No. 879,494.

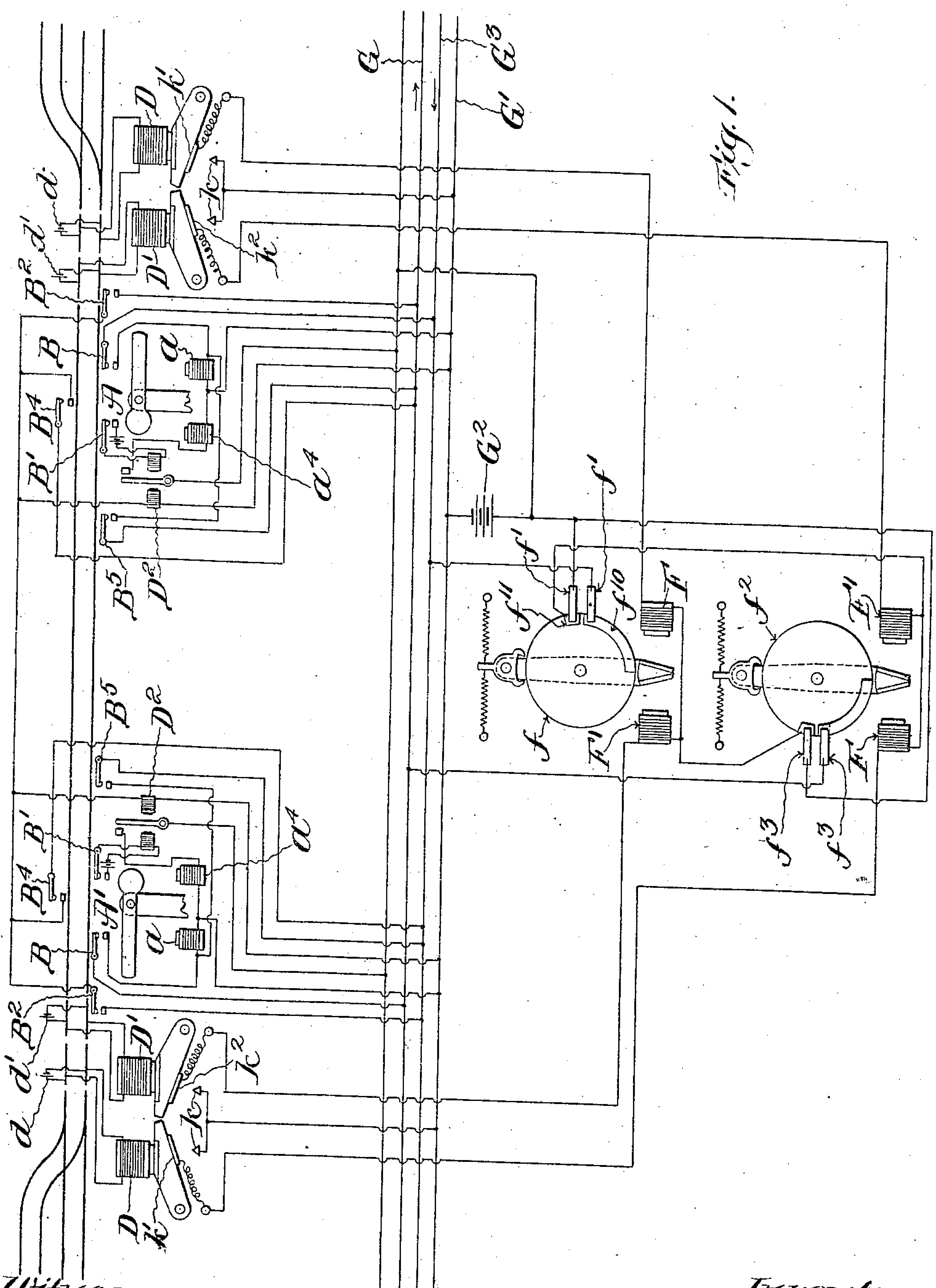
PATENTED FEB. 18, 1908.

B. C. ROWELL.

TRAIN PROTECTION FOR RAILWAYS.

APPLICATION FILED FEB. 13, 1899.

6 SHEETS—SHEET 1.



Witnesses:

Arthur E. Randall

John R. Snow

Inventor:

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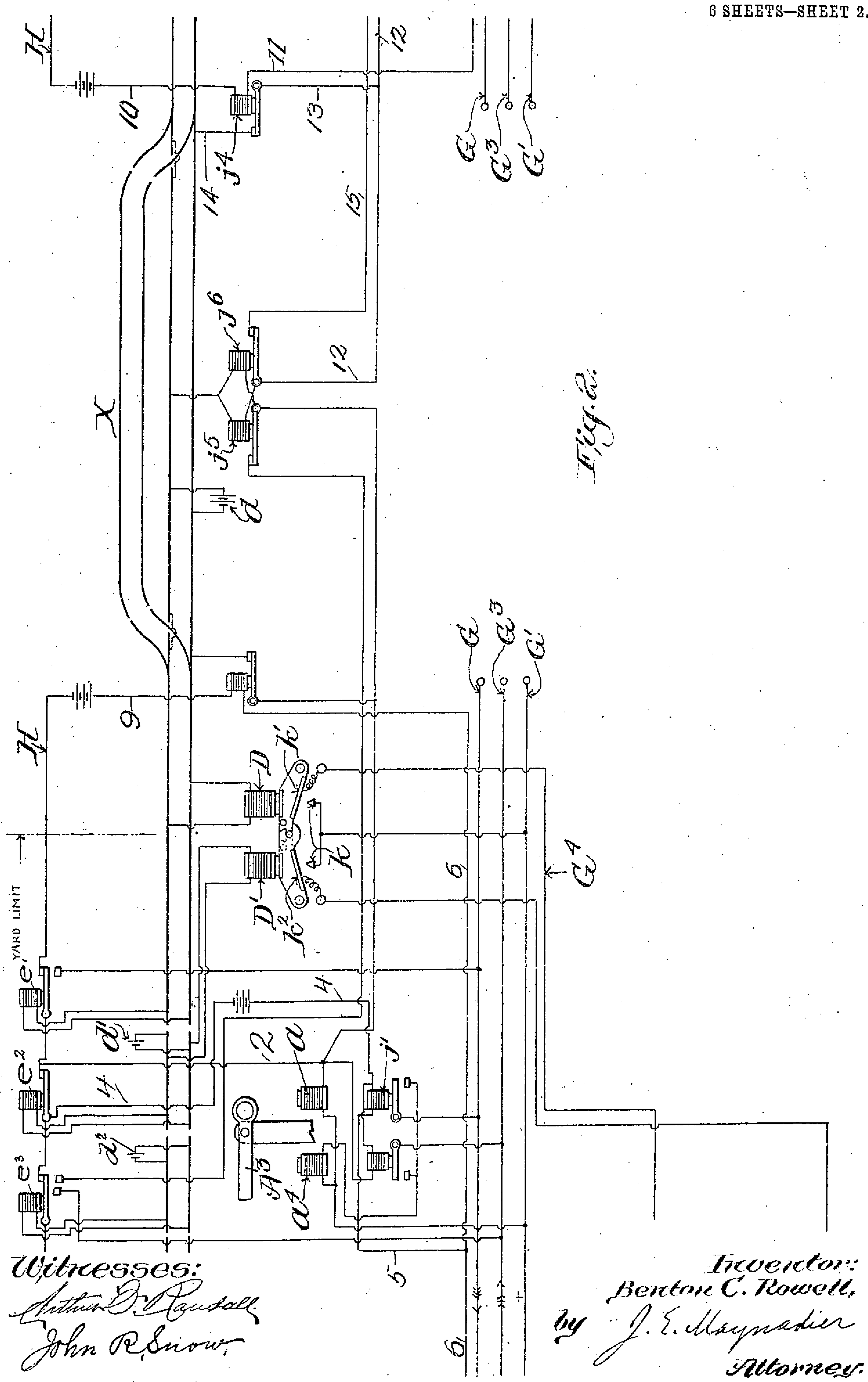

Fig. 2.

