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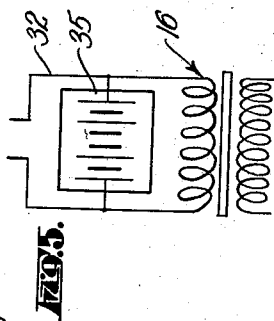
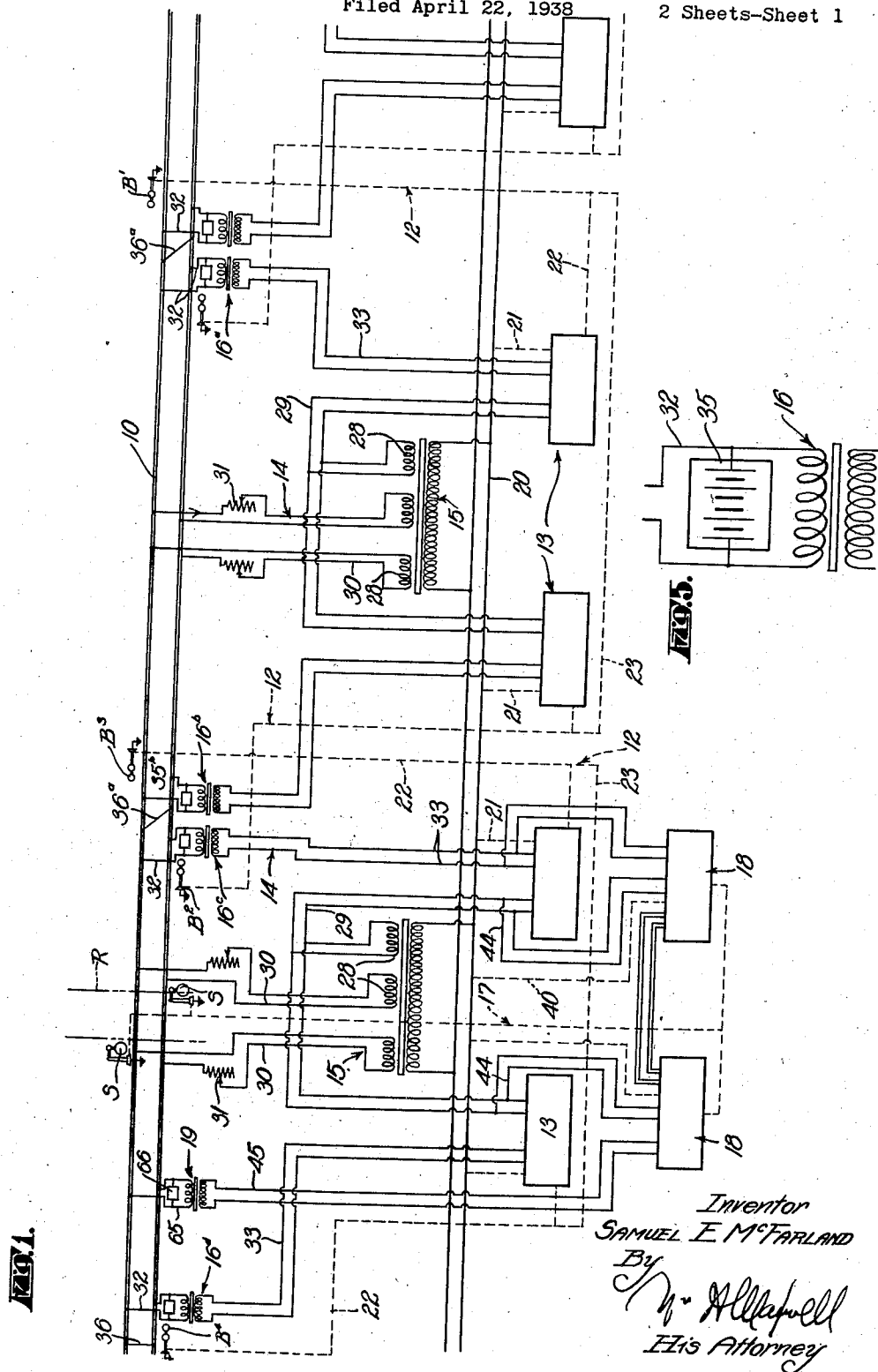
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2,186,201

TRACK SIGNAL CONTROL SYSTEM

Filed April 22, 1938

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 2.

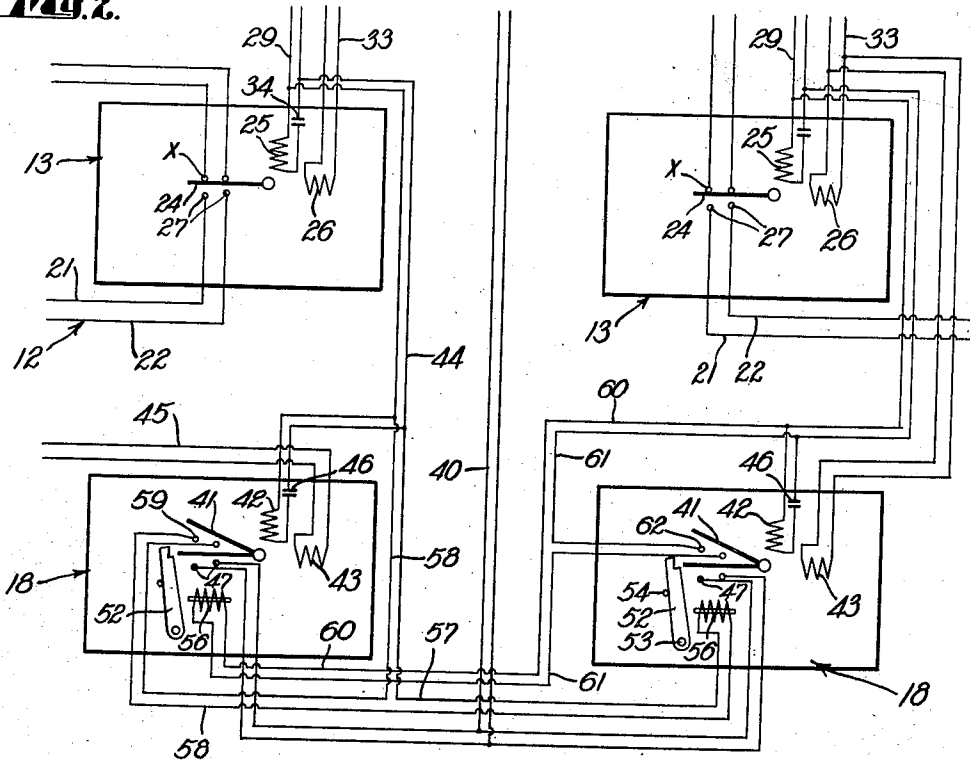


Fig. 3.

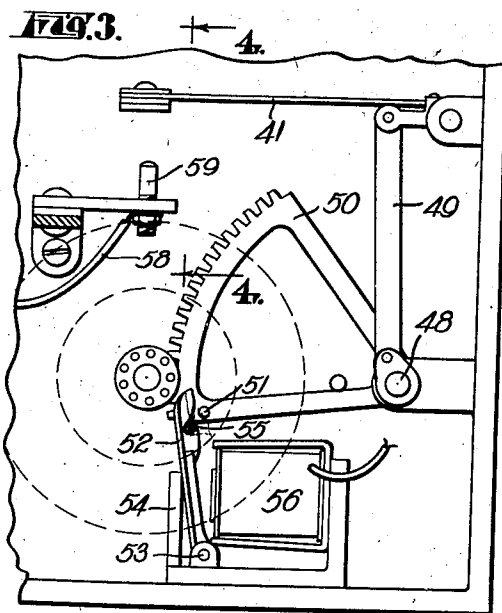
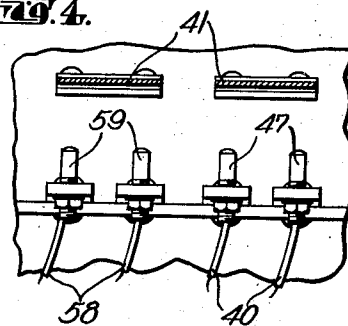


Fig. 4.



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TRACK SIGNAL CONTROL SYSTEM

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Application April 22, 1938, Serial No. 203,538

7 Claims. (Cl. 246—130)

This invention relates to signal systems and relates more particularly to an improved railway track signal system. A general object of this invention is to provide a simplified, inexpensive and dependable track signal control system.

This application is a continuation-in-part of my application for Letters Patent Serial No. 118,802, filed January 2, 1937.

The block signal systems and other railway track systems now in general use are costly to install and are not altogether satisfactory. It is the general practice in such signal systems to employ the track rails as conductors in the circuits of the control relays which govern the signal apparatus. In most track signal systems current of voltages in the order of from 6 to 16 volts is supplied to the rails. The use of current of such voltages in signal systems has numerous disadvantages. For example, a signal control system employing high voltage current is always subject to disruption and failure due to current leaks and shorts when the track is wet or submerged and it is usually necessary to insulate the block sections or guarded sections of the track from the adjacent portions of the track. In the case of electrically operated railways where the rails form the return conductor for the power current the insulation of the blocks or guarded sections of the track necessitates the employment of impedance bonds or like devices to transmit the power current or propulsion current from one track section to another while preventing the flow of the signal system current from one track section to another. The insulated rail sections, the impedance bonds and the other devices used in track signal systems employing current of more than one volt are expensive and require costly inspections and repairs. Where signal control current of more than one volt is used the blocks or guarded track sections must of necessity be quite limited in length. It has been proposed to employ current of high frequency in signal control circuits where the rails are utilized as conductors and to use current of different frequencies in the adjacent blocks or track sections. The use of high frequency current necessitates the installation and maintenance of special generators and other special equipment and systems employing polyphase and high frequency current have not proven successful.

Another object of this invention is to provide a track signal control system in which the rails may be conductively continuous so that insulated rail bonds are not required and in the case of an

electric railway impedance bonds or like devices are not required.

Another object of this invention is to provide a track signal control system that is dependable under all conditions and that is unaffected by the submerging of the rails, variation in the character of the road bed, foreign matter on the tracks, etc.

Another object of this invention is to provide a track signal control system in which the guarded portions of the track or the blocks may be of great length, for example, they may each have a length of 7000 feet or more.

An important object of this invention is to provide a track signal control system of the character mentioned that utilizes a track current or control current of low voltage thereby avoiding the numerous difficulties and limitations inherent in signal control systems employing high voltage current.

Another object of this invention is to provide a track signal control system of the character mentioned in which the circuits of two adjacent signal controls overlap one another longitudinally of the track so that the desired sequence and duration of signals is assured. This feature of the invention makes the system particularly advantageous for the control of warning signals at highway intersections, etc. and provides for the sustained actuation of the signals until the rear of the train has passed the intersection irrespective of the direction of travel of the train.

Another object of this invention is to provide a track signal control system in which two or more signal relays may be governed to operate in any desired sequence or relation by the current supplied to a single or given zone or portion of the track without cutting the rails. This feature of the invention makes it possible to control both block signals and intersection signal devices by a single power supply connected with or delivering current to the rails of a portion of the track.

Another object of this invention is to provide a signal control system of the character mentioned embodying novel and particularly effective interlocking relays.

A further object of this invention is to provide a track signal control system of the character mentioned that does not necessitate the employment of expensive generators or other special equipment.

The various objects and features of my invention will be fully understood from the following detailed description of a typical preferred form

and application of my invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is a diagrammatic wiring diagram of the signal control system of the invention as employed in connection with a track for the control of block signals and intersection signals. Fig. 2 is an enlarged fragmentary wiring diagram illustrating two sets or pairs of control relays. Fig. 3 is an enlarged fragmentary vertical sectional view of one of the interlocking relays illustrating the improved locking means and control means provided by the invention. Fig. 4 is a fragmentary vertical detailed sectional view taken as indicated by line 4—4 on Fig. 3, and Fig. 5 is an enlarged diagrammatic view of one of the step up transformers and its filter.

The signal control system of the present invention is suitable for governing signals, control devices, and signal devices of various natures and is susceptible of substantial variation to adapt it for employment in different situations. In the following detailed description I will describe the invention as employed to operate or control the block signals and intersection signal devices associated with a portion of a two-way track. It is to be understood that the invention is not to be construed as limited or restricted to the specific form or application of the invention about to be described.

In Fig. 1 of the drawings the numeral 10 designates the rails of the railway track. The rails 10 may be considered as typical steel railway rails of a standard design and weight. For example, it may be considered that the rails 10 are typical 75 pound rails. It is a feature of the invention that the rails 10 are conductively continuous; that is, each rail 10 forms a continuous unbroken electrical conductor. Accordingly, insulated joints are only required at crossings, sidings and at the end of a double track merging into a single track. The two rails 10 constituting the track are electrically separate and independent throughout the length of the portion of the track protected or guarded by the signal system. The fact that the rails 10 are conductively continuous as just described is important as it materially simplifies the installation and maintenance of the track and materially increases the efficiency of the railway if electrical propulsion is used as it is unnecessary to divert or otherwise direct the propulsion current handled by the rails. I have shown a highway or road R intersecting the track and have illustrated suitable warning signals S at each side of the road R where it intersects the track. I have also illustrated a series of block signals B¹, B², B³ and B⁴ arranged longitudinally of the rails 10 to define blocks or guarded zones of the track. The signals S and the block signals B¹, B², B³ and B⁴ may be of any desired type that may be operated or governed by electrical means. The present invention is not concerned with the forms of signal devices or signals S and B¹, B², B³ and B⁴ employed and the details of these devices are omitted from the present description. The term "block" as used in the description of the present invention refers to a part or portion of track comprising the conductively continuous rails 10.

The improved signal control system of the present invention may be said to comprise, generally, operating circuits 12 for the block signals B¹, B², B³ and B⁴; relays 13 controlling the circuits 12, control circuits 14 for the relays 13 comprising transformers 15 supplying low voltage current to

the rails 10 at points between the ends of the blocks or track portions guarded by the sets of signals B¹ and B², B³ and B⁴ and transformers 15^a, 15^b, 15^c and 15^d receiving the current from the rails 10 adjacent the ends of the said blocks and delivering the control current to the related relays 13; an operating circuit 17 for the intersection signals S, relays 18 controlling the circuit 17; and control circuits for the relays 18 comprising the power means 15, the rails 10 and one or more transformers 19 connected with the rails 10 and delivering the control current to the relays 18.

The operating circuits 12 for the block signals B¹, B², B³ and B⁴ may be connected with any suitable or convenient source of electrical energy. In the drawings I have shown a power line 20 paralleling the track and supplying current to the circuit 12. It may be assumed that the power line 20 carries A. C. current of 110 volts. Each circuit 12 comprises a lead 21 extending from the power line 20 to a relay 13 and a lead 22 extending from a relay 13 to the related or controlled block signal B¹, B², B³ and B⁴. The signals B¹ and B², and B³ and B⁴ controlling or guarding the adjacent track portions or blocks may be interconnected to be simultaneously controlled or operated. A connecting lead 23 connects the lead 22 of the signal B¹ with the lead 22 of the signal B² and a similar lead 23 connects the lead 22 of the signal B³ with the lead 22 of the signal B⁴. For the purpose of simplifying the illustration I have shown the signals B¹, B², B³ and B⁴ grounded and have shown the circuits 12 in broken lines to distinguish them from the other circuits of the system.

The relays 13 are provided to govern the operating circuits 12 of the block signals B¹, B², B³ and B⁴ and there is a relay 13 provided to control each block signal. The relays 13 may be of any selected type, it being preferred to employ a conventional or standard line or track relay. As diagrammatically illustrated in Fig. 2 of the drawings each relay 13 includes a movable element 24 governed by two windings 25 and 26. The manner of energizing and controlling the windings 25 and 26 of the relays 13 will be hereinafter described. The elements 24 are cooperable with sets or pairs of contacts 27 to govern the circuits 12. One contact 27 of each relay 13 is a terminal of a lead 21 while the other contacts 27 are connected in the leads 22 so that the circuits 12 are energized or made by the movable relay elements 24. When both windings 25 and 26 of a relay 13 are energized the element 24 is out of engagement with the contacts 27 and the circuits 12 are broken. While I have shown only two contacts 27 in each relay 13 to provide for the energization of the respective signals B¹, B², B³ and B⁴ when the relay elements 24 drop, it is to be understood that the relays 13 may include other contacts, for example, they may include pairs of contacts X that are normally made to provide appropriate signals at the block signals.

The control circuits 14 for the relays 13 are important features of the invention. The control circuits 14 assure the dependable operation of the system under all conditions of operation and are such that the guarded track portions or blocks may be of great length. The circuits 14 are supplied with current by the above-mentioned transformers 15. There is a transformer 15 for supplying current to each set or pair of circuits 14 guarding a track portion or block. The primary windings of the transformers 15 may be

connected in the power line 20 or may be supplied with A. C. current from any other convenient source. Each transformer 15 has three secondaries 28. One secondary 28 of each transformer 15 supplies current of the correct voltage, amperage and frequency to the windings 25 of the two related relays 13 at a block or guarded track portion. Conductors or leads 29 from the said secondaries 28 deliver current to the windings 25. Thus the windings 25 of the relays 13 are continuously supplied with current.

Each circuit 14 includes one of the secondaries 28 of a transformer 15 and leads 30 extending from the secondary 28 to the rails 10 to deliver the current to the rails. The turns ratio of the transformer 15 is such that the leads 30 deliver low voltage and high amperage current to the rails 10. This is an important feature and will be hereinafter discussed. The points of connection of the leads 30 with the rails 10, that is, the points of current feed to the rails 10 are also of importance. The leads 30 are connected with the rails 10 at points between the ends of the guarded rail portions or blocks and the two pairs of leads 30 supplying current to the two transformers 16^a and 16^b or 16^c and 16^d of a block are in spaced relation. As illustrated in the drawings the points of input or feed to the rails 10 may be spaced at opposite sides of the medial point or plane of a block, it being understood that this location of the points of feed is not essential. An adjustable resistance 31 is provided in one lead 30 of each pair of leads 30 so that the voltage of the current supplied to the rails 10 may be regulated at will. The relationship between the character of the current, the points of feed of the current to the rails 10, the points of connection of the related transformers 16^a, 16^b, 16^c and 16^d with the rails 10 are factors that will be more fully described.

The transformers 16^a, 16^b, 16^c and 16^d are associated with the rails 10 to receive the track current or electrical energy therefrom. The transformers 16^a, 16^b, 16^c and 16^d are spaced longitudinally along the track from their respective power inputs or feeds as provided by the secondaries 28 and the leads 30 of their circuits. The primaries of the transformers 16^a, 16^b, 16^c and 16^d are connected across the rails 10 by taps or leads 32. It is to be observed that the portions of the rails 10 between the current feeds or leads 30 and the taps 32 of the transformers 16^a, 16^b, 16^c and 16^d constitute conductors in the circuits 14.

The lengths of the portions of the rails 10 between the input leads 30 and the transformer taps 32 are known, determined or measured. The rails 10 are of standard weight and of standard design and therefore have a known or fixed resistance per lineal unit. Accordingly, the portions of the rails 10 connected in the circuits 14 between the power input leads 30 and the related taps 32 may be considered as resistances in the circuits 14 which resistances have a given ohmage. The electrical energy delivered to a portion of the track by the leads 30 for conductance to a transformer 16^a, 16^b, 16^c and 16^d is of such character that it has only sufficient voltage to overcome the resistance offered by the rail portion and the adjacent bond 36 or 36^a with a very small residual voltage to be stepped-up by the said transformer 16^a, 16^b, 16^c or 16^d. In practice the electrical energy or power delivered to a transformer 16^a, 16^b, 16^c or 16^d through the medium of a length of the track is of such low strength that it cannot be read on an ordinary milliammeter or milli-

voltmeter although the meter has all of its readings or calibrations below 1. The bonds 36 and 36^a mentioned above will be hereinafter described.

The transformers 16^a, 16^b, 16^c or 16^d are designed to receive the low voltage current of the character just mentioned and to step it up to sufficient voltage for the control or maintenance of the control relays 13. The transformers 16^a, 16^b, 16^c and 16^d are of a special type to receive very low voltage and high amperage power and step up the same to sufficient voltage to maintain the related relays 13 in their normal condition. I prefer to construct both the primary and the secondary windings of the transformers 16^a, 16^b, 16^c and 16^d of large diametered copper wire and to provide the primary and secondary windings with very small cores. There is very low inