

July 26, 1938.

F. B. HITCHCOCK

2,125,240

TRACK CIRCUIT FOR RAILROADS

Filed Nov. 15, 1934

2 Sheets-Sheet 1

1.5

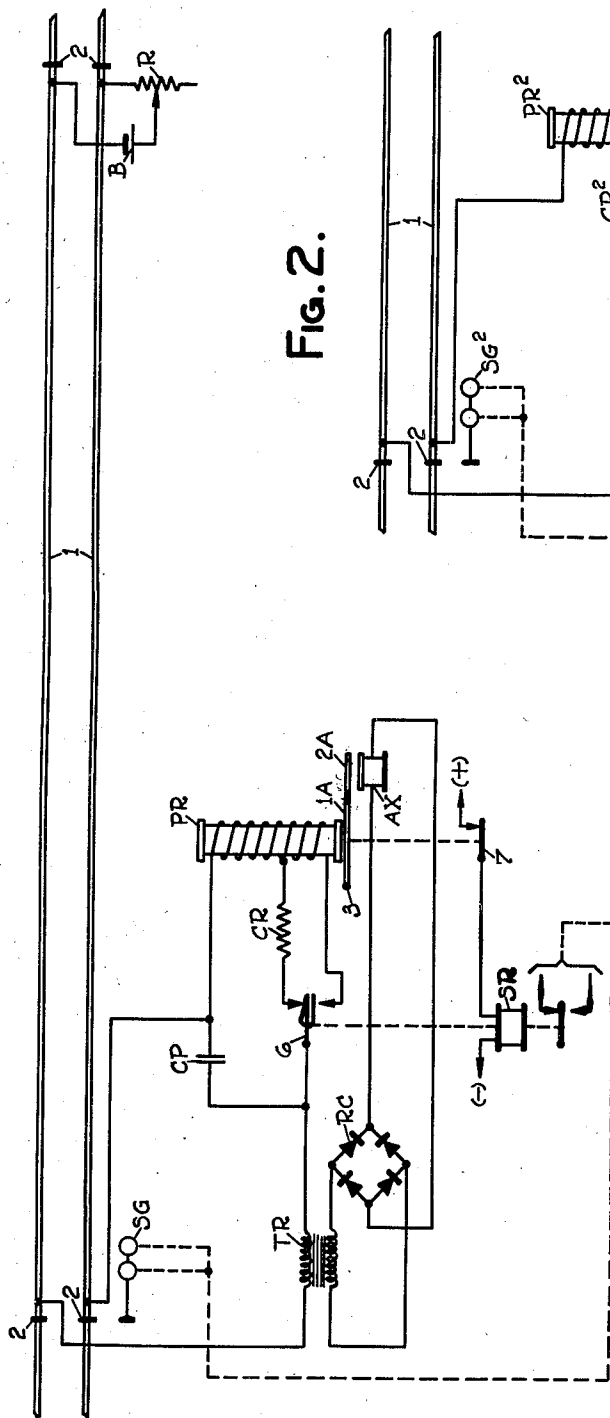
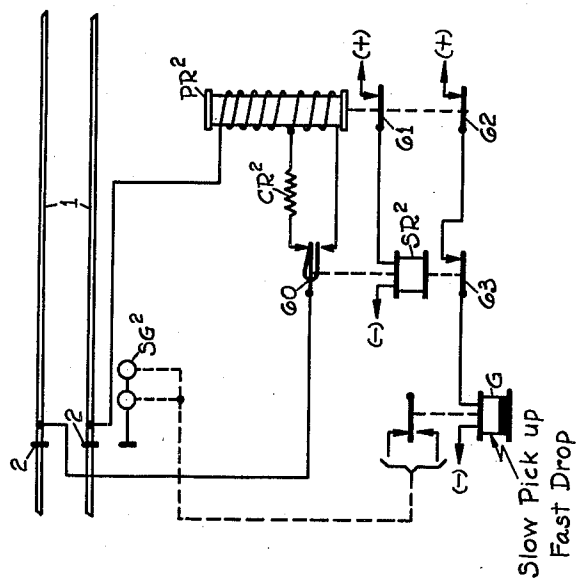


Fig. 2.



July 26, 1938.

F. B. HITCHCOCK

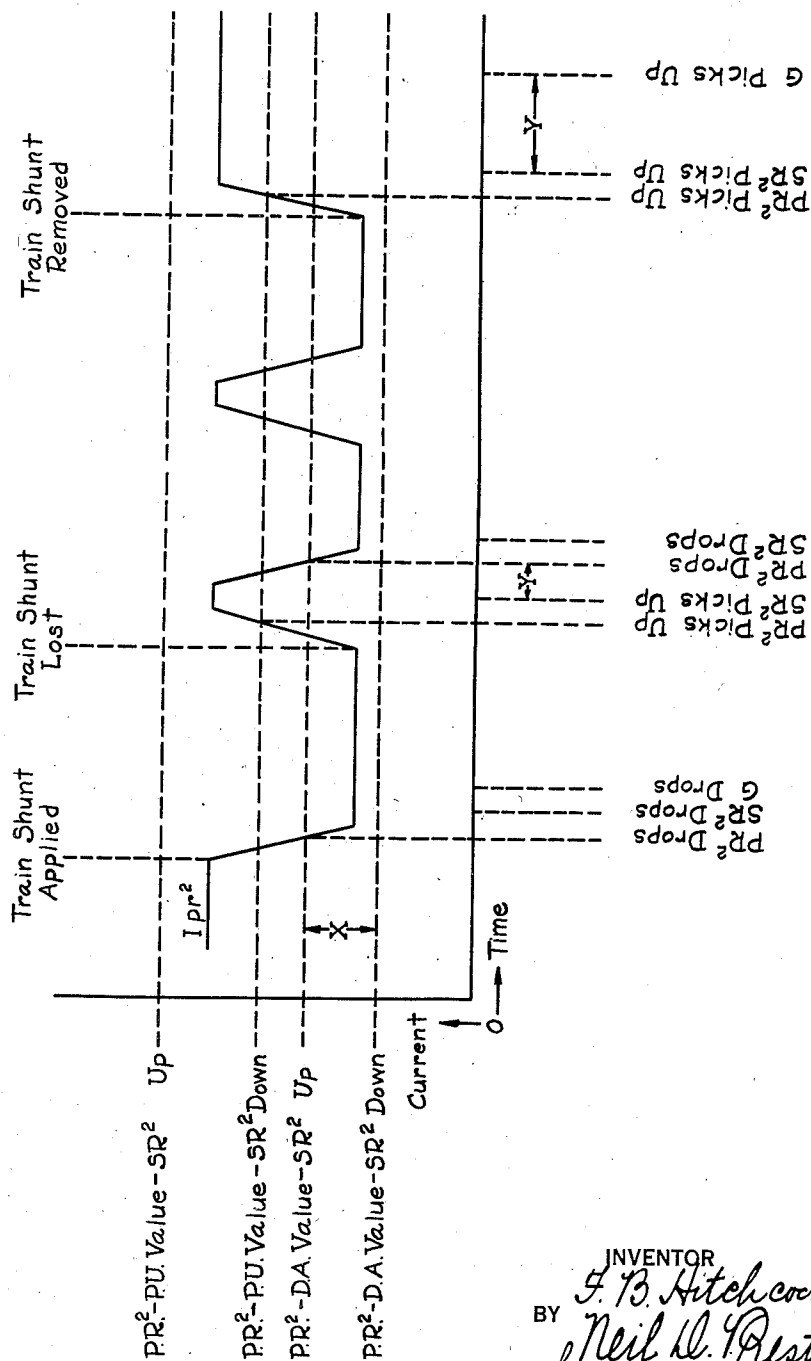
2,125,240

TRACK CIRCUIT FOR RAILROADS

Filed Nov. 15, 1934

2 Sheets-Sheet 2

Fig. 2.A.



INVENTOR
F. B. Hitchcock,
BY Neil W. Preston,
his ATTORNEY

UNITED STATES PATENT OFFICE

2,125,240

TRACK CIRCUIT FOR RAILROADS

Forest B. Hitchcock, Greece, N. Y., assignor to
General Railway Signal Company, Rochester,
N. Y.

Application November 15, 1934, Serial No. 753,177

9 Claims. (Cl. 246—41)

This invention relates to direct current track circuits, and more particularly to the control of track relay operation in such circuits.

A track relay of the ordinary construction is slow dropping and comparatively quick in picking up, because the dropping of the relay, due to the entrance of a train upon the track to which the relay is connected, is caused by shunting the winding of the relay, which shunted winding acts as a short-circuited winding and maintains the flux in the magnetic circuit for an appreciable period of time.

The slow dropping and the quick picking up of a track relay is undesirable for controlling switches and wayside signals because a short train may move from one track circuit to another track circuit so quickly that the track circuit in the rear will have its track relay picked up before the track relay of the occupied track circuit has had time to drop. The result is a momentary period during which both track circuits manifest clear traffic conditions, which may actually cause the next signal in the rear to momentarily indicate a clear condition or which may allow the undesired release of a switch. In the case of single track signalling, where stick relays are employed, such a condition may actually effect the picking up or the dropping of a stick relay and thereby reverse the direction of traffic set up.

Also, with the present high speed operation of trains, it has been found that there is a greater tendency for the track circuit to be affected by momentary losses of shunt than heretofore observed. This is due to the fact that the wheels of the train are actually out of contact with the rails during short intervals, particularly where there is a slight unevenness of the rail surface. In other words, a high speed train may in effect only hit the high spots, so to speak. Therefore, the current through the track relay of a track circuit may be of a continuously varying value when the track is traversed by a high speed train. This recurring loss of shunt may so increase the current in the track relay winding that the relay will pick up or chatter, resulting in a momentary false clear indication and in the case of single track signalling where stick relays are employed may actually effect the picking up or dropping of a stick relay to reverse the direction of traffic set up.

In view of the above and other important considerations, it is one purpose of the present invention to provide a track circuit relay combination which is quicker to release than it is to pick up.

Another purpose is to provide that recurring

variations in the train shunt, or even momentary entire losses of the train shunt, will not affect the desired steady control of the circuits governed by the track relay.

It is proposed in accordance with one form of the present invention to employ a circuit organization in which the impulses in the track circuit resulting from a recurring loss of shunt are operative to augment the actual shunting effect of the train to maintain the track relay in its retracted or dropped away condition. In a modification, a primary track relay and a secondary relay so control a slow to pick up relay that, even though the primary track relay is intermittently picked up and dropped by a recurring loss of shunt, the controlled circuits (such as the signals for the associated track section) are not affected because the duration of the picked up condition of the primary relay is less than the time required to pick up the slow pick up relay.

Other objects, purposes and characteristics of the present invention will in part be obvious from the accompanying drawings and will in part be more specifically described hereinafter.

In describing the invention in detail reference will be made to the accompanying drawings in which:—

Fig. 1 illustrates a track circuit having a primary and a secondary relay, together with means for making use of the train entrance, train exit and the recurring loss or variation of shunt in the track circuit to augment the tendency of the primary track relay to assume its dropped away position.

Fig. 2 shows a modification in which the primary and secondary relays may follow the recurring losses of train shunt, but unless they are energized for a predetermined period of time the circuits which they control are not changed, due to the use of a slow to pick up relay.

Fig. 2A is a graphic representation of the sequential operations of the apparatus of Fig. 2, in which the values of certain varying elements are plotted as ordinates against time as abscissa. The graph of Fig. 2A is illustrative only and is for the purpose of conveniently describing the invention but is not intended to be in any sense of a limiting nature or representative of the values involved.

Referring to Fig. 1, track rails 1 are divided by insulated joints 2 into blocks of which only one block has been illustrated. This block includes the usual track battery B and series resistance R connected to one end of the track section.

It will be understood that the track section of

Fig. 2 likewise has a track battery and a series resistance connected thereto in a similar manner, but since it is believed unnecessary to duplicate this portion of the circuit it has been omitted from the Fig. 2 drawing.

Fig. 1 includes a primary relay PR comprising an armature 1A pivoted at 3 and having fastened thereto but magnetically separated therefrom an auxiliary armature 2A. In other words, the armatures 1A and 2A are mechanically connected by non-magnetic material. As clearly indicated in the diagrammatic showing, armature 1A is controlled by relay PR, which relay has an auxiliary winding AX cooperating with auxiliary armature 2A. The double winding of the upper portion of relay PR may be conveniently referred to as the operating winding of the relay while the lower portion AX may be conveniently referred to as the retention winding of the relay, since this winding AX has a retaining effect on the armature of the relay for a purpose which will be explained in detail.

Associated with relay PR is a secondary relay SR which controls signal SG, for example, and which also substitutes compensating resistance CR for the lower winding of relay PR under certain conditions. Transformer TR is connected in the track circuit and is used for the purpose of translating the changes of current value in the track circuit into a direct current, through the medium of rectifier unit RC for the purpose of energizing winding AX. Capacitor or condenser CP is connected in shunt with the primary relay winding PR to compensate for some of the inductive reactance of this winding for the purpose of permitting the recurring impulses to more readily affect the secondary winding of the transformer. In other words, condenser CP serves to by-pass these impulses past the winding of relay PR.

Fig. 2 illustrates a signal SG² controlled by a slow pick up signal control relay G which is in turn controlled by primary relay PR² and secondary relay SR². Compensating resistance CR² is substituted for the lower winding of relay PR² in order to maintain a fixed resistance value for the circuit, with relay SR² in either its picked up or its dropped away condition.

Operation.—It is convenient to describe the operation of Fig. 2 first. Then with this operation in mind it will be shown how Fig. 1, which is the preferred form of the invention, operates to improve certain features of the embodiment of Fig. 2.

The purpose of relay G may be more clearly understood by first assuming that it is omitted from the Fig. 2 circuit and that the signal control is by way of contacts on relay SR² which may be made slow to pick up.

It will be assumed that the track section is unoccupied. Both relays PR² and SR² are maintained picked up, the former over a circuit extending from the (+) terminal of the track battery (assumed to be connected to the upper track rail), upper track rail, front contact 60 of relay SR², resistance unit CR², upper winding of relay PR² and lower track rail to the (−) terminal of the track battery. Relay SR² is energized over a circuit extending from (+), front contact 61 of relay PR² and winding of relay SR², to (−).

When the track section becomes occupied by a train sufficient current is shunted through the wheels and axles to effect the release of relay PR², which in turn releases relay SR² by opening front contact 61. The dropping of contact 60 of

relay SR² shifts the circuit to exclude resistance CR² and to include the lower portion of the winding of relay PR² in the track circuit. The total winding of relay PR² is now effective to actuate the armature of the relay when the track section becomes unoccupied. Assuming that the reduced current in the circuit extending to the windings of relay PR² remains constant during the shunted condition of the track, it will be apparent that the increased number of turns provided by the lower winding of the relay will produce an increased magnetomotive force in relay PR², but this increased magnetomotive force is still insufficient to attract the armature.

The operation of the primary and secondary relays of Fig. 2 may be more clearly seen from the graphic representation shown in Fig. 2A. The normal or unshunted current value in the circuit leading from the track rails to the windings of relay PR² by way of contact 60 is represented by the curve Ipr² at the extreme left portion of the graph. It will be understood that the resistance value of resistance unit CR² is equal to the resistance value of the lower winding of relay PR².

When the train shunt is applied to the track rails at the point indicated in Fig. 2A, the current in the primary relay circuit suddenly drops as indicated by curve Ipr². It will first be assumed that the train shunt reduces this current only to a point within the band between the dotted lines X. When this current value reaches the drop away value of relay PR² (with SR² up) this relay drops as indicated. The opening of front contact 61 causes relay SR² to drop at the point indicated.

A momentary loss of shunt assumed to be at the point marked "Train shunt lost" will effect the picking up of relay PR² when the current builds up to the pick up value of this relay with relay SR² down at the point indicated. Assuming that relay SR² is made slow to pick up (remembering that under this condition relay G is not provided), then upon the next application of the shunt, relay PR² will not immediately drop because the current does not reach the drop away value of relay PR² with relay SR² down. Therefore relay PR² remains up even after the shunt is applied until relay SR² picks up to shift the drop away value of relay PR² to the upper boundary line of band X, when relay PR² will drop.

It will thus be seen that, even though relay SR² be made slow to pick up, such a momentary loss of shunt will cause it to pick up momentarily which may cause a false clear condition to be indicated as above referred to. Of course if the train shunt is of such a value that the current is reduced to or below the drop away value of relay PR² with relay SR² down (lower boundary line of band X), then when the shunt is again applied relay PR² will be dropped and the operation will be as desired, because under this condition relay PR² will follow the loss of shunt condition without relay SR² being picked up. However, as above mentioned, when the shunt applied is effective to reduce the current only to the point indicated by the curve Ipr² then a momentary loss of train shunt will be followed or repeated by the secondary relay SR², irrespective of the fact that it is slow to pick up.

The circuit of Fig. 2 (with relay G included) remedies this condition by allowing relays PR² and SR² to follow the recurring or momentary shunt and loss of shunt and repeating the conditions of these two relays by the additional relay

G, which is slow to pick up. Therefore relay G will not be picked up during the above described condition because, notwithstanding the fact that relays PR² and SR² may be picked up, the relay G, which actually controls the signals, will not pick up. The pick up circuit for relay G extends from (+), front contact 62 of relay PR², front contact 63 of relay SR² and winding of relay G, to (-).

In view of the above description, it will be seen that there is an operating objection to the circuit of Fig. 2. This is the fact that recurring losses of shunt will cause relays PR² and SR² to vibrate or chatter, thus causing unnecessary wear and tear on the relays. The circuit of Fig. 1 overcomes all of the objections above mentioned, the operation of which will now be described.

Before describing the operation of Fig. 1 it will be mentioned that relay G of Fig. 2 is sufficiently slow to pick up so that it will not be picked up during the time indicated by the band Y of the Fig. 2A representation. In other words, with relays PR² and SR² picked up the energizing circuit of relay G is completed but it must not be picked up if relay PR² is immediately dropped due to an immediate re-application of the shunt. When the shunt is removed by the train leaving the track section, then this band Y will be extended as indicated at the right hand portion of the time chart for a sufficient period of time to pick up the G relay.

Referring to Fig. 1, the primary and secondary relays PR and SR respectively are shown in their picked up or energized conditions. The circuit for energizing relay PR extends from the (+) terminal of battery B, upper track rail, upper winding of transformer TR, front contact 6 of relay SR, resistance unit CR, upper winding of relay PR, lower track rail and resistance unit R to the (-) terminal of battery B. The current flowing over this circuit sufficiently energizes relay PR to cause armature 1A to be picked up as illustrated. A circuit is closed for energizing relay SR which extends from (+), front contact 7 of relay PR and winding of relay SR, to (-).

When a train enters the track section illustrated, the application of the shunt to the track rails reduces the current flow in the above described circuit, which so reduces the magnetomotive force acting on armature 1A that this armature is dropped. Recalling that it is desirable to quickly drop the armature of relay PR when a train enters the track section, it will now be pointed out how this is effected in the circuit of Fig. 1.

The sudden reduction of current flow in the track circuit at the track relay in response to the entrance of a train is accompanied by a sudden reduction in current flow through the upper winding of transformer TR. Recalling that the unshunted condition of the track circuit permits current to flow through the upper winding of transformer TR from left to right, it will be apparent that the sudden change in the value of this current induces a current in the lower winding of the transformer. This induced current is caused to flow in a predetermined direction by the rectifier unit RC to provide a direct current which flows through winding AX of the primary relay. The current in winding AX causes the attraction of armature 2A towards this retention winding, which effects the quick dropping of the armature 1A to which extension 2A is attached. The dropping of front contact 7 deenergizes relay SR and since this relay is quick acting, the signal con-

trolling circuit is affected in a very short period of time after the track rails are shunted.

When the train leaves the track section the removal of the shunt permits current to flow from track battery B over the above described circuit, which now includes both windings of relay PR because of the dropped away condition of contact 6 of relay SR. The additional turns of the winding of relay PR, which are thus rendered effective, cause relay PR to be more sensitive in picking up its armature. In addition to this, the sudden increase of current through the upper winding of transformer TR induces a current in the lower winding of this transformer which induced current is caused to flow by the rectifier unit RC through winding AX in the same predetermined direction as above mentioned.

This current flow through winding AX exerts a momentary retaining effect upon armature 1A because the extension 2A is acted upon by the magnetic flux in the core of winding AX. This renders relay PR slow to pick up which is desirable for the reason previously explained.

The circuit of Fig. 1 provides an arrangement in which momentary losses of train shunt and response to recurring variations in train shunt do not cause the primary relay to respond, even though the pick up and drop away values are substantially the same. This is because rapid variations in track circuit current induces an alternating current in the secondary winding of transformer TR which is changed to uni-directional current by rectifier RC to render the retention winding AX of relay PR effective to exert a steady downward pull on armature 1A. In other words, momentary losses of train shunt cause a transformer effect which results in the energization of the retention winding thereby delaying the response of relay PR. If the losses of train shunt do not last for a period greater than such delay then relay PR will not repeat such losses.

Assuming that the illustrated track section is occupied by a train, the primary and secondary relays PR and SR will be in their dropped away conditions. Assuming now that the shunt is momentarily lost and again applied, relay PR will not be picked up to close the pick up circuit for relay SR. This is due to the fact that the loss of shunt causes a momentary and sudden increase in current through the primary winding of transformer TR which is effective to induce a current flow in the secondary winding as above described for energizing retention winding AX, which acts to maintain armature 1A in its retracted position. When the shunt is again applied the reduction in current flow through the upper winding of transformer TR induces a current flow in the opposite direction in the lower winding of this transformer, but due to the connection of the rectifier unit RC in the circuit this current flows in the same direction through winding AX for again exerting a retaining effect upon armature 1A. Thus the effect of a recurring loss of shunt in the track circuit is actually made use of to prevent the picking up of the primary relay.

Furthermore, these recurring variations in the train shunt value cause relay PR to remain dropped away so long as the low point in these variations fall below the drop away value of the relay combination. This is because the initial drop away value of the combination is determined with relay SR picked up and once the combination is deenergized, the pick up value

is decreased but the recurring variations steadily energize the retention winding so that the effective pull on armature 1A to pick it up is substantially below the pick up value required.

5 Since the recurring loss of shunt across the track rails operate (in effect) to produce an alternating current flow in the circuit including the upper winding of transformer TR, the connection of condenser CP across the winding
10 of relay PR provides a by-pass for this alternating current, which removes the impedance of the relay winding from the circuit so that this alternating current will have a maximum effect in the transformer winding.

15 The above rather specific description of the preferred form and the modified form of the present invention is given solely by way of example which is not intended in any manner to limit the invention. It is to be understood that
20 various modifications, adaptations and alterations may be applied to meet the requirements of practice without in any manner departing from the spirit or scope of the present invention, except as limited by the appended claims.

25 Having thus described my invention, what I claim is:—

1. In a track circuit for railroads, a track section, a source of current and a primary relay having a first winding connected to the rails of
30 said section, a secondary relay controlled by said primary relay, a signal controlled by said secondary relay, means controlled by a rapidly recurring shunt applied across said rails by a vehicle for generating an alternating current, means
35 for transforming said alternating current into direct current, and means for applying said direct current to a second winding of said primary relay which opposes the action of said first winding of said primary relay, whereby the applica-
40 tion of said shunt across said rails and the application of said direct current to said second winding controls the operation of said primary relay.

2. In a track circuit for railroads, a track section, a source of current and a first winding
45 of a track relay connected to the rails of said section, means controlled by a rapidly recurring shunt applied across said rails by a vehicle for generating an alternating current, means for transforming said alternating current into direct
50 current, means for applying said direct current to a second winding of said track relay, which opposes the action of said first winding of said track relay on the armature of such track relay, whereby the application of said shunt across
55 said rails and the application of said direct current to said second winding controls the release of said track relay, and means including a condenser for bypassing impulses past the first winding of said track relay.

3. In combination, a track circuit for railroads, a track circuit source of energy, a track relay having a main winding connected in series with
60 said track circuit and said source, an auxiliary winding on said track relay opposing the action of said main winding, a rectifier, and means inductively coupling said auxiliary winding to said track circuit through said rectifier.

4. In combination, a track circuit for railroads, a source of energy connected at one end
70 of said track circuit, a track relay connected at the other end of said track circuit and having a movable contact biased to its inactive position, a main operating magnet on said track relay for operating said contact to an active position, said main operating magnet having a
75

winding connected in series in said track circuit, a hold-down magnet for urging said contact towards its inactive position, said hold-down magnet having a winding inductively coupled to said track circuit, and means for causing all current flow in said hold-down magnet to be in the same direction for either a decrease or increase in current flow in said track circuit.

5. In combination, a section of railroad track, a signal governing traffic over said section, a
10 source of energy connected across the rails at one end of said section, a track relay connected across the rails at the other end of said section and responsive to the current flow therein, electro-magnetic means responsive only to varia-
15 tions in current flow in said track circuit to assume a particular magnetized condition of only one polarity during such variations, and means jointly controlled by said track relay and said electro-magnetic means for governing said signal.

6. In combination, a section of railroad track, a signal governing traffic over said section, a
20 source of energy connected across the rails at one end of said section, a track relay connected across the rails at the other end of said section, a rectifier, a transformer, electro-magnetic means controlled through said rectifier and said trans-
25 former connected with the rails at said track relay end so as to be responsive only to alternating current or impulse current in said rails but so as to always be energized in the same
30 direction, and contact means controlled by said track relay and said electro-magnetic means so as to be picked up only when the current in said track rails is steadily above a predetermined
35 value and so as to be dropped away whenever said current in said rails is steadily below said value, is continuously varying in value to in effect form impulses, or whenever alternating current is in said rails.

7. In combination, a section of railroad track, a signal governing traffic over said section, a
40 source of energy connected across the rails at one end of said section, a track relay connected across the rails at the other end of said section and responsive to the steady current flow in
45 said track rails and dropped away upon the shunting of said track rails by a train, a transformer having primary and secondary windings, means connecting the primary winding of said
50 transformer in series with said track relay, a condenser connected in multiple with said track relay, electro-magnetic means responsive to all currents induced in said secondary winding of said transformer so as to be magnetized in only
55 one direction by such currents, and means jointly controlled by said track relay and said electro-magnetic means for governing said signal.

8. In a track circuit for railroads, a section of
60 track, a source of current connected to the rails at one end of said section, a normally energized track relay connected to the rails at the other end of said section and responsive to drop away upon the application of a shunt across said rails
65 by the entrance of a train into said section which reduces the current flow in said track relay to a value equal to or below its drop away value, a secondary relay directly repeating said track relay, means controlled by said secondary relay
70 for changing the pick up value of said track relay from a first range to a second range just slightly above the drop away value of said track relay when said track relay is dropped away, a hold-down magnet for said track relay, and means responsive to both an increase and a
75

decrease of current supplied to said track relay for supplying current in the same direction to said hold-down magnet.

5 9. In a track circuit for railroads, a section of track, a source of current connected to the rails at one end of said section, a normally energized track relay connected to the other end of said section and responsive to a train shunting said rails to drop its contacts away, a recti-

fier, a hold-down magnet for said relay, and a transformer having a primary winding connected in series with said relay and having a secondary winding connected to said hold-down magnet through said rectifier, whereby said hold-down 5 magnet is temporarily energized in the same direction for each change in current in said track relay.

FOREST B. HITCHCOCK.

DISCLAIMER

2,125,240.—*Forest B. Hitchcock*, Greece, N. Y. TRACK CIRCUIT FOR RAILROADS.
Patent dated July 26, 1938. Disclaimer filed May 18, 1940, by the assignee,
General Railway Signal Company.

Hereby enters this disclaimer by disclaiming from claim 5 any system of railway signalling, except wherein the "electro-magnetic means" which assumes "a particular magnetized condition of only one polarity during such variations" in "current flow in said track circuit" for either an increase or a decrease in such current flow.

[*Official Gazette June 11, 1940.*]