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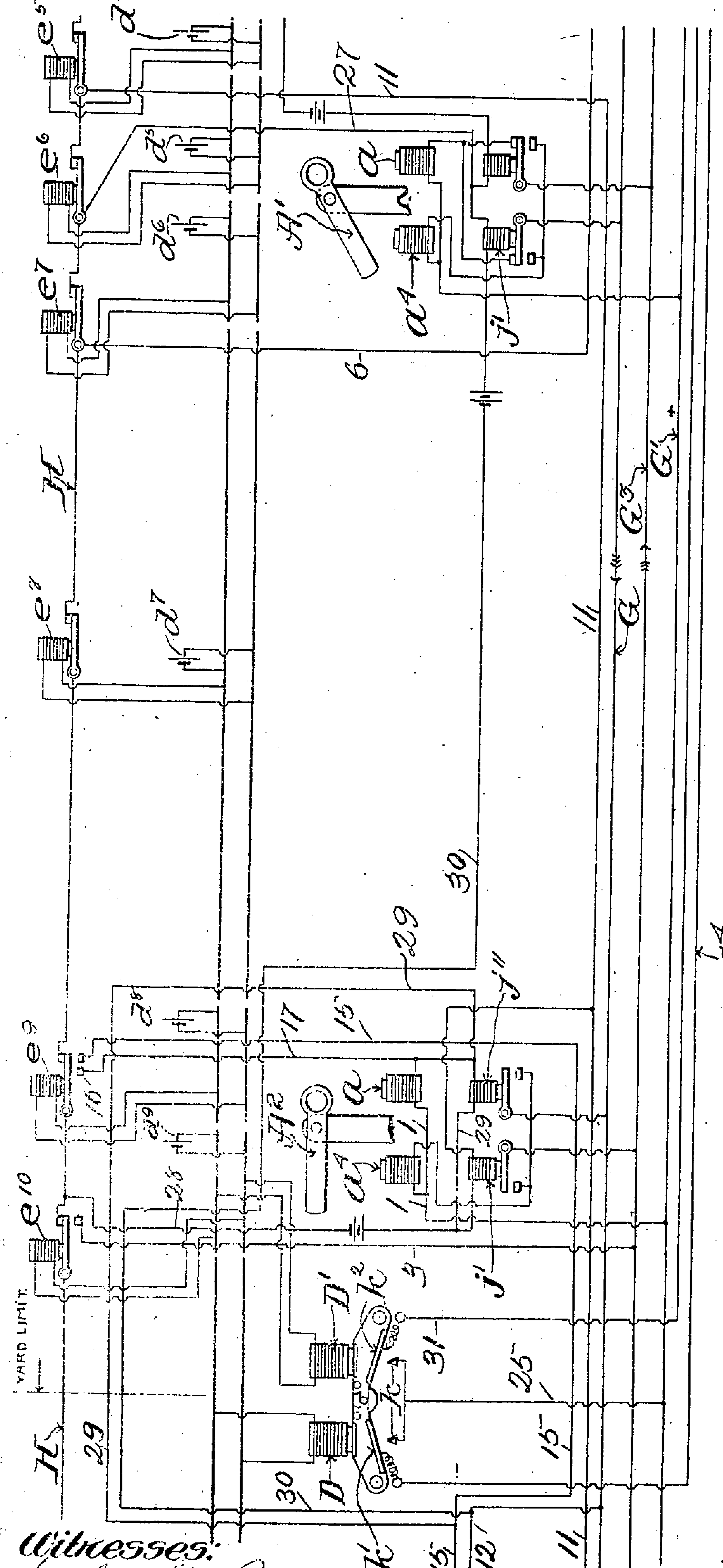

Fig. 2a

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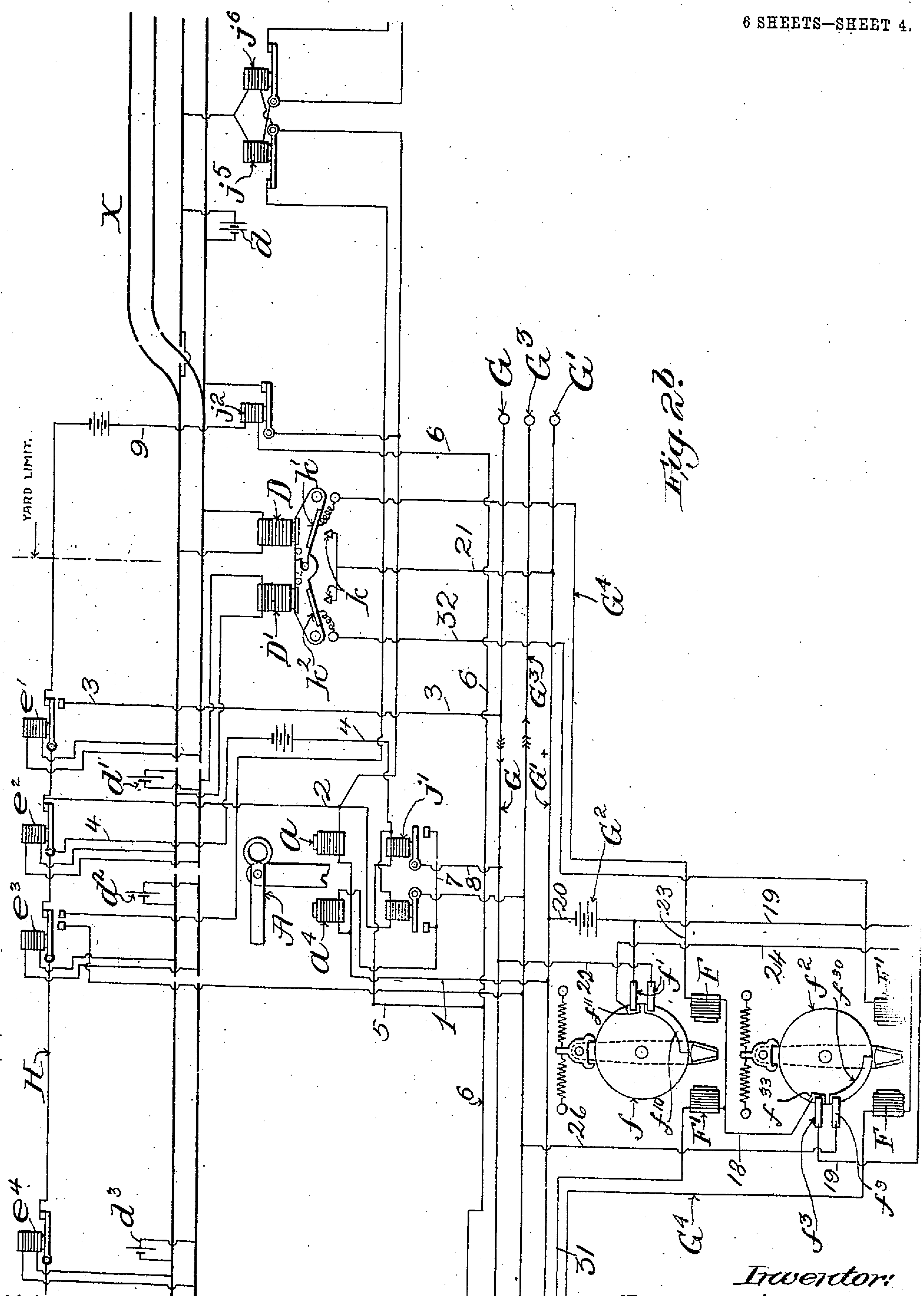

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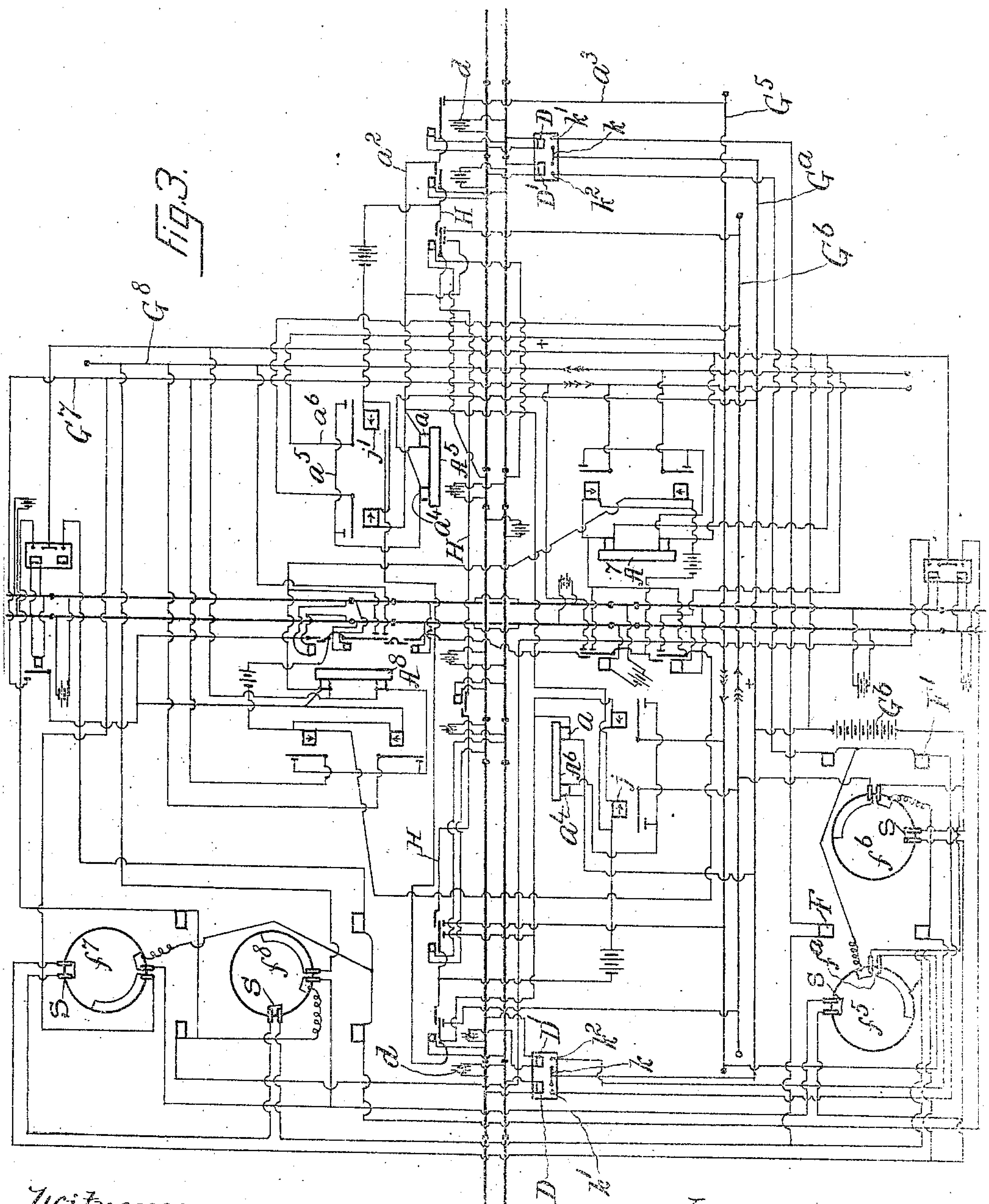

Fig. 3.

Witnesses:

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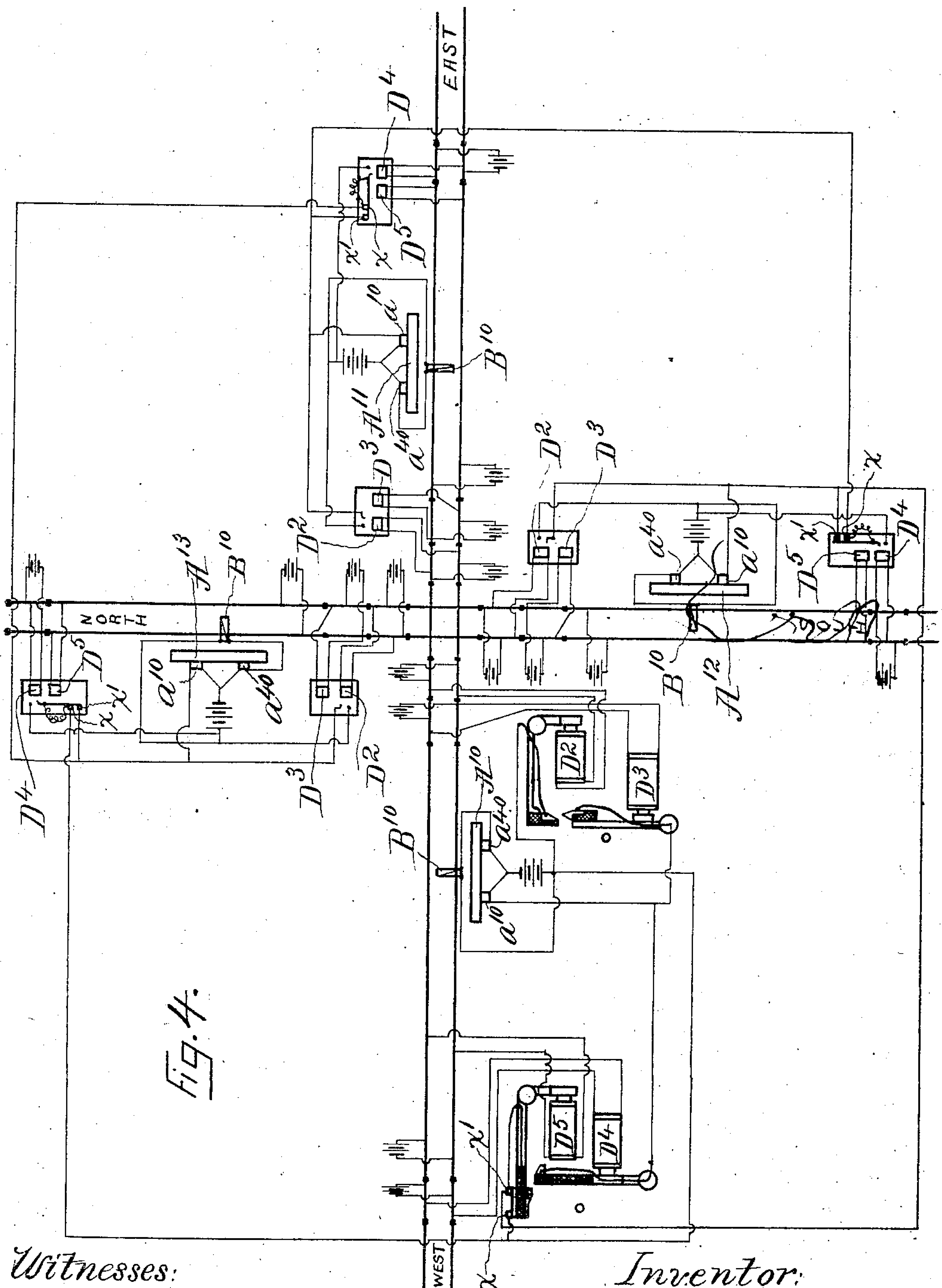
6 SHEETS—SHEET 6.



Witnesses:
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Wm Magruder

Inventor:
Benton C. Rowell
By [signature] Attorney.

UNITED STATES PATENT OFFICE.

BENTON C. ROWELL, OF CHICAGO, ILLINOIS, ASSIGNOR TO ROWELL POTTER SAFETY STOP COMPANY, OF PORTLAND, MAINE, A CORPORATION OF MAINE.

TRAIN PROTECTION FOR RAILWAYS.

No. 879,494. Specification of Letters Patent. Patented Feb. 18, 1908.

Application filed February 13, 1899. Serial No. 705,435.

To all whom it may concern:

Be it known that I, BENTON C. ROWELL, of Chicago, in the county of Cook and State of Illinois, have invented a new and useful System of Train Protection for Railways, of which the following is a specification, reference being had to the accompanying drawings, in which—

Figure 1 is a diagram illustrating the simplest form of my system; Figs. 2, 2^a and 2^b are a diagram illustrating the preferred form of my system, this diagram being continued from sheet to sheet in order to clearly show its working; Fig. 3 is a diagram illustrating the application of my system at a grade crossing; Fig. 4 is a diagram illustrating a simpler form of the application of my system to a grade corssing.

My system is designed to make it impossible for one railway train to come into contact with another, and while many systems have heretofore been devised intended to accomplish that result, I am the first to devise a block system comprising two or more signals, automatic appliances for shifting each to safety, and means connecting the automatic safety shifting appliance such that when a train in the proper direction controls one of them, no other train can operate any conflicting or opposing signals. By "signals" I mean blocking appliances which either warn the engineer to stop the train, or which automatically stop the train, including audible and visible signals, as well as apparatuses which automatically apply the brakes, or derail the train.

Fig. 1 is a diagram of a system embodying my new principle, which I will now explain more fully, together with the best mode which I have contemplated applying that principle, for although I have contemplated mechanical means, and compressed air means, yet electrical means are much simpler and in other respects preferable. The blocking appliances A and A′ are at danger except when shifted to safety by a train about to pass one of them, and the means by which a train with the right of way nearing signal A, shifts signal A from danger to safety in order that it may pass, and back to danger in passing, also operates automatically to make it impossible for a too closely following train to shift that signal from danger to safety; and also to make it impossible for an opposing train to shift signal A′ from danger to safety. A train running towards signal A from the right will short circuit battery d, cause armature of magnet D to connect k and k', and complete the circuit through magnet F of disk f and move disk f one step.

The circuit of battery d is completed by the wires from the poles of battery d to the tracks, and by the wires from the tracks to the coil of magnet D, but when the wheel and axle of a train extends across the tracks near battery d, the current of that battery flows mainly through the wheels and axles, and the current through the coil of magnet D becomes so small that the armature of magnet D drops, and k' makes contact with k. The circuit through magnet F is completed from battery G^2 through wire G', through the wire from G' to k, through the wire from k' to the coil of F, through coil of F and the wire from that coil to f^3 and through the wire from f^3 to battery G^2. This motion of disk f one step, caused by energizing magnet F, causes connecting strip f^{10} to bridge the fingers f', and also carries strip f^{11} clear of its finger f'.

Connecting fingers f' partially completes the safety circuit, for trains running from right to left, over the section of track shown in Fig. 1, and disconnecting strip f^{11} from its finger f' breaks the circuit of magnet F of disk f^2 which circuit includes k k' to the left of Fig. 1, and controlled by trains running from left to right. One of these safety circuits which is partially completed by connecting fingers f' is from battery G^2 through the wire to upper f', through f^{10} to lower f', and through wire from lower f' to wire G^3, along G^3 to wire leading to switch B, and by switch B by wire to coil of magnet a, through that coil by wire to wire G', and along G' to battery G^2; and all the others can readily be traced from this one as an example. The circuit of magnet F of disk f^2 is from battery G^2 via f' f'' to F and from F to k' at the left of Fig. 1 and thence (when k k' at the left are closed) through wire connecting k with G' back to G^2. This train next short circuits battery d', and causes magnet D′ to drop its armature, but as that armature falls on the armature of magnet D, the switch k^2 k is not closed; moreover closing k^2 k would be idle if made while k' k is closed for the reason that closing k' k energizes magnet F of disk f and thereby opens switch f^1 f^{11} of disk f, and breaks the circuit at $f' f^{11}$ which should be closed at $k^2 k$ in order to energize magnet F′ of disk f^2. This circuit is through switch $k^2 k$, by wire connecting k with G′, by G′ through battery G^2, from G^2 through switch $f' f^{11}$ (when closed) by wire from f' through the coil of magnet F′ of disk f', and by wire from that coil back to switch $k^2 k$. This train from right to left next closes track switch B^2 of signal A but this is idle for one terminal of this switch B^2 connects with wire G and there is no current in wire G since the connection between $f^3 f^3$ cannot be completed while any train running from right to left occupies this section of track; and this track switch B^2 is idle except when operated by a train running over this section from left to right. This train from right to left next closes track switch B of signal A, and completes safety circuit through magnet a, of signal A, thereby shifting signal A from danger to safety. This is done by well known mechanism set in operation by energizing magnet a, one example of which is described in my Patent No. 671,032, dated April 2, 1901. This train from right to left next closes track switch B^4, but this is idle for one terminal of B^4 goes to G, which is dead when a train moving from right to left is on the section. This right to left train next closes track switch B′, and completes a local circuit through a magnet and causes the armature of that magnet to close danger circuit through danger magnet a^4 of signal A. When this danger circuit is thus closed danger magnet a^4 of signal A shifts signal A back to danger. That signal cannot be shifted to safety by a following train energizing safety magnet a, until the circuit through the danger magnet a^4 is broken by the energization of the releasing magnet D^2 of A through the subsequent closure of B^4 at A′ as hereinafter stated. The lower switch point of B^4 of A′ is connected through the coil of D^2 of A with G′, and the upper switch point of B^4 of A′ is connected with G^3 so that when switch B^4 of A′ is closed magnet D^2 of A is energized. This circuit through danger magnet a^4 of signal A, Fig. 1, is through battery G^2, wire G′ to wire connecting coil of a^4 with G′, coil of a^4, wire leading to the switch whose moving member is the armature of magnet D^2 of signal A, wire connecting that armature to the wire just above wire G, in Fig. 1, which is a wire connecting the like terminals of the coils of magnets a^4 of signal A, and of signal A′, Fig. 1, back to battery G^2. This right to left train next closes track switch B^5, but idly for one terminal of B^5 connects with wire G, which is dead until a train from left to right has entered the section and connected right bound wire G with battery G^2; that is so long as any train from right to left has control of the section by connecting its left bound wire G^3 with battery G^2, no train entering the section from left to right can make connection between right bound wire G and battery G^2. This right to left, or left bound, train closes track switch B^5 of signal A′, and shifts that signal to safety, by energizing safety magnet a of signal A′.

The circuit completed by closing B^5 of A′ is by wire leading from the movable member of B^5 to wire G^3, and by wire leading through magnet a from the stationary member of B^5 to wire G′, for wires G′ and G^3 are then in electrical connection with battery G^2 by reason of f^{10} bridging fingers f', as already explained. The circuits of the danger magnets a^4 are closed by the track switches B′, which when closed complete each a local circuit through a magnet and cause the armatures of those magnets to close each a circuit through magnets a^4, for the wires of these danger circuits through magnets a^4 connect one with the wire G′ and the other with the upper wire not lettered but shown in Fig. 1 as parallel with the wires G, G^3 and G′, and which is electrically the same as wire G^3, so far as its use with the danger magnets a^4 of Fig. 1 is concerned being connected with G^2 as indicated at the left of Fig. 1.

The circuit through D^2 of signal A is not made when a left bound train closes track switch B^4 of signal A for the reason that one terminal of the wire leading from the movable member of B^4 connects with wire G which is dead while a left bound train is in the block shown in Fig. 1; but when B^4 of signal A′ is closed a circuit from battery G^2 is completed through wire G′, wire from G′ through D^2 of A to stationary member of B^4 of A′ through movable member of B^4, by wire to G^3, and from G^3 to battery G^2 as already explained. The armature between the magnet D^2 and the magnet in the local circuit of B′ remains inert and must be moved back by relieving magnet D^2, in order to break the circuit through danger magnet a^4. This left bound train next closes track switch B′ of signal A′, and thereby energizes danger magnet a^4 of signal A^1, as before described with reference to danger magnet a^4 of signal A. This left bound train next closes track switch B^4, of signal A′, and completes a circuit through relieving magnet D^2, of signal A, causing magnet D^2 of signal A to attract its armature and break the circuit of danger magnet a^4 of signal A, which allows a following left bound train to shift signal A from danger to safety; for the magnets a and a^4 of each signal, are so connected that a current through one of them will be idle, if there then be a current through the other; as will be clear on reference to my Patent, No. 671,032, dated April 2, 1901.

The circuit through relieving magnet D^2 of signal A is from battery G^2, wire G^1, wire connecting G′ to coil of D^2 of signal A, wire connecting that coil with switch B^4, wire connecting B^4 with wire G^3, wire connecting wire G^3 with lower f', bridge f^{10} and upper f' back to battery G^2. The first left bound train next closes track switch B of signal A^1 but idly, for one terminal of switch B goes to wire G, which is then dead as before explained. This left bound train next closes track switch B^2 of signal A^1, and completes a circuit through relieving magnet D^2 of danger magnet a^4 of signal A^1, thus leaving signal A' under control of the following left bound train, as the first left bound train is now nearing the turnout on the left of this section. The circuit through the relieving magnet D^2 of danger magnet a^4 of signal A^1, is much the same as just described; that is from battery G^2, wire G', wire connecting G' with coil of D^2 of signal A', wire connecting that coil with switch B^2, wire connecting B^2 with G^3 and back to battery G^2 as before. This first left bound train next short circuits battery d' at the left of this section and thereby connects k and k^2 and closes a circuit through magnet F' of disk f, which causes disk f to move back one step. This back motion one step of disk f returns that disk to its position shown in Fig. 1, if there be no other left bound train then on the section; but in case a second left bound train has entered the section and turned disk f a second step, the first left bound train will as it leaves the section turn disk f back one step, and the second left bound train, as it leaves the section will turn disk f back the second step, and leave disk f in the position shown in Fig. 1. This circuit through magnet F' of disk f is through battery G^2, wire G' to wire connecting G' and k, k^2 and wire connecting k^2 with coil of F', that coil and wire connecting it with upper f^3, and wire from upper f^3 back to battery G^2.

The first left bound train as it leaves the section short circuits battery d at the left of the section, but does not thereby connect k and k', for when battery d' is short circuited before battery d is short circuited the armature of magnet D cannot connect k and k', for although that armature is no longer held away from k by magnet D, it is held away from k by the fallen armature of magnet D'.

A train entering the section shown in Fig. 1 from the left first moves disk f^2 one step, just as the train entering from the right first moves disk f one step. In short the detailed description already given as to a train running from right to left over the section shown in Fig. 1, applies, *mutatis mutandis*, to a train running over the section shown in Fig. 1 from left to right.

In Fig. 1, signal A, track switch B, operative to shift signal A from danger to safety only by trains from right to left, and track switch B^5, operative to shift signal A from danger to safety only by trains from left to right, embody one feature of my invention, and this is also true of signal A' and its track switches B and B^5, one at one side the other at the other side of signal A'; and this feature may be regarded as the unit of my invention; for these signals might return to danger by gravity. These two units in combination embody my invention in its best form. It will now be plain also that a train from right to left must move disk f in a direction to close one switch and open the other and next move disk f in a direction to open one and close the other, and cannot move disk f^2 at all; while a train running from left to right must move disk f^2 in a direction to close one and open the other and next move disk f^2 in a direction to open one and close the other, and cannot move disk f at all. This apparatus, so far as it is in effect a signal which indicates not only the presence of a train, but also in which direction that train is running, forms the subject of my Patent 695649, dated March 18, 1902.

This simplest mode of applying my new principle requires that the engineer shall pay regard to the signals; and in order to apply my principle in such a manner that even runaway engines on a single track whether in opposite directions or one following another cannot meet, I use as that blocking appliance the well known safety stop, which when at danger automatically applies the brakes, or some form of derailing apparatus and means by which each train in shifting such a signal from danger to safety renders inoperative not only the means by which the signals immediately in its rear and front can be shifted from danger to safety; but also the means by which the second signal in its rear and front can be so shifted, the vital point being that one danger signal at least must always be between two opposing trains, and one danger signal at least must always be between any train and a following train, even if all danger signals be disobeyed, as in the case of runaway trains.

This mode of applying my new principle is fully shown in the diagram Figs. 2, 2^a and 2^b in which A A' and A^2 are blocking appliances which cannot be passed when at danger. A left bound train with the right of way nearing signal A (Fig. 2^b) short circuits track battery d, and thereby cuts off current from magnet D, when its armature drops and takes its place in readiness to complete a circuit through magnet F by wire G^4 and main battery G^2. As the left bound train runs on toward signal A it short circuits track battery d' and cuts off current from magnet D' whose armature drops and allows the armature of D to complete the circuit through magnet F of disk f. This circuit through magnet F of disk f is the disk operating circuit for left bound entering trains and is traced as follows: from k' through wire G^4 to F, wire 18 to f^{33} of disk f^2 f^3; wire 19 to battery G^2; wire

20; wire G′ and wire 21 to k. When energized, magnet F rotates disk f one step, and thereby causes f^{10} to connect points f' f', which connects left bound wire G with the plus wire G′ of the main battery G^2, through the following circuit:—from left bound wire G through wire 22 to lower f', f^{10}: upper f'; wire 23; wire 19; battery G^2; and wire 20 to plus wire G′. This connection so far completes all the left bound safety circuits that they are ready for operation when fully completed by the passage of the left bound trains.

It will be seen that the armatures of magnets D and D′, Fig. 2^b, are so connected that neither armature can fully fall until both magnets are short circuited, and that k and k' are not in contact until both D and D′ are short circuited.

The movement of disk f one step as described breaks that circuit through which right bound trains move disk f^2 step by step, by the disconnection of upper f' and f^{11} of disk f. This circuit through which right bound entering trains operate disk f^2 is controlled by the magnets D D′ of Fig. 2^a and is traced as follows:—from k' of Fig. 2^a via wire G^4 to F of disk f^2; wire 24; contacts f^{11} and f' (when closed); wires 23 and 19 to battery G^2; wire 20 to wire G′; and thence through wire 25 to k. This is the disk operating circuit for right bound entering trains and like the disk operating circuit for the left bound entering trains above described serves to prepare the signal operating circuits for operation by the right bound trains as the latter traverse the section by connecting wire G^3 with plus wire G′ through wire 26; contacts f^3 f^3 (when connected by f^{30}; wire 19; battery G^2 and wire 20 to plus wire G′. This connection so far completes all the right bound signal operating circuits that they are ready for operation when fully completed by the passage of the right bound train. But of course no entering right bound train can control its disk operating circuit, after disk f has been moved by the presence of a left bound train near signal A, because of the break at f' f^{11}, and the left bound train is thus secure against head on collision as soon as it has made preparations for shifting signal A to safety; and the left bound train cannot make those preparations if a right bound train has completed its preparations to enter that section, because of the break made at f^3 f^{33} in the left bound trains disk operating circuit.

It will now be plain that head on collisions are imposible with a block system embodying my new principle; for even in the almost impossible contingency of completing the circuit through magnet F of the left bound train at the same instant that it is completed through magnet F of the right bound train the only result will be that neither train can complete its preparations for traveling over the section and both will be blocked; and in that case (which will happen rarely, if ever) both trains (if not runaway) will back on to the nearest turnout, and one will thereby give the other the right of way, for as neither disk was moved one full step, one of them will return to its normal position (that shown in Fig. 2^b) as soon as the train controlling it has backed far enough; and the return of either disk to its normal position will give safety to the other train; for the disk f or f^2 of the train which had not backed far enough to break the circuit through magnet D^1 will be moved one full step as soon as the disk of the other train returned to its normal position; and its safety circuit will be completed, as described below, through the safety magnet a of its signal, which will shift its signal to safety. The left bound safety circuits are from plus wire G′ through wire I, safety magnet a, and wire 2, to the track wire H, and from the track wire by wire 3 to wire G; and the right bound safety circuits are the same circuits are the same but from plus wire to right bound wire G^3; that is the wires 1, 2 and 3 connect wires G′ and G through safety magnet a of A, shown in Fig. 2^b, but connect wires G′ and G^3. The track wire is the usual track wire kept unbroken by relays e' e^2, etc. and track batteries d^2 d^3 etc. so long as the track relays are kept energized, but broken when these relays are demagnetized by short circuiting their batteries d^2 etc. as will be fully understood without description, for this is and has long been a matter familiar to all skilled in the art.

When the left bound entering train has completed its disk operating circuit through magnet F, by short circuiting the track batteries d d' it completes its safety circuit through safety magnet a of signal A; for when said batteries d d' are short circuited the armature of the line relay e' is dropped, and wire 3 (Fig. 2^b) is connected to line H and the safety circuit through a is complete. When this circuit is completed signal A shifts from danger to safety and the left bound train passes it, and in passing short circuits the track battery d^2.

As soon as the left bound train has short circuited track battery d^2 relay e^3 drops its armature and the circuit through magnet j' is broken. This circuit which remains broken so long as track wire H is broken by the running of the train from signal A to A′, and until the train has passed track battery d^6 at signal A′, is from track wire H by wire 4, local battery in wire 4, magnet j', and from magnet j' by wires 5 and 6 to the left back to track wire H at relay e^7 whose magnet is energized by track battery d^6. The result of breaking this circuit of magnet j' is that the armature of magnet j' drops and completes the danger circuit through danger magnet a^4 of signal A. This danger circuit is from wire G′ through wire I, magnet a^4, wire 7, armature of magnet j' and wire 8 to wire G; and as long as that circuit remains complete a following train cannot shift signal A from danger to safety; for even if a following train should get to A before the preceding left bound train has passed A′, and complete its safety circuit (through magnet a of signal A) that magnet could not overcome the danger magnet a^4, while its circuit G′, I, a^4, 7, 8 and G, was unbroken; and signal A would remain at danger, and the following train would be stopped either by signal A, or else by its engineer, if he saw the semaphore, or other visible signal forming part of signal A, and obeyed that visible signal.

Signal A′, when used as shown in Fig. 2^a is normally at safety and the left bound train after passing it and battery d^6, restores the circuit through track wire H, wires 4, 5 and 6 and magnet j', and the lifting of the armature of magnet j' breaks the circuit through danger magnet a^4 of signal A, but of course, leaves that signal at danger, although a following train having the right of way can shift it to safety and pass it as before described. As the left bound train passes A′, of Fig. 2^a, it sets that signal to danger by breaking the circuit through magnet j' of signal A′, whose armature falls and makes the circuit through magnet a^4 of signal A′ and signal A′ remains at danger until the train has passed signal A^2.

The circuit of magnet j' at A′ is traced as follows:—from said magnet j' by wire 27 to wire H at a point between relays e^6 and e^7; wire H to wire 28 at A^2; wire 29; a magnet j^{11}; wires 2 and 15 to relay j^6 Fig. 2; wire 12 to wire 30 Fig. 2^a and back to magnet j' at A′. But as soon as the left bound train has passed relay e^7 the circuit made up of wires H, 4, 5, 6 and magnet j' of signal A is closed and magnet j' attracts its armature, and breaks the circuit through danger magnet a^4 of signal A, thereby giving right of way to a following train approaching signal A; and also when circuit H, 4, 5 and 6 through magnet j' of signal A is thus restored a circuit through magnet j^2, Fig. 2^b, is completed through wires H, 6 and 9 and energizing magnet j^2 gives right of way to a left bound train which has one danger signal to pass before it can travel over the section of track between signal A and that preceding danger signal. Thus while a left bound train which has passed signal A is traveling toward A′ it is protected from following trains by signal A, and also by the danger signal next in rear of A; but after it has got under protection of A′ and while traveling up to and past A^2 it is protected from following trains by A′ alone.

As the left bound train is about to pass signal A′, Fig. 2^a, it short circuits battery d^5 and opens relay e^6 and thereby breaks a circuit made up of track wire H, wire 10, containing a battery and magnet j^4 (Fig. 2) and wire 11 back to wire H at relay e^5 on the right of Fig. 2^a. On the breaking of this circuit the armature of magnet j^4 drops and breaks the circuit from one pole of battery d, Fig. 2, to upper rail, from the upper rail to magnet j^5, thence to armature of j^6, thence by wires 12 and 13 to armature of j^4, thence to the lower rail by wire 14 and through the lower rail back to battery d. When this circuit through magnet j^5, is thus broken magnet j^5 drops its armature and thereby breaks the circuit of which the armature of magnet j^5, is a part, and thereby prevents an opposing or right bound train from passing signal A^3, because the wires connecting with the armature of magnet j^5 are part of the circuit of safety magnet a of A^3 which therefore cannot be energized to shift signal A^3 to safety while its circuit is open at j^5. But if an opposing or right bound train should have passed signal A^3, Fig. 2, before the left bound train opens relay e^6 and breaks the circuit through magnet j^4 (namely the circuit H, 10 and 11, Figs. 2 and 2^a) the opposing right bound train will short circuit battery d of Fig. 2 and demagnetize magnets j^5 and j^6 whose armature will drop, and the dropping of the armature of magnet j^6 will break the circuit of magnet j' of signal A′, and through the fall of the armature of magnet j' shift A′ to danger, so that the left bound train, then between A, Fig. 2^b, and A′, Fig. 2^a, cannot pass A′. Moreover when the armature of magnet j^6 drops it simultaneously breaks a circuit of which the armature of j^6 is a part, and which must be restored before a left bound train can shift signal A^2, Fig. 2^a, to safety. This circuit is made up of wire 15 of Figs. 2 and 2^a, switch 16 wire 17, coils of magnet a of signal A^2 (Fig. 2^a) and wire 1 to wire G′; and on the other side of j^6 wire 12 of Figs. 2 and 2^a, to wire G; wires G and G′ being connected through disk f as above described.

When the siding or turn out X is electrically clear of the main line as shown in Fig. 2^b a train on that turn out cannot short circuit battery d, and is precisely as if it were not present, but after the left bound train has shifted A^2 of Fig. 2^a to safety and passed that signal and shifted it back to danger, as already fully described with regard to signal A of Fig. 2^b, it will if it runs over the main line past turn out X, Fig. 2, short circuit battery d, and drop armature of j^5 and j^6, and A′ of Fig. 2^a will remain at danger until the left bound train has passed signal A^3 of Fig. 2. The left bound train after passing signal A^2 first demagnetizes "out" magnet D′, and next "in" magnet D of Fig. 2^a, (reversing its operation on entering the section shown in Fig. 2^b) and thereby moves disk f back one step. This operation of magnets D′, D in the order named causes the armature of D′ to be freed first and then when the armature of D falls, k^2 contacts with k and closes a circuit through magnet F′ of disk f which effects the return of disk f and this circuit is traced as follows:—from contact k^2 by wire 31 to magnet F′ and thence by wire 18, contacts f^{33} and f^3, wire 19, battery G^2, wire 20, wire G′ and wire 25 to k. This circuit is the disk operating circuit for outgoing left bound trains. The disk operating circuit for out going right bound trains is as follows:—from k^2 of Fig. 2^b, by wire 32 to magnet F′ of disks f^2; wire 24 contacts f', f^{11} (when together) wires 23 and 19, battery G^2 and wires 20, G′ and 21 to contact k. If no following train enter the section before the left bound train counts out by moving disk f back one step, as just described, then all the conditions will be as shown in Figs. 2, 2^a and 2^b; but if a following train has entered the section before the first left bound train has left it will move disk f a second step, and disk f will not be brought back to its normal position until the second train has counted out, and so as to any number of left bound trains. This enables any desired number of trains to run in one direction on a section before an opposing train can enter that section; that is if two, three, four or more trains enter a section successively on the right, disk f will be moved two, three, four or more steps in one direction, and each of these trains must leave that section in order to bring disk f back to a position which will enable an opposing train to get a clear signal.

What has been said as to left bound trains is applicable to right bound trains, *mutatis mutandis*, as will be obvious.

It will now be clear that in this mode of applying my new principle, there is, under all circumstances at least one danger signal between any train running on the single track, and any other train running on that track, whether opposing or following; and that each of these danger signals operates both as a head blocking appliance and a rear blocking appliance, and both directions; but while this mode of applying my new principle affords absolute protection from collision, whether head on, or rear end, and also absolute protection for a train on a siding, and also against accidents from open switches, yet this protection depends upon the proper working of the mechanical, fluid, or electrical means used for inter-connecting the danger signals; and this form of my system is open to the objection that it is not wholly safe to rely on such means, no matter how well designed and constructed.

The step by step apparatus indicated by the disks f and f^2 need no detailed description as it forms the subject matter of my Patent No. 695,648, dated March 18, 1902.

The apparatus by means of which a train on entering the section shown in Fig. 2 demagnetizes magnet D before it demagnetizes magnet D′; and demagnetizes D′ before D on leaving the section, and thereby energizes magnet F on entering and magnet F′ on leaving, needs no detailed description as it forms the subject matter of my Patent No. 695,649, dated March 18, 1902. Moreover, my invention which forms the subject matter of this application has no relation to details of construction or any particular apparatus; but relates wholly to my new system of train protection, as above explained.

While I have described my new system as applied to a single track over which trains are run in both directions, it will be obvious that it is applicable to grade crossings, as illustrated in Fig. 3, for a train running in either direction over either of two tracks which cross each other at grade is an opposing train to a train running on the other track. In this example of my system when one train is ready to shift its signal from danger to safety, in order that it may run over the crossing it makes inoperative the means by which opposing trains can shift their respective signals from danger to safety. For example, as a train approaches from the east in Fig. 3 it closes at k k' a circuit from battery G^b through magnet F just as a circuit from battery G^2 is closed at k k' through magnet F of Fig. 2^b, and for the same purpose, namely, to move disk f^5 one step and connect wires G^a and G^5 through battery G^b of Fig. 3, as disk f is moved one step and wires G′ and G connected through battery G^2 of Fig. 2^b. This circuit closed at k k' at the east of Fig. 3 is through the switches s of disks f^6, f^7 and f^8, and is as follows: from k by plus wire to battery G^b, from G^b to and through switch s of f^6, thence to and through switch s of f^7, thence to and through switch s of f^8, thence through magnet F back to k'. When disk f^5 is thus moved one step its switch f^a is closed and this makes a partially completed circuit from battery G^b through switch f^a of disk f^5, by which the plus wire of battery G^b and wire G^5 are connected; and wire G^5 is the left bound wire for all trains entering on the east and running from right to left in Fig. 3; that is signal A^5 can be shifted to safety by connecting one terminal of the coils of its safety magnet a with wire G^a and the other terminal with wire G^5, as already explained with regard to safety magnet a of signal A and plus wire G′ and left bound wire G^3, of Fig. 2^b. The main difference between Figs. 2, 2^a and 2^b on the one hand and Fig. 3 on the other is that the circuit of magnet F of disk f^5 is broken by the movement of either f^6, f^7, or f^8. The like circuit for the like magnet of disk f^6 is broken by the movement of f^5, f^7 or f^8; the like circuit for magnet of f^7 broken by f^5, f^6 or f^8; and for f^8 by f^5, f^6 or f^7; and it will now be plain that a train entering at the east cannot connect its plus wire and G^5 through battery G^b unless there be no train on the crossing; nor can a train entering at the north connect its plus wire and G^7 through battery G^b unless there be no train on the crossing; nor can a train entering at the west connect its plus wire and G^6 through G^b unless there be no train on the crossing; nor can a train entering at the south connect its plus wire and G^8 through G^b unless there be no train on the crossing.

In the form shown in Fig. 4 an east bound train when it enters the first insulated section at the west short circuits the first track battery at the west and causes D^4 at the west to drop its armature which moves out against a stop, thereby bringing a contact on its outer end into the path of a contact on the under side of the armature of D^5. This east bound train next short circuits the second track battery at the west, causing the armature of D^5 to drop, and its contact to engage the contact on the armature of D^4. This separates contacts x x' at the west, but completes a safety circuit through the contacts thus brought into engagement, which safety circuit is from the contact carried by armature of D^5 to x' of west, thence by wire to x' of south, but x' and x of south are then bridged, so that the rest of the safety circuit is from x of south to x' of east, across x' x of east, by wire from x of east to and across x' x of north, by wire from x of north direct to the battery of signal A^{10} to safety magnet a^{10} and to the contact carried by the armature of D^4. That is when the armatures of D^4 D^5 move they make the circuit through the safety magnet for the east bound train and break the safety circuit at x x' at the west for all opposing trains; for the armature of the track magnet D^5 west must be attracted by that magnet in order that north or east or south bound trains may get a right of way; and the armature of second track magnet north must be attracted by that magnet in order that west or east or south may get a right of way, and so on as will be clear. But if the armature of the north, east and south track magnets be under control of those magnets, that is, if the east bound train has the right of way, it will complete its safety circuit through its safety magnet a^{10}, and shift signal A^{10} from danger to safety. But when the rear of this east bound train leaves the first insulated section west, magnet D^4 is reënergized and when magnet D^4 has been thus reënergized the main safety circuit of signal A^{10} is broken. A the east bound train passes signal A^{10}, then at safety, it closes track switch B^{10} of A^{10}, and completes a local danger circuit through danger magnet a^{40} of signal A^{10}, and shifts A^{10} back to danger; but as D^5 west is not reënergized until the rear of the east bound train leaves the second insulated section west, the main safety circuit common to west, south, east and north remains open at x x' west. After passing signal A^{10} the east bound train demagnetizes the magnets D^2 D^3 but idly; for it is through those magnets D^2 D^3 that west bound trains with right of way send a current through magnet a^{10} of signal A^{10} in order to shift signal A^{10} to safety. This local safety circuit completed by magnets D^2 D^3 at west when operated by west bound trains is a local circuit from battery of A^{10} to contact carried by armature of D^2, through that contact and the contact carried by the armature of D^3, thence through coils of a^{10} back to battery; but this local circuit through a^{10} of A^{10} can be closed only by deënergizing magnet D^2 first and D^3 second, which cannot be done by east bound, but is done by west bound, trains. But after the east bound train demagnetizes D^3 D^2 west in that order and idly it next demagnetizes D^2 and D^3 east in that order, which is the proper order to close local safety circuit through safety magnet a^{10} of signal A^{11}, thus shifting A^{11} to safety.

As the rear of the east bound train leaves the second insulated section west, its front enters the corresponding section east, and thereby not only causes magnet D^5 of west to attract its armature and close x x' of west, but also causes D^5 of east to drop its armature and open x x' of east, so that the east bound train is fully protected by opening switch x x' of east, when switch x x' of west is closed. As the east bound closes track switch B^{10} of A^{11} it completes a local danger circuit through a^{40} of A^{11}, (like that traced through a^{40} of A^{10}) which shifts A^{11} back to danger. As the rear of the east bound train leaves the insulated sections it of course reënergizes the magnets D^5 and D^4, closes switch x x' east, thus restoring the system to normal.

It will be plain without further description how a north or a south or a west bound train get the right of way, and protection from opposing trains. It will also be clear that four batteries for operating magnets a^{10} and a^{40} of the four signals A^{10}, A^{11}, A^{12} and A^{13} are shown simply to make the diagram Fig. 4 more symmetrical and more easily understood, for it will be obvious to all skilled persons that one will suffice, this being a mere matter of wiring.

What I claim as my invention is:

1. In a block system, a blocking appliance; automatic means for shifting that blocking appliance to safety on the approach of a train running in one direction; automatic means for shifting that blocking appliance to safety on the approach of a train running in the opposed direction; and automatic means for shifting that blocking appliance back to danger as a train passes in either direction.

2. In a block system, a blocking appliance; two safety circuits for shifting it from danger

to safety, one automatically operated by a train approaching from one direction, the other automatically operated by a train approaching from the opposite direction; a danger circuit automatically operated by a train passing in either direction; and means by which the first train to enter the block automatically makes its own safety circuit, and also inhibits the making of the other safety circuit by a train in the opposed direction.

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Witnesses:

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