No. 860,945. PATENTED JULY 23, 1907.

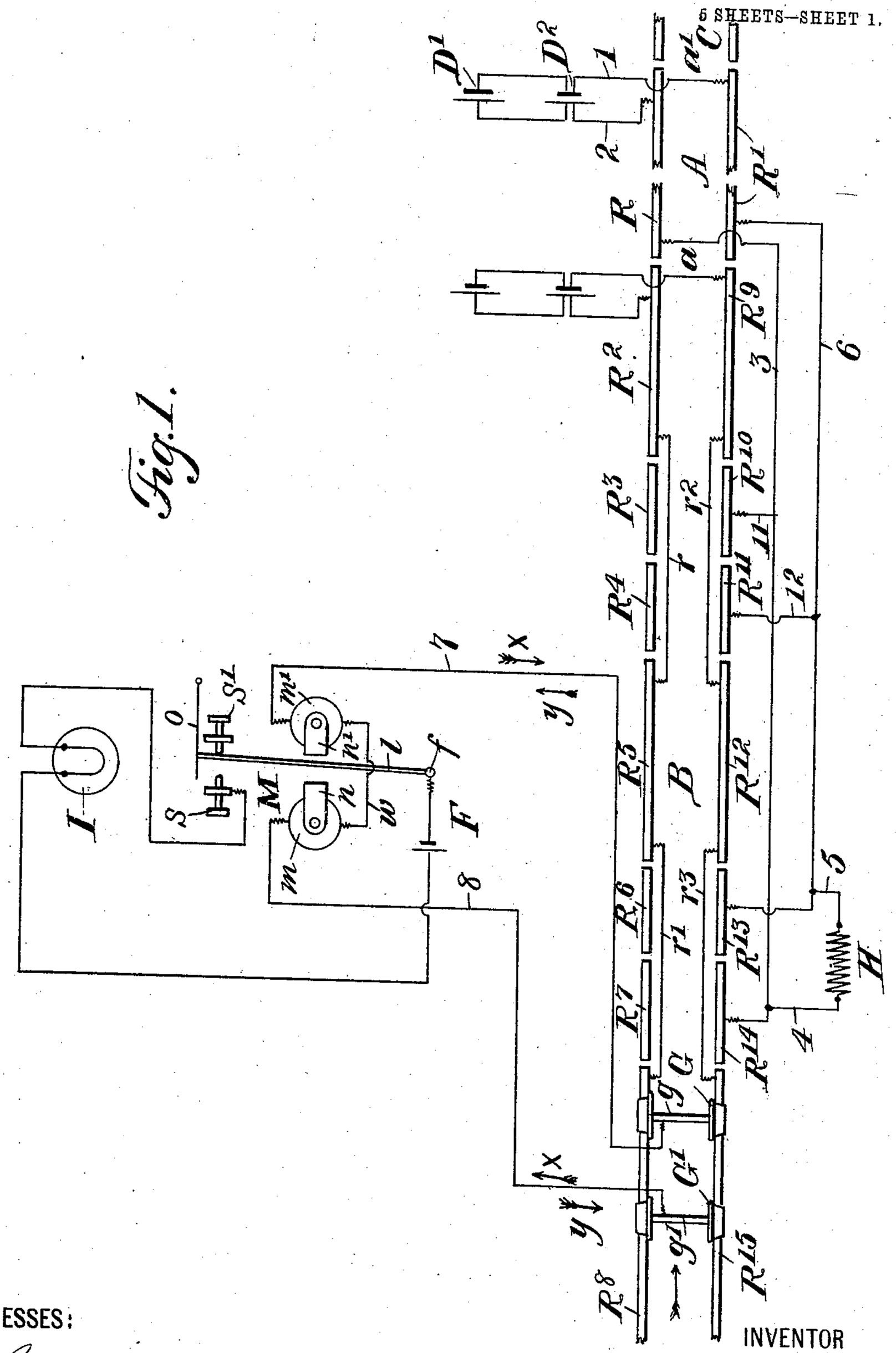
H. W. SPANG.

APPARATUS FOR RAILWAY SIGNALING.

APPLICATION FILED SEPT. 22, 1902.

5 SHEETS—SHEET 1.

Fig. 1.



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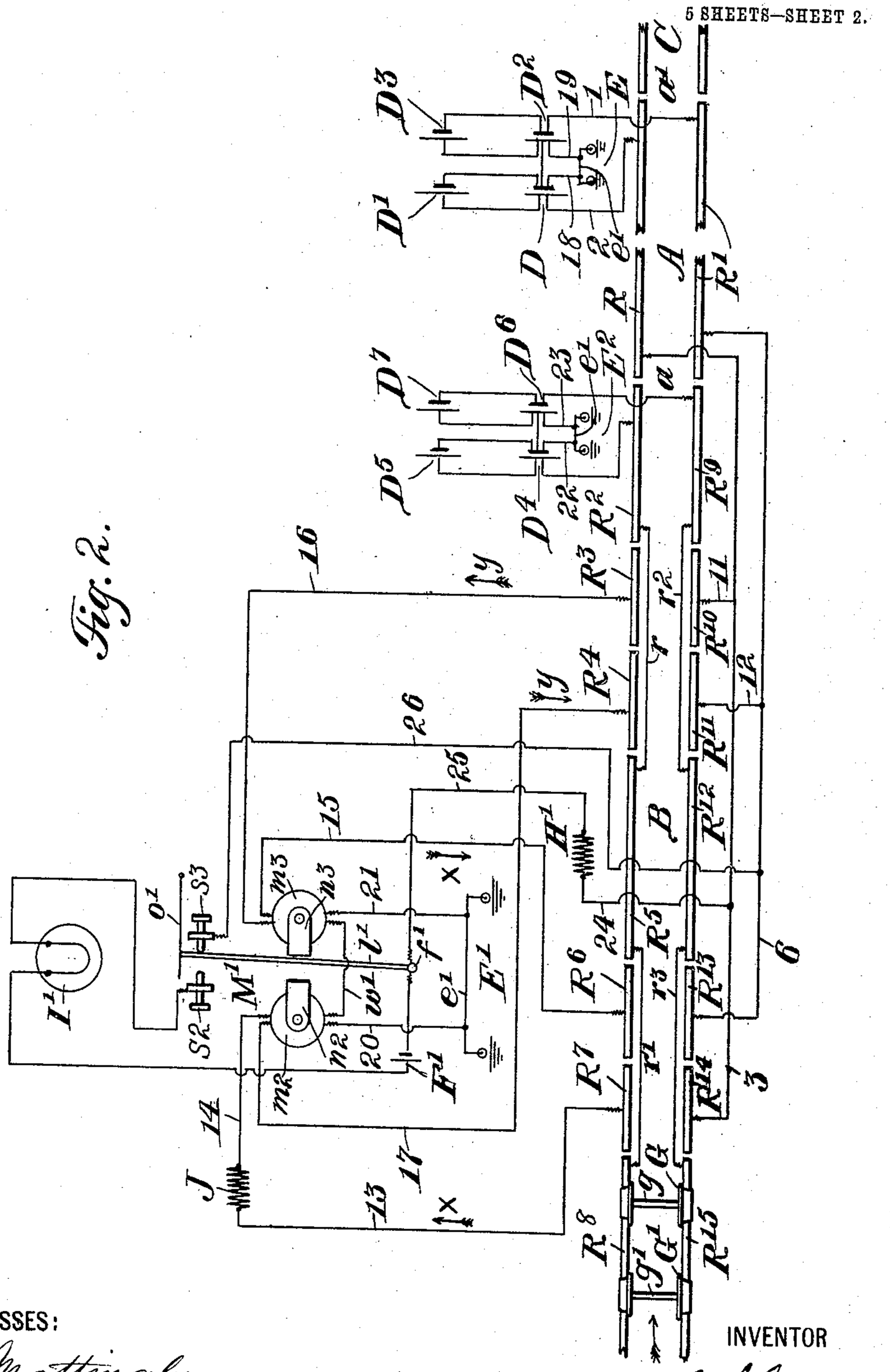
5 SHEETS—SHEET 2.

Fig. 2.



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5 SHEETS—SHEET 3.

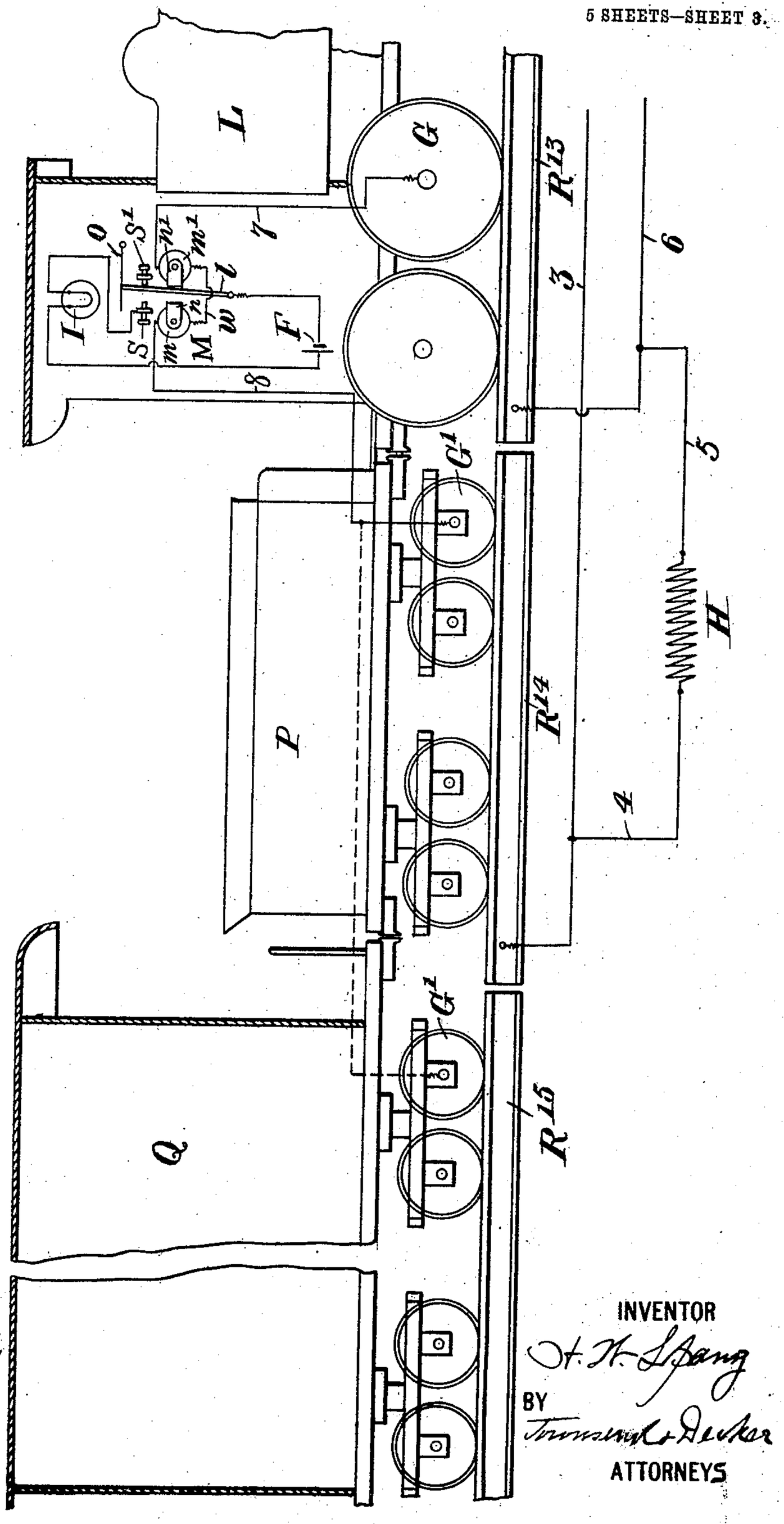

Fig. 3.

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5 SHEETS—SHEET 4.

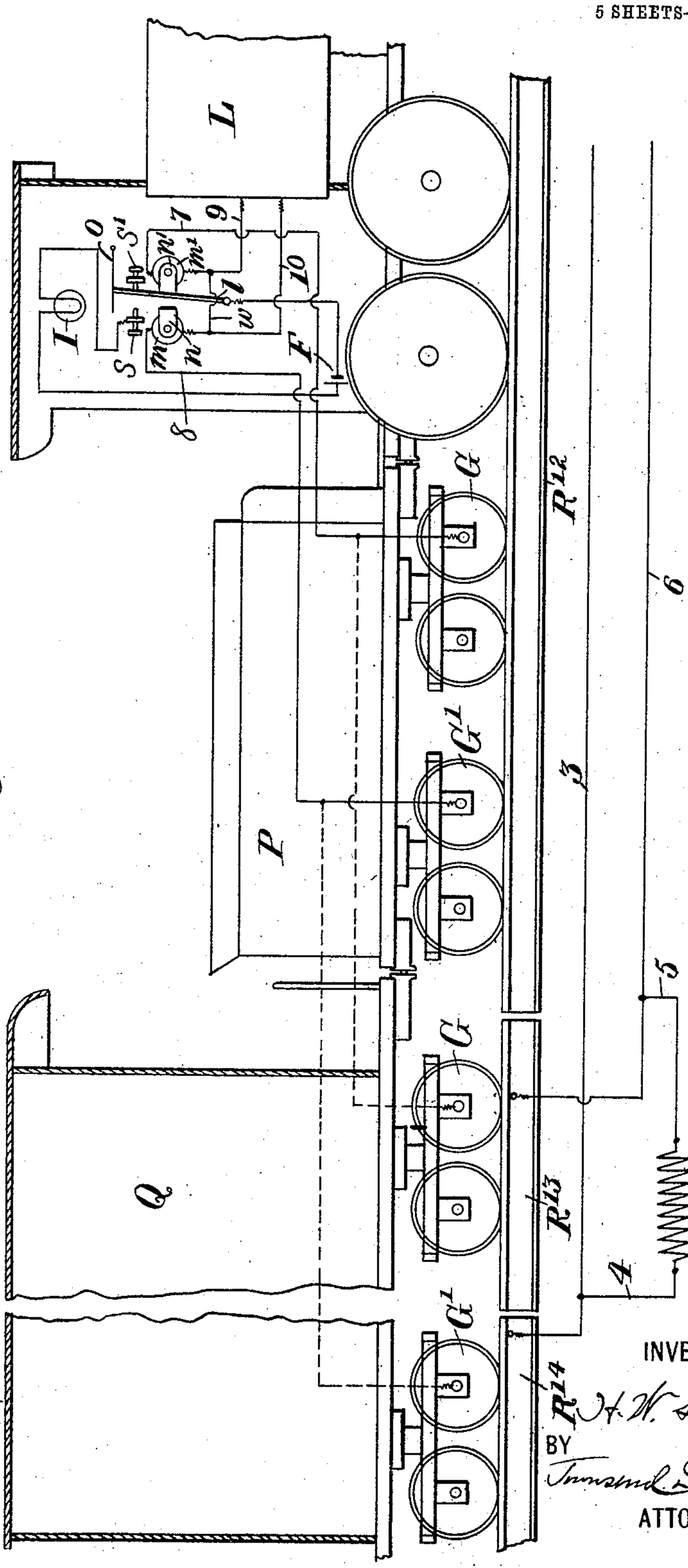

Fig. 4.

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5 SHEETS—SHEET 5.

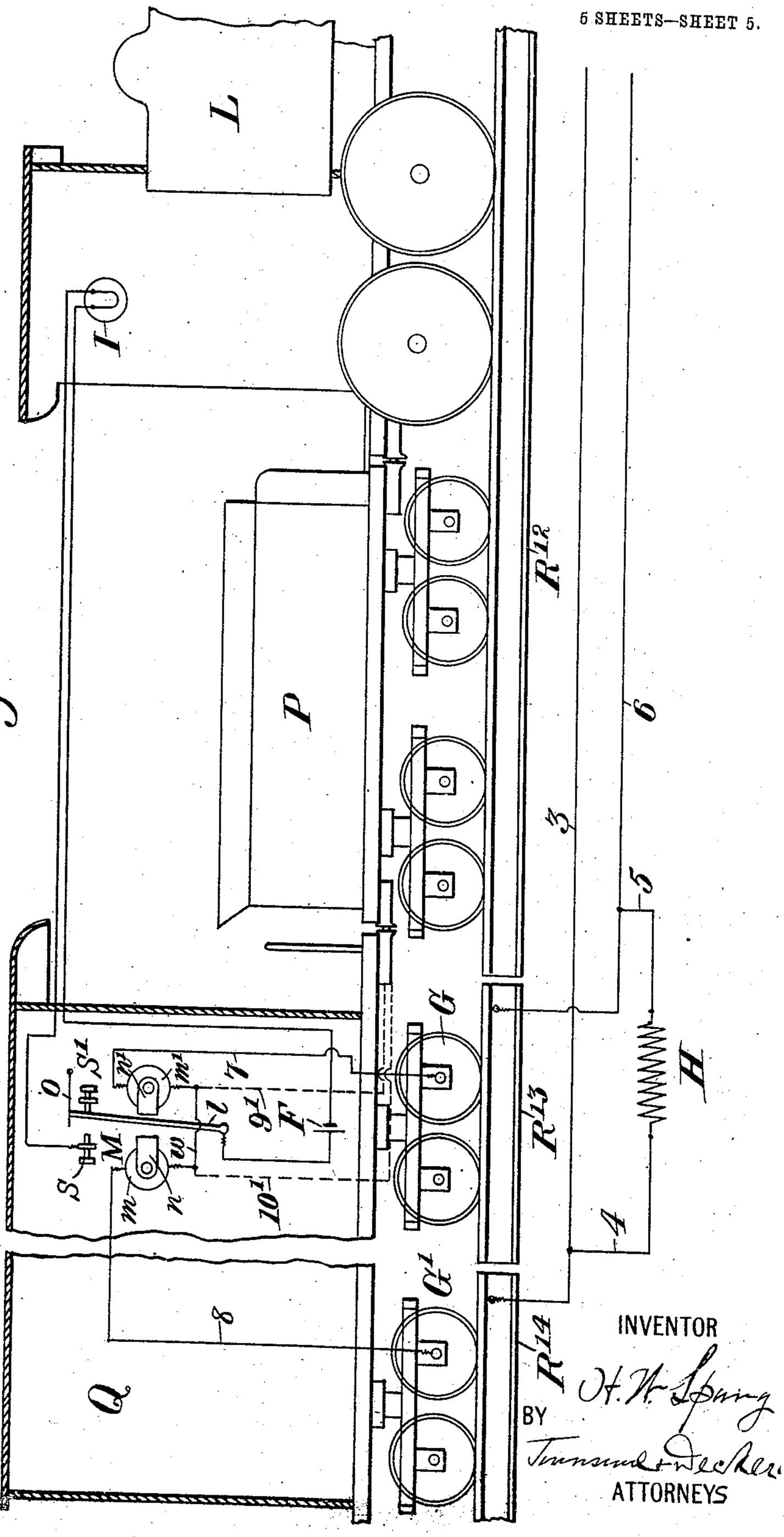

Fig. 5

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR RAILWAY SIGNALING.

No. 860,945. Specification of Letters Patent. Patented July 23, 1907.

Application filed September 22, 1902. Serial No. 124,292.

To all whom it may concern:

Be it known that I, HENRY W. SPANG, a citizen of the United States, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Electric Circuits and Apparatus for Railway Signaling, of which the following is a specification.

My invention relates to means for controlling the action of an electromagnet by the moving of the rolling equipment of a railway and is designed primarily to furnish a means whereby the current from a battery connected to a safety circuit of any kind, as for instance, the rails of a section of track may be caused to flow directly, first in one direction and then in an opposite direction through an electromagnet on the rolling equipment or on the permanent way without the use of special devices and so as to dispense with the use of local batteries and special current reversers or controllers.

In these respects my invention constitutes an improvement upon that class of circuits shown in Figure 1, in United States Letters Patent No. 164,228, of June 8, 1875, in which the two lines of rails of a section of railway track are used as the principal conductors between a galvanic battery and a polarized relay magnet which controls or operates a visual or audible signal, or both, through the action of a circuit controller or controllers, adapted to successively energize such magnet by currents flowing first in one direction and then in an opposite direction.

My invention consists in the combination with a circuit, as for instance, a track circuit consisting of two lines of rails of a section of track connected with galvanic batteries or cells, of insulated rails or short track sections which in connection with the wheels of a locomotive and tender or of the front and rear trucks of a tender or of an adjacent car will cause a polarized relay or electromagnet on the locomotive or car to be successively energized by currents from said battery flowing first in one direction and then in the opposite direction and give a safety signal thereon for a suitable period of time.

It further consists in the combination of a track circuit consisting of two lines of rails of a section of track connected with galvanic batteries or cells at one end thereof and with insulated rails or short track sections in the preceding section of track at the other end thereof, wheels and axles of a locomotive and tender or of the front and rear trucks of a tender or of an adjacent car, a polarized relay or electromagnet on the permanent way and which controls a signal circuit or signal and which normally is in a partial open circuit, and insulated rails or short track sections in which said partial circuit terminates, all as hereinafter described, whereby said magnet may be successively energized by currents flowing first in one direction and then in the opposite direction and give a safety signal thereon for a suitable period of time and at a safe distance ahead of the preceding section of track and when such section is clear.

It further consists in the combination of an open partial circuit embracing a relay or electromagnet which controls a signal circuit or signal along the permanent way with circuit controller or controllers, two lines of rails of a section of track and two or more galvanic batteries with ground connections so arranged that when the metallic circuit is completed each helix of magnet and each line of rails will also be in an independent ground circuit.

It further consists in the combination of a relay or electromagnet upon a locomotive and which controls a signal thereon, such magnet being in portion of a circuit terminating in the wheels of the locomotive and tender, or in the wheels of a locomotive and those of one truck of an adjacent car, and insulated from each other, with portion of the electric circuit along the permanent way and containing a battery which is connected to two adjacent insulated rails or short sections of track which when bridged by said wheels will cause said magnet to be energized and a signal given.

It further consists in the combination of a relay or electromagnet upon a locomotive or adjacent car and which controls a signal circuit or signal thereon, such magnet being in a portion of circuit terminating in the wheels of the front and rear trucks of tender or of a car and insulated from each other and the helices or wire connecting them being connected with the metal work of locomotive, so as to form a ground connection via the rails, batteries and ground connection of the section of track upon which it is then moving or located, with the portion of the electric circuit along the permanent way consisting of ground connection, and batteries connected with two adjacent insulated rails or short track sections, all arranged so that when said rails or track sections are bridged by said wheels each helix of such magnet will be in an independent ground circuit as well as in a complete metallic circuit.

It further consists in the combination of a relay or electromagnet upon a car of a train and which controls a signal circuit which extends to an incandescent lamp or other signal upon locomotive, such magnet being in portion of a circuit terminating in the wheels of the front and rear trucks of car, and insulated from each other with the portion of the electric circuit along the permanent way consisting of a battery which is connected to two insulated rails or short sections of track which when bridged by said wheels will complete circuit and cause signal to be given thereon.

It further consists in the combination of resistance

in a track circuit with means under the control of a locomotive or train for including and excluding it from such circuit.

My invention consists also in the combinations of circuits and devices hereinafter described and then specified in the claims.

In the accompanying drawings, Fig. 1, is a diagram illustrating one form of my invention as applied to one track of a double track system, in which the trains always move in one direction as indicated by the arrow; the second or return track not being illustrated herein; Fig. 2 is a modification thereof, as applied to a signal controlling magnet on the permanent way which may be used in conjunction with the magnet on the locomotive or other portion of the rolling equipment and energized simultaneously therewith or may be used independently thereof; Fig's. 3, 4 and 5, are side elevations of a locomotive and tender and adjacent car illustrating the portion of electric circuit thereon.

Similar reference characters are used to designate like parts in all the views.

A, is a section of track, which may be a mile long, more or less, and having its rails insulated or separated from metallic contact with the rails of the adjacent sections B and C, as shown at *a*, and *a'*.

Each line of rails R, R', of section A, and R^2, R^5, R^8, R^9, R^{12}, R^{15}, of section B, should have metallic continuity throughout its length by means of suitable metallic bonds or connectors at the rail joints thereof and metallic connectors *r*, *r'*, r^2 and r^3, around any insulated rails of said line.

Rails R^3, R^4, R^6 R^7, R^{10}, R^{11}, R^{13}, R^{14}, are insulated or separated from each other, and their insulations or separations, are preferably directly opposite each other, and each of said rails can be a single rail or two or more bonded rails, according to the distance employed between wheels G, G', of the rolling equipment moving on said rails.

Rail R^{14} is connected to one pole of the guard or other circuit to which the battery or other generator is joined, and the next rail R^{13} is connected to the opposite pole of said circuit. Proceeding in the direction of the arrow the rails R^{11}, R^{10}, succeeding rails R^{14}, R^{13}, in the order named, are connected in the reverse manner to said poles; that is to say, R^{11} is connected, not to the same pole as R^{14}, but to the opposite pole, viz: that to which R^{13} is connected, while R^{10} is connected to the same pole as R^{14} and to the pole opposite to that to which R^{13} is connected. These rails then, in combination with the wheels G, G', and axles *g*, *g'*, constitute the elements of a pole changer or reverser for causing the current from the same battery or generator to flow first in one direction and then in the other over the partial circuit connected to wheels and axles G, *g*, G', *g'*, and according to the position of said wheels and axles respectively with relation to the four points or contacts R^{14}, R^{13}, R^{11}, R^{10}. The said insulated rails or short track sections are also better adapted for strongly energizing a relay or electromagnet upon a locomotive or car by a battery located on the permanent way, than is possible with two insulated rails or short track sections, opposite each other, and two adjacent longer sections of rails, for the reason that the latter offer longer and better paths for the low of portion of the current to the earth via the adjacent ties, ballast, etc. when moist. Such insulated rails are preferably selected at a suitable point ahead of the near end, *a*, of section of track A, so that when wheels G, G', of locomotive and tender, or of a car moving in direction of arrow contact respectively with rails R^6, R^{13}, R^7, R^{14}, and section of track A is clear, a safety signal will be given at a safe distance ahead of the near end, *a*, thereof, and will continue to be given until wheels G', G', contact with rails R^3, R^{10}, R^4, R^{11}. The distance between the two sets of insulated rails of section B varies according to the length of time during which the signal is to be given.

D'—D^2 Fig. 1 and D, D', D^2, D^3, and D^4, D^5, D^6, D^7 Fig. 2 are gravity batteries or cells connected in multiple in Fig. 1, and in series multiple in Fig. 2 constituting sectional generators.

H, or H', is an ordinary resistance and its function is to keep the said batteries in proper working order. It can also be in the form of wire coils of a relay or electromagnet or solenoid and operate a visual signal or current indicator, so as to indicate to an engineer the condition of section A before signal is given upon locomotive, or along railway.

M, M', are polarized relays of suitable type and consist of electromagnets *m*, *m'*, m^2, m^3, connected together by wires, *w*, *w'*, and to the iron cores thereof, iron poles *n*, *n'*, n^2, n^3, are attached and by which lever *l* or *l'* is attracted and moves on its fulcrum, *f* or *f'*, contacting alternately with conducting stop *s* or s^2 and insulated stop *s'* or s^3. Lever *l* or *l'* is supported by a permanent magnet and as the polarity of poles *n*, *n'*, or n^2, n^3, is alternately changed by currents flowing in opposite or reverse directions over the helices *m*, *m'*, or m^2, m^3, it alternately contacts with stops *s* and *s'* or s^2 and s^3.

In order to prevent lever *l* of magnet M being moved by the jar of locomotive or car, from the position in which it is placed, a flat pressure spring, *o*, or any other suitable device can be employed against the top or any other suitable part of said lever.

Relay magnet M, upon the locomotive, is connected by wires 7 and 8, with the wheels G, G', of locomotive and a truck of tender P, or of an adjacent car as shown in Fig. 3, the said wheels being insulated from each other, and when lever *l* is moved in one direction by poles *n*, *n'*, and contacts with stop *s*, it will close circuit of battery F over incandescent lamp I or otherwise operate a visual or other signal and when lever *l* contacts with stop *s'* the circuit of battery F will be open and no signal given.

In order that each helix *m*, *m'*, of relay magnet M upon locomotive may also be operated in an independent ground circuit, it is necessary to connect them or the wire, *w*, connecting them, by wires 9 and 10 with a suitable metal portion of locomotive L, and wires 7 and 8 with wheels of front and rear trucks of tender or of an adjacent car, as shown in Fig. 4. The ground connection thereby formed will consist of the locomotive and rails of section B which connect with batteries D^4, D^5, D^6, D^7, and the ground connection or connections thereof, the current of said batteries being at the same time shunted from magnet M by wheels and axles of locomotive.

In some cases, and especially where the four insulated rails or short sections of track must conform with the usual track construction and have their insulations

or separations diagonally opposite each other it may be desirable to place relay magnet M and signal battery F in a baggage or other car, Q, adjacent to tender, P, with the signal circuit wires extending from such car to incandescent lamp I, upon locomotive as shown in Fig. 5, and if desired, a signal lamp upon such car or any other car of train can also be operated with such signal circuit. In such cases wires 7 and 8 are preferably connected with wheels G, G′, of the front and rear trucks of such car or trucks of different cars, and wire, *w*, is connected by wires 9′ and 10′ with coupling of car and thence to wheels of tender or directly with tender or locomotive in any efficient manner.

Magnets M and M′ being momentarily energized are not liable to retain their residual magnetism or be subjected to induced electrical discharges taking place between the rails and the adjacent earth, simultaneously with lightning discharges taking place in line with adjacent and even remote points, and thereby prevent the polarized electromagnets being demagnetized, which is a common occurrence with such magnets now employed along the permanent way in connection with constant track and other closed circuits.

When wheels G, G′, of locomotive and tender or of a car moving in direction of arrow Fig. 1, contact respectively with rails R^6, R^{13}, and R^7, R^{14}, of section B and section of track A is clear, the current of batteries D′, D^2, will flow over wire 2, rails R, wire 3, rail R^{14}, wheels G′, wire 8, magnet M, wire 7, wheels G, rails R^{13}, wire 6, rails R′ and wire 1, causing lever *l* to contact with stop *s*, and close circuit of battery F over incandescent lamp I; the direction of current over wires 8, 7, and magnet M being indicated by arrows *x*. When wheels G, G′, contact respectively with rails R^3, R^{10}, R^4, R^{11}, the current of batteries D′, D^2, will flow over wire 2, rails R, wires 3, 11, rails R^{10}, wheels G, wire 7, magnet M, wire 8, wheels G′, rail R^{11}, wires 12, 6, rails R′ and wire 1, causing lever *l* to contact with stop *s′* and break circuit of battery F; the direction of current over wires 7, 8, and magnet M, being indicated by arrows *y*. When wheels G, G′, contact respectively with rails R^6, R^{13}, and R^7, R^{14}, of section B, Fig. 2 and section of track A is clear, the current of batteries D, D′, D^2, D^3, flow over wire 2, rails R, wire 3, rails R^{14}, wheels G′, and axle *g′*, rail R^7 wire 13, resistance J, wire 14, magnet M′, wire 15, rail R^6, wheels G and axle *g*, rail R^{13}, wire 6, rails R′, and wire 1 also over wires 18, 19, 20, 21, and ground connections, E E′ causing lever *l′* to contact with stop s^2 and close circuit of battery F′ over incandescent lamp I′, the direction of current over wires 13, 14, resistance J, magnet M′ and wire 15 being indicated by arrows *x*. When the wheels G, G′, contact respectively with rails R^3, R^{10}, R^4, R^{11}, the current of batteries D, D′, D^2, D^3, will flow over wire 2, rails R, wires 3, 11, rails R^{10}, wheels G and axle *g*, rail R^3, wire 16, magnet M′, wire 17, rail R^4, wheels G′ and axle *g′*, wires 12, 6, rails R′ and wire 1 also over wires 18, 19, 20, 21, and ground connections E E′; the direction of current over wires 16, 17, and magnet M′ being indicated by arrows *y*.

The resistance of J can be low and its object is to cause the helices m^2, m^3, to be principally energized by the battery current flowing over rails R^3, R^{10}, R^4, R^{11}, when the wheels of a locomotive contact with them and while the wheels of a portion of train are still moving over and contact with rails R^6, R^{13}, R^7, R^{14} thereby causing lever *l′* to move from stop s^2 to stop s^3 and break the signal circuit of battery F′ which previously was closed when wheels of locomotive first contacted with rails R^6, R^{13}, R^7, R^{14}, there being no longer any necessity for a signal being given when locomotive reaches rails R^3, R^{10}, R^4, R^{11}.

The helices m^2, m^3, of magnet M′, Fig. 2 when energized will not only be in a complete metallic circuit embracing batteries D D′, D^2, D^3, and both lines of rails R R′ of section A, but each helix or wire coil will also be in an independent ground circuit: one ground circuit consisting of ground connections, E, batteries D D′, rails, R, insulated rail, R^{14}, wheels G′ and axle *g′*, insulated rail R^7 helix or coil, m^2, and ground connection E′. The other ground circuit consisting of ground connection E′, helix or coil m^3, insulated rail R^6 wheels G and axle *g*, insulated rail R^{13}, line of rails R′ batteries D^2 D^3 and ground connection E.

The helices *m*, *m′*, of magnet M, when connected with locomotive as shown in Fig. 4 and employed in connection with track circuit shown in Fig. 2, will not only be in a complete metallic circuit embracing batteries D, D′, D^2, D^3, and both lines of rails R, R′, of section A, but each helix or wire coil will be in an independent ground circuit; one ground circuit consisting of ground connection E, batteries D, D′, rails R, insulated rail R^{14}, wheels G′, wire 8, helix *m*, wire 10, thence to ground connection E^2 via locomotive, rails R^{12}, R^9, and batteries D^6, D^7. The other ground circuit will consist of ground connection E^2, batteries D^4, D^5, rails R^2, R^5, and locomotive to wire 9, helix *m′*, wire 7, wheels G, insulated rail R^{13}, wire 6, rails R′, batteries D^2, D^3, and ground connection E. It will be observed that current of batteries D^4, D^5, D^6, D^7, will be shunted by wheels and axles of locomotive when they occupy rails R^5, R^{12}, or R^2, R^9, and wheels G, G′, contact with rails R^{13}, R^{14}, or R^{10}, R^{11}. With such ground circuits the resistance and retardation offered to the battery current will be greatly reduced, and consequently the current flow between the rails via the intervening wooden ties and ballast, also between the rails and earth, and vice versa, will be reduced to a minimum, so that the rails may be used for longer signal circuits than is possible with the ordinary track circuit.

Resistance H in Fig. 1 is in a constant closed circuit consisting of batteries D′, D^2, rails R, R′ of section A and wires 1, 2, 3, 4, 5 and 6 and when magnet M upon locomotive is energized it is in multiple with said resistance. Resistance H′ in Fig. 2 is normally in a closed circuit consisting of batteries D, D′, D^2, D^3, rails R, R′ of section A, lever *l′* and stop s^3 of magnet M′ and wires 1, 2, 3, 6, 24, 25 and 26, and when magnet M′ is energized by current of said batteries flowing over wires 13, 14, 15 and resistance J and lever *l′* contacts with stop s^2 the said resistance is then upon an open circuit, the object of which is to enable magnets M′ and M to be then fully energized in multiple with each other. Wire 9 or 10, 18 or 19, 20 or 21 and 22 or 23 can be dispensed with and still a ground circuit formed for either of helices m^2, m^3 of magnet M′ and either of helices *m*, *m′* of magnet M. Magnet M′ can in some

cases be operated by reverse currents solely upon a metallic circuit by dispensing with ground connections E, E′.

I do not confine myself to the operation of the controlling magnet on the locomotive or other portion of the rolling equipment in a shunt with controlling magnet on the permanent way, Fig. 1 or 2, as it can be operated independently thereof, in connection with either partial circuit on the permanent way, having generator, shown in said figures.

I do not confine myself to the circuit reversing devices shown and described for operating polarized magnet M upon the locomotive or car by reverse currents in connection with rails of section of track A, since one of the features of my invention consists broadly in operating said magnet directly by reverse currents from a battery or generator on the permanent way and over a track circuit closer formed of wheels and axles and rail sections which succeed one another but with which said wheels and axles coöperate to properly complete the circuit because of the fact that they form portions of the rolling equipment that are insulated from one another because they belong to different trucks.

It is also to be understood that my invention is not limited to operation of magnets for signaling on railways, but that said magnets may be employed for any other purpose, or in any other manner in connection with the control or government of the movement of the rolling equipment of a railway. Wires 3, 6, 11 and 12, Fig. 1, can also be respectively connected with insulated rails R^7, R^6, R^4, and R^3.

It will be obvious further that the four or eight rails and the two sets of wheels and axles coöperating therewith might be used as a current reverser or pole changer for causing the current of a battery on the partial circuit of which the wheels or axles form the poles, to flow alternately in opposite directions over the circuit to which the four or eight rails successively engaged thereby are connected.

It is also obvious that the four rails R^7, R^{14}, R^6, R^{13}, and the two sets of wheels and axles coöperating therewith can be used as a circuit closer, either with a polarized or ordinary relay or electromagnet upon the rolling equipment or permanent way.

Each of the ground connections, E, E′, E^2, in Fig. 2, can consist of a suitable number of iron pipes or other metallic bodies driven well into or buried in the earth and to which wires e' are connected at intervals, and thereby constitute ground connections of high efficiency.

Resistance H, Fig. 1 and H′ Fig. 2 can be dispensed with by supplying a number of track sections from the same electrical generator or source. By employing in place of magnet M′ Fig. 2 a differential wound magnet with two sets of coils of different resistances, and connecting the lower resistance coils with rails R^3, R^4, and the higher resistance coils with rails R^6, R^7, the resistance J can be dispensed with.

What I claim as my invention is:

1. In a railway signal apparatus the combination with a partial circuit upon the permanent way consisting of four insulated rails or short sections of rails of railway track following one another, to which the two poles of a generator are reversely connected, of a partial circuit upon the rolling equipment consisting of a signal controlling polarized relay or magnet which terminates in wheels of the rolling equipment, insulated from each other in said equipment, so that when said rails are successively bridged by said wheels the said relay will be energized first by current flowing in one direction and then by current flowing in the opposite direction substantially as shown and described.

2. In a railway signal apparatus, the combination with a partial circuit upon the permanent way consisting of four insulated rails or short sections of rails of railway track following one another, to which the two lines of rails of a track section having a generator at one end thereof are reversely connected, of a partial circuit upon the rolling equipment consisting of a signal controlling polarized relay or magnet which terminates in wheels of the rolling equipment, insulated from each other in said equipment so that when said rails are successively bridged by said wheels the said relay will be energized first by current flowing in one direction and then by current flowing in the opposite direction substantially as shown and described.

3. In a railway signal apparatus, the combination with a partial circuit upon the permanent way, consisting of four insulated rails or short sections of rails of railway track, following one another in the same line of rails, to which the two poles of a generator are reversely connected, of another partial circuit upon the permanent way consisting of a signal controlling polarized relay or magnet which terminates in four insulated rails or short sections of rails following one another in the opposite line of rails so that when the said rails are successively bridged by the wheels and axles of a locomotive or train, the said relay or magnet will be energized first by the current flowing in one direction and then by current flowing in the opposite direction, substantially as shown and described.

4. In a railway signal apparatus, the combination with a partial circuit upon the permanent way, consisting of four insulated rails or short sections of rails of railway track following one another in the same line of rails to which the two lines of rails of a block section having a generator at one end thereof are reversely connected, of another partial circuit upon the permanent way consisting of a signal controlling polarized relay or magnet which terminates in four insulated rails or short sections of rails following one another in the opposite line of rails so that when the said rails are successively bridged by the wheels of a locomotive or train, the said relay or magnet will be energized first by current flowing in one direction and then by current flowing in the opposite direction, substantially as shown and described.

5. In a railway signal apparatus, the combination with a partial circuit upon the permanent way consisting of four insulated rails or short sections of rails, in two or all of which the two poles of a generator terminate, of a partial circuit upon the rolling equipment consisting of a signal controlling relay or magnet which terminates in wheels of the rolling equipment belonging to different trucks and hence are insulated from one another so that when said insulated rails are bridged by the said insulated wheels of different trucks the circuit will be completed substantially as shown and described.

6. In a railway signal apparatus, the combination with a partial circuit upon the permanent way consisting of four insulated rails or short sections of rails to two or all of which the two lines of rails of a track section having a generator at one end thereof are connected of a partial circuit upon the rolling equipment consisting of a signal controlling relay or magnet which terminates in wheels of the rolling equipment belonging to different trucks and hence are insulated from one another, so that when said insulated rails are simultaneously bridged by the said insulated wheels the circuit will be completed substantially as shown and described.

7. In a railway signal apparatus, the combination with a partial circuit upon the permanent way consisting of two insulated rails or short sections of rails following each other, in which the two poles of a generator terminate, of another partial circuit along the permanent way, consisting of a signal controlling relay or magnet terminating in two insulated rails or short sections of rails, following

each other in the opposite line of rails so that when all the said insulated rails or short sections of rails are simultaneously bridged by the wheels and axles of a locomotive or train the circuit will be completed substantially as shown and described.

8. In a railway signal apparatus, the combination with a partial circuit upon the permanent way consisting of a signal controlling relay or magnet terminating in two insulated rails or short sections of rails following each other of another partial circuit along the permanent way, consisting of two insulated rails or short sections of rails, following each other in an opposite line of rails and to which the two lines of rails of a block section, having a generator at one end thereof, are connected, so that when said rails or short sections of rails are simultaneously bridged by the wheels and axles of a locomotive or train the circuit will be completed substantially as shown and described.

9. In a railway signal apparatus the combination with a partial circuit upon the permanent way, consisting of four insulated rails or short sections of rails, in two or all of which the two poles of a sectional generator terminate, and ground connections taken from points between the sections of said generator, of a partial circuit upon the rolling equipment consisting of a signal controlling relay or magnet which terminates in wheels of the rolling equipment belonging to different trucks and hence are insulated from one another, and ground connections taken from points between coils of said magnet via locomotive and rails upon which it is then moving so that when said insulated rails are simultaneously bridged by the said insulated wheels, a complete metallic circuit and two independent ground circuits will be completed substantially as shown and described.

10. In a railway signal apparatus the combination with a partial circuit upon the permanent way consisting of four insulated rails or short sections of rails, to two or all of which the two lines of rails of a block section having a sectional generator are connected, and ground connections taken from points between the sections of said generator, of a partial circuit upon the rolling equipment consisting of a signal controlling relay or magnet which terminates in wheels of the rolling equipment belonging to different trucks and hence are insulated from one another, and ground connections taken from points between coils of said relay via the locomotive and rails upon which it is then moving, so that when said insulated rails are bridged by the said insulated wheels a complete metallic circuit and two independent ground circuits will be completed substantially as shown and described.

11. In a railway signal apparatus the combination with a partial circuit upon the permanent way consisting of two insulated rails or short sections of rails following one another in which two poles of a sectional generator terminate, and ground connections taken from points between the sections of said generator of another partial circuit along the permanent way, consisting of a signal controlling relay or magnet, terminating in two insulated rails or short sections of rails following one another in an opposite line of rails and ground connections taken from points between the coils of said relay or magnet, so that when all the said insulated rails or short sections of rails are simultaneously bridged by the wheels and axles of a locomotive or train, a complete metallic circuit and two independent ground circuits will be completed substantially as shown and described.

12. In a railway signal apparatus the combination with a partial circuit upon the permanent way consisting of two insulated rails or short sections of rails, to which two lines of rails of a block section having a sectional generator at one thereof are connected and ground connections taken from points between the sections of said generator, of another partial circuit along the permanent way, consisting of a signal controlling relay or magnet, terminating in two opposite insulated rails or short sections of rails and ground connections taken from points between the coils of said relay or magnet, so that when all the said insulated rails or short sections are simultaneously bridged by the wheels and axles of a locomotive or train, the circuits will be completed substantially as shown and described.

13. In a railway signal apparatus, the combination with a partial circuit upon the permanent way consisting of four insulated rails or short sections of rails, in two of which the two poles of a generator terminate of a partial circuit upon the rolling equipment consisting of a signal controlling relay or magnet which terminates in wheels of the rolling equipment and insulated from each other, so that when said insulated rails are simultaneously bridged by the said insulated wheels, the circuit will be completed substantially as shown and described.

14. In a railway signaling system the combination with a partial circuit along the permanent way consisting of two lines of rails of a track section having a generator connected therewith at one end thereof of a signal controlling relay or magnet along the permanent way having both its terminals normally disconnected from the opposite end thereof and means adapted for successively completing and breaking the circuit substantially as shown and described.

15. The combination substantially as described of four short sections of railway track following one another but connected reversely to the opposite poles of a circuit as described, and wheels of the rolling equipment coöperating therewith to form the elements of a current reverser, as and for the purpose described.

16. The combination substantially as described of four rails or rail sections insulated from one another and successively traversed by the wheels of the rolling equipment, a circuit having its poles connected to the first two and to the last two of said rails reversely as described, and wheels of the rolling-equipment belonging to different trucks and coöperating with said rails to form a pole changer or circuit reverser.

17. The combination substantially as described of a track circuit consisting of two lines of rails of a section of track, a battery or batteries or other suitable generator connected therewith, insulated rails or short track sections in another section of track, a polarized electromagnet, wheels and axles of the rolling equipment belonging to different trucks respectively and coöperating with said short rail sections as described to pass current directly from said generator to said magnet circuit first in one direction and then in the opposite direction.

18. In a railway signaling system the combination with a partial circuit along the permanent way consisting of two lines of rails of a track section having a sectional generator at one end thereof, with ground connections taken from points between the sections of generator, of a signal controlling relay along the permanent way having both its terminals normally disconnected at the opposite end thereof and ground connections taken from points between the coils of said relay and means adapted for successively completing and breaking the circuit substantially as shown and described.

19. The combination substantially as described of a relay or electromagnet upon the moving equipment and having its terminals connected with wheels and axles which belong to different trucks and are therefore insulated from one another, and ground connection from said magnet to the metal work of the locomotive so as to form ground connection via the rails, batteries and ground connection of the section of track over which the locomotive is moving.

20. The combination substantially as described, of an electromagnet on the moving equipment connected to wheels and axles belonging to different trucks which are insulated from one another in said rolling equipment, an independent ground connection from the circuit of said magnet over wheels and axles independent of those which form the terminals of the magnet circuit, insulated rails or short track sections adjacent to one another adapted to coöperate with the wheels and axles of the trucks insulated from one another to complete a metallic circuit from two or more batteries to said magnet, and intermediate ground connections taken from the circuit between said batteries, as and for the purpose described.

21. The combination substantially as described of two insulated short sections of railway track, following one

another, in each line of track rails, and opposite each other and to such two sections in one line of rails are connected the two poles of a primary circuit or generator as described, and insulated wheels of the rolling equipment coöperating therewith to form the elements of a circuit closer.

22. In a railway signal apparatus the combination with a normally closed circuit consisting of two lines of rails of a track section having a generator connected therewith at one end and a resistance at the other end thereof, of a circuit controller operating to successively open and close the circuit through the said resistance substantially as shown and described.

23. In a railway signal apparatus, the combination with a normally closed circuit consisting of two lines of rails of a track section having a generator connected at one end and a resistance at the other end thereof, of a circuit controller under the control of a locomotive or train for successively opening and closing the circuit through said resistance substantially as shown and described.

24. In a railway signal apparatus, the combination of a partial circuit on the rolling equipment containing a signal controlling polarized relay or magnet and terminating in the wheels of different trucks of the rolling equipment, insulated from one another, a partial circuit on the permanent way consisting of a signal controlling polarized relay or magnet terminating in four insulated rails or short sections of rails following one another and a partial circuit on the permanent way, consisting of two lines of rails of a track section having a generator at one end and reversely connected at the opposite end with four insulated rails or short sections of rails, following one another, so that when the said insulated rails are successively bridged by said wheels, both relays or magnets will be energized, first by current flowing over them in one direction and then in the opposite direction substantially as shown and described.

25. In a railway signal apparatus the combination of a partial circuit on the rolling equipment containing magnet coils of a signal controlling polarized relay or magnet and terminating in the wheels of different trucks of the rolling equipment, insulated from one another, independent connections between said coils with the locomotive, a partial circuit on the permanent way consisting of the magnet coils of a polarized relay or magnet terminating in four insulated rails or short sections of rails, following one another, independent connections between said coils with ground connections, and a partial circuit on the permanent way consisting of two lines of rails of a track section having a sectional generator at one end and reversely connected at the other end with four insulated rails or short sections of rails, ground connections from points taken from between the sections of generator, and a partial circuit consisting of the two lines of rails of the preceding track section having a sectional generator at one end and ground connections taken from between the sections of generator, so that when the said insulated rails are successively bridged by said wheels, both relays or magnets will be energized, first by current flowing over them in one direction and then in the opposite direction substantially as shown and described.

Signed at New York, in the county of New York and State of New York, this 19th day of September, A. D. 1902.

HENRY W. SPANG.

Witnesses:
J. GALLWITZ,
E. L. LAWLER.