraction of the same switch-arm to plate A, followed immediately by its advance to plate B. The effect of this double movement is to first generate a momentary reverse current that dissipates the magnetism, and then to stop current-flow altogether, thus restoring the brake mechanism to its inert condition. In all of these actions the cells, which are for the time being retained in circuit in the weaker battery, become the theater of a refluent current, which of course operates for the moment to reverse the electrolytic action in those cells and to recharge them at the expense of battery *a*.

As it will be the locomotive switch mechanism *b''*, operating to liberate current of battery *a*, that will be most frequently used for braking purposes, the effect will be to maintain battery *b* in constant efficiency and to make it possible to have that battery comparatively quite small and compact and securely incased in a position on the locomotive where it will seldom require to be inspected, replenished, or disturbed for any purpose. On the other hand, the cells of battery *a* may be relatively capacious and may be accessible for sufficiently frequent replacement of spent cells by freshly-charged ones. The counter electro-motive forces of the cells in circuit in the weaker battery operate as resistances, and supersede the necessity which would otherwise arise for resistance-coils or other specially-provided resistances, in which a portion of the force of the dominant battery would expend itself, without serving the added useful purpose above stated of maintaining the efficiency of the reversed battery.

If on placing freshly-charged cells in battery *a* its potential should exceed that of battery *b*, the tendency to equilibrium will cause a gentle overflow of current from battery *a*, which, while not of sufficient activity to affect the brake mechanism, will continue until both batteries are of equal potentiality, whereupon electrolytic action will wholly cease. If on such replenishment of battery *a* both switch-arms be simultaneously moved to the extreme left, as in Fig. 3, all the cells of battery *b* will share in the above process of restoration to uniform potentiality, which having been accomplished, both arms may be replaced in the normal position shown in Fig. 1.

It is manifestly desirable that a train having the above-described means for both discretional and automatic braking should contain an instrumentality whereby audible signals may be sent from either extremity of the train to the other, and whereby also prompt and audible alarm or warning may be given at each extremity of any accidental separation of the train. For the above objects there may be applied to such a train a light metallic circuit, 17, independent of the brake-circuit.

Located at each extremity of the train (say on the caboose and the locomotive, respectively) is a small storage-battery, 16^a 16^b, the two batteries being of like potential or electro-motive force, and so connected by the lines 17 as to place their said forces in opposition—that is to say, positive being presented to positive and negative to negative pole of the respective batteries, so that, as in the case of my brake system, the two battery-forces are normally in equilibrium and without current-flow.

Near each such signal-battery is a magneto bell or sounder, 18^a 18^b, which, in event of accidental rupture of the train, both ring noisily and continuously each on its own fragment of the train until stopped by the attendant thereupon. Accompanying each sounder is a key or push-button, 19^a 19^b, which enables officers on the respective ends of an unbroken train to give and exchange signals.

A reference to Figs. 4, 5, 6, and 7 shows that a depression of the push-button—say button 19^b—at one end of the train, as in Fig. 6, cuts out the bell and battery at that end, and, by liberating the current of the distant battery, operates to sound its bell. The pivoted attachment 20 of each key permits the attendant to shift it to the position shown by dotted lines in Fig. 4, and by thus breaking the circuit to secure on a separated portion of the train the same inactivity of the sounder as resulted from the condition of equilibrium on the unbroken train. Furthermore, the alarm-circuit 17 is, like the brake-circuit, so coupled up from car to car as to automatically bring the outgoing and the returning conductors in contact in each portion of a severed coupling, as shown in Fig. 7, and by thus creating an independent closed circuit on each severed portion of the train to bring each sounder automatically into activity and continue the same until stopped by the person in charge by a lateral deflection of the push-button 19^b, as already stated.

The circuits may be coupled between consecutive vehicles of the train by means of any suitable spring terminals, as diagrammatically represented by dotted lines in Figs. 5 and 7.

The group of electro-magnetic signaling or alarm instrumentalities 16^a 18^a 19^a upon the caboose (seen to the left of Figs. 5, 6, and 7) and the identically-similar group of instrumentalities 16^b 18^b 19^b upon the engine (seen to the right in Figs. 5, 6, and 7, and partially in Fig. 4) may be spoken of as distinct entities, and in this specification will be respectively known as the organisms Y and Y'.

I claim, in an electric circuit for operating the brake mechanism of railway-trains—

1. The combination of two relatively distant and antagonized sources of electricity normally in equilibrium, each source compris-

ing several "elements" united in series and each having means for cutting out one or more of its said elements, whereby the remaining elements are converted into a conduit for counter-current from the other source, to which they discharge the function of resistances and by which they are re-enforced, substantially as and for the purposes set forth.

2. The combination of two multicelled storage-batteries having their poles of like sign permanently in opposition and a switch for each battery, whereby one or more of its cells may be consecutively cut in or out of circuit, substantially as set forth.

3. In combination with means on each vehicle of a train for electrical communication with each other and with the brake-magnets, and in circuit thereof, the following devices, to wit: two storage-batteries at remote extremities of the circuit, whose poles of same sense are permanently in opposition, and of which each battery has the same number of cells, a switch, and connections connecting said cells in series and having separated communications with said switch, whereby the officer in charge of either battery can cut one or more cells thereof either into or out of circuit, substantially as and for the purposes set forth.

4. A closed metallic brake-circuit coextensive with a railway-train, having at or near its respective extremities two series storage-batteries, *a b*, of mutually-opposed and normally-equal potentials, and of which each battery has its several cell-couplings, a series of contact-plates for each battery, the several plates of which series are connected, respectively, with said couplings, and a shiftable contact or switch-arm, and the terminal plate of said series electrically connected, respectively, with the outgoing and the returning portions of the circuit, as and for the purposes set forth.

5. The two structurally-identical organisms *Z Z'* at remote points of a circuit, each consisting of a storage-battery, *a*, or *b*, couplings 10, connecting the cells of said battery in series, a shiftable contact, 9, connecting with one branch of the circuit, a series of insulated contact-plates arranged concentrically about the axis of contact 9 and having individual connections with the respective cell-couplings 10, and the terminal plate of said series having communication with the outer branch of said circuit, substantially as and for the purposes set forth.

6. In combination with switch mechanism *a''* or *b''* and the series storage battery *a* or *b*, having the cell-connections 10, that communicate with said mechanism, and the blind cell-coupling 10', as and for the purpose designated.

7. In a metallic circuit, 6, the organisms *Z* and *Z'*, of opposed and normally-equal electromotive forces and of unequal electrical capacities, combined and operating in the manner and for the purposes explained.

In testimony of which invention I hereunto set my hand.

GEORGE F. CARD.

Attest:

GEO. H. KNIGHT,

E. M. WILLIAMS.