(No Model.)

G. KAPP.

RETURN CIRCUIT FOR ELECTRIC RAILWAYS.

No. 570,599. Patented Nov. 3, 1896.

Fig. 1.

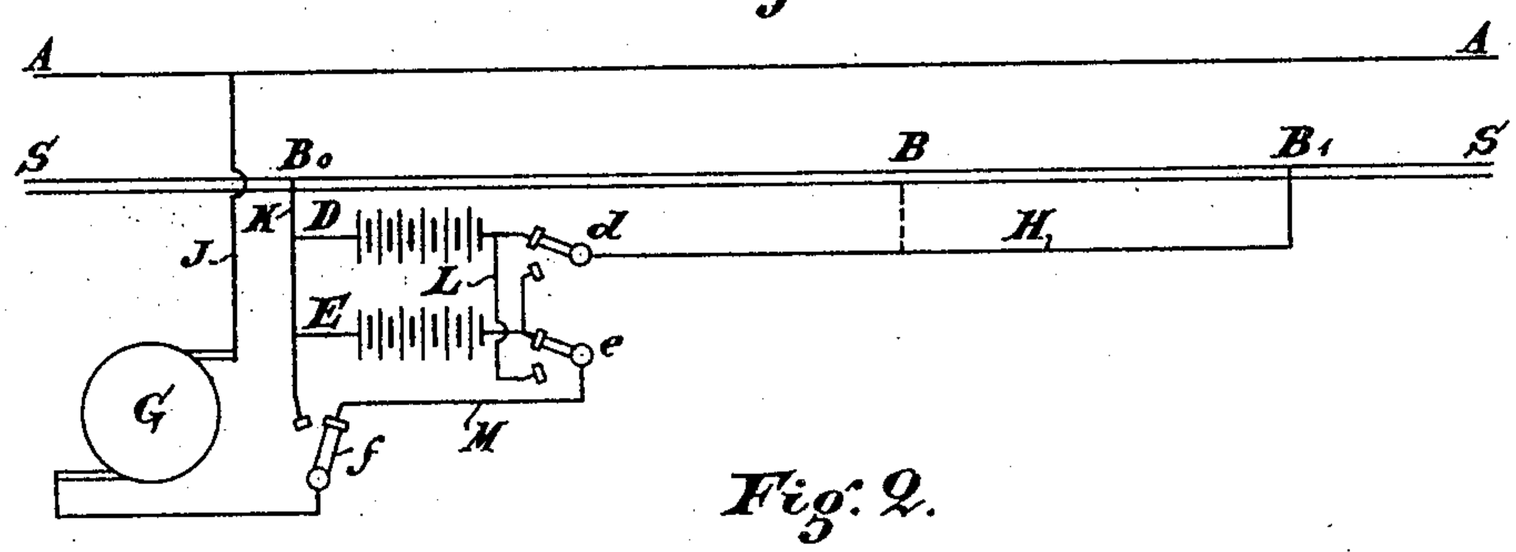


Fig. 2.

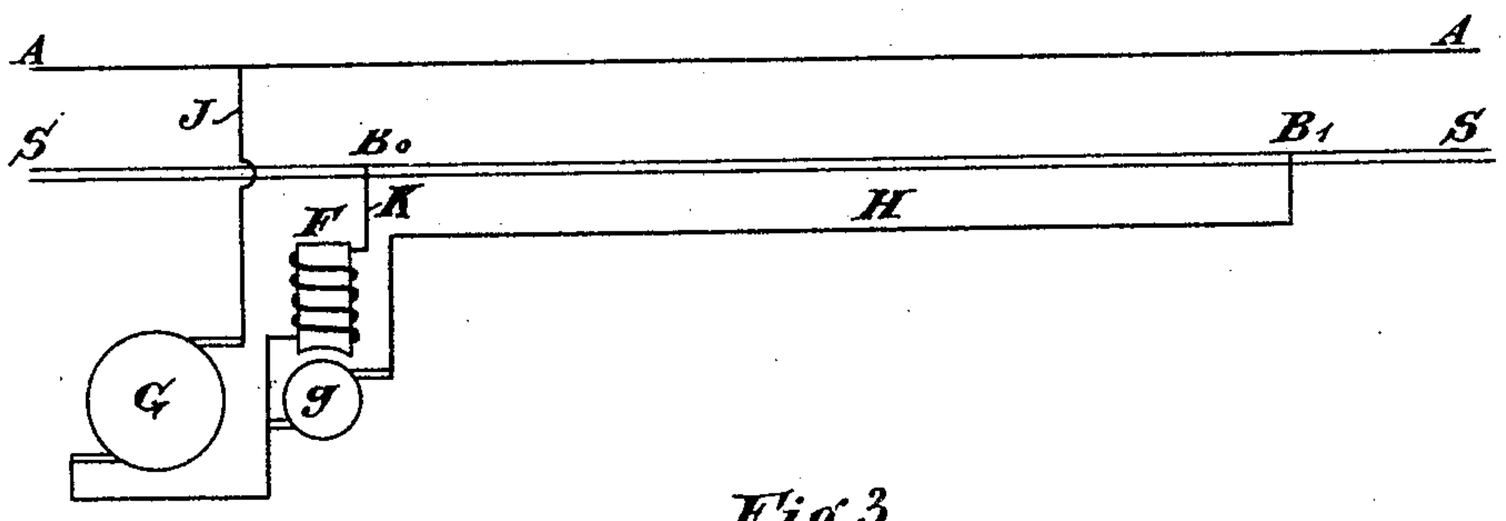


Fig. 3.

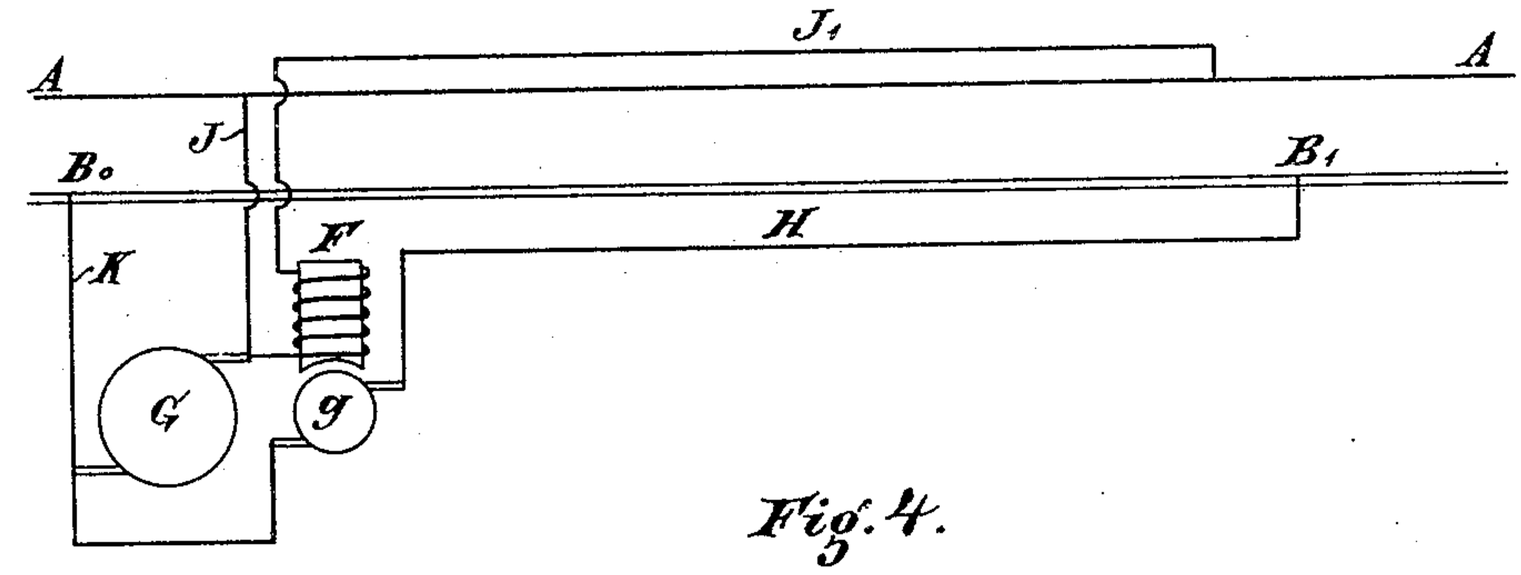
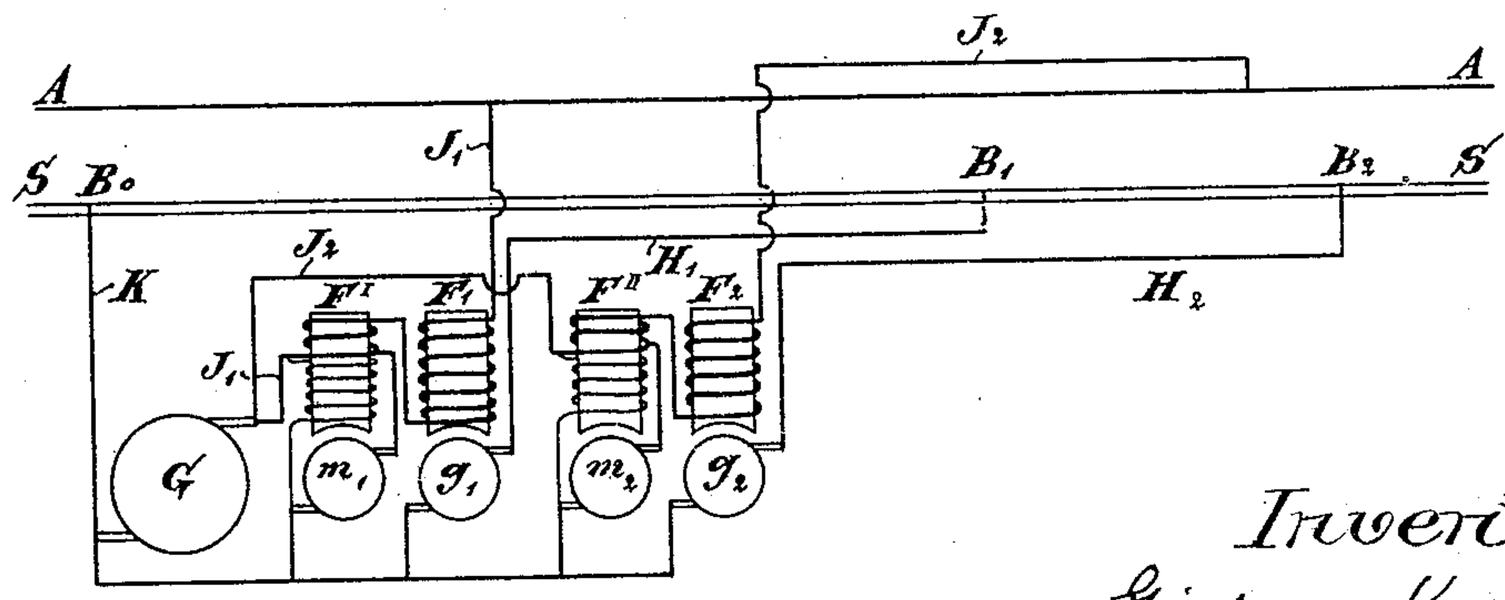


Fig. 4.



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RETURN-CIRCUIT FOR ELECTRIC RAILWAYS.

SPECIFICATION forming part of Letters Patent No. 570,599, dated November 3, 1896.

Application filed December 31, 1895. Serial No. 573,882. (No model.)

To all whom it may concern:

Be it known that I, GISBERT KAPP, a subject of the Queen of Great Britain, residing at Berlin, in the Kingdom of Prussia, German Empire, have invented new and useful Return-Circuits for Electric Railways, of which the following is a specification.

My present invention relates to electric railways using the rails as return. In railways of this description a potential difference exists between different parts of the track and causes earth-currents. The object of my invention is to reduce these earth-currents by reducing the said potential difference.

According to the usual constructions the connection between the return-pole of the generator and the track is made either only at the nearest point of the track or by means of so-called "return feeders" at several points, which are suitably distributed. These return feeders generally are insulated cables, and their resistance is so chosen that for a certain distribution of ampere load along the track the potential of all the return feeding-points on the track is approximately the same and not much different from that of the earth. This arrangement requires, however, an unnecessarily large resistance in the shortest feeder, causing waste of power, and, further, a large weight of copper in the longer feeders, causing a considerable expense. Moreover, the arrangement is only effective in minimizing the earth-currents as long as the distribution of ampere load along the track remains that for which the feeders are designed. If parts of the track are more heavily and others more lightly loaded, differences of potential between the various return feeding-points arise; and since in the practical working of electric railways the ampere load of any particular section of the track is subjected to very large fluctuations the difference of potential and the earth-currents between any two points of the track, in spite of the arrangement of a plurality of suitably-distributed return feeders, may become so great as to disturb telephones and cause damage by electrolytic action to pipes and other metallic masses buried in the ground. The main feature of my invention consists in avoiding the said inconveniences by the following means: I make the shortest return feeder of as low a resistance as is economically practicable and the other feeders of such a resistance as will cause neither too much loss of power nor too heavy an outlay. Into the said longer return feeders I insert auxiliary generators of electricity, either secondary batteries or dynamos, acting as sources of electromotive forces, which promote the flow of the return currents, and I adjust those electromotive forces in such a manner that each return feeder carries that part of the total return current which corresponds to the section of track served by it.

Other features of my invention shall be explained with reference to the diagrammatic figures of the annexed sheet of drawings, of which—

Figure 1 represents an arrangement of a return feeder with auxiliary batteries. Fig. 2 represents a combination of a return feeder with an auxiliary dynamo. Fig. 3 represents another combination of a return feeder with an auxiliary dynamo. Fig. 4 represents a combination of return feeders and auxiliary dynamos inserted into them with special electromotors for driving the dynamos.

Referring to Fig. 1, the working wire A A is connected by the feeder J with the positive pole of the main generator G of the power-station. The double line S S may represent the rails used as return. The point B^0 of the track, which is near to the power-station, is connected with the negative pole of the generator G by the shortest return feeder K, while a more remote point B′ of the track by an insulated return feeder H, provided with a secondary battery D, is connected with the first and shortest return feeder K. Preferably I use a second battery E, connected likewise at one side with the return feeder H and at the other side with the return feeder K, and by adding two auxiliary connections L and M and switches *d*, *e*, and *f* at three of the knot-points I am enabled to charge the battery E by the entire return current or to have it put out of circuit, while the battery D, in promoting the flow of the current in the return feeder H, is discharged, and vice versa. The positions of the switches in Fig. 1 correspond to the first case, the united currents of the return feeders K and H passing the battery E to charge it. This battery being fully charged

is put out of circuit by shifting the switch *f*. When afterward the battery D is fully discharged, the switches *d* and *e* are shifted and the switch *f* is shifted back into the position shown, so that the battery E is discharged and the united return currents pass the battery D to charge it. To vary the electromotive force of the batteries according to the ampere load on the track, I alter the number of cells inserted by means of a suitable switch, (not shown in the drawings,) which may be worked by hand or automatically by the outgoing or return current.

At suitable points where the return feeder H is conveniently near to the track I connect track and return feeder by conductors of appropriate resistance, as indicated at the point B of the track by dotted lines, so that part of the current is tapped off from the track by the said conductors.

If an auxiliary dynamo *g*, Figs. 2 and 3, instead of the secondary batteries, is used as a source of electromotive force for the return feeder H, its field F may be excited by the current of the return feeder K, as shown in Fig. 2, or if several feeders J J′, instead of a single one, transmit the power from the generator G to the working wire A A that one of these feeders which is connected with the working wire next the point B′ of the track in Fig. 3, the return feeder named J′, may be used for exciting the field F. In both cases the electromotive force of the dynamo *g* depends upon the ampere load on the track, and in the second case particularly upon the ampere load at the point B′ of the track in such a manner that both vary together in the same sense. The dynamo *g* may be driven at constant speed by the motor of the main generator G, or by a special motor.

The object of the arrangement shown in Fig. 4 is to still better adapt the amount of electromotive force of each auxiliary dynamo to the ampere load on that part of the track which is served by the return feeder the dynamo is inserted into. The dynamos *g* and g^2, controlling the return feeders H′ and H^2, are driven by electromotors *m′* and m^2, which are fed with current by the outgoing feeders J′ and J^2. The fields F′ and F^2 of the motors *m′* and m^2 are excited by shunted circuits, but each is further controlled by a second coil, through which passes the whole or part of the feeder-current in such direction that an increase of the intensity of the current, afforded by an increase of the load on the track, by weakening the field enhances the speed of the motor, and vice versa. The speed of the dynamo driven by the motor increases correspondingly, and at the same time its field F′ F^2, being also excited by the feeder-current, is strengthened, so that the electromotive force of the dynamo may rise nearly proportionately to the ampere load on the respective part of the track.

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

1. In electric railways using the track as return-conductor, the combination with insulated return feeders connected to the track at points remote from the power-station, of auxiliary sources of electromotive force inserted into the said return feeders, substantially as described and for the purpose specified.

2. In electric railways using the track as return-conductor, the combination with insulated return feeders connected to the track at points remote from the power-station, of auxiliary dynamos inserted into the said return feeders and excited by the currents of the outgoing feeders, these outgoing feeders being connected with the trolley-wire at or near the points of the track which are served by the return feeders, and means for driving the said dynamos, substantially as described and for the purpose specified.

3. In electric railways using the track as return-conductor, the combination with insulated return feeders connected to the track at points remote from the power-station, of auxiliary dynamos inserted into the said return feeders and special electromotors for driving the said dynamos, excited partly by shunt-coils and partly by coils through which the outgoing feeder-currents pass, the latter coils being connected in such manner that the strength of motor-field is reduced when the feeder-current increases, substantially as described and for the purpose specified.

4. In electric railways using the track as return-conductor, the combination with insulated return feeders, connected to the track at points remote from the power-station, of auxiliary dynamos inserted into the said return feeders and excited by the currents of the outgoing feeders connected with the trolley-wire at or near the points which are served by the return feeders, and special electromotors for driving the said dynamos excited partly by shunt-coils and partly by coils through which the outgoing feeder-currents pass, the latter coils being connected in such a manner that the strength of the motor-field is reduced when the feeder-current increases, substantially as described and for the purpose specified.

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

GISBERT KAPP.

Witnesses:
W. HAUPT,
CHAS. H. DAY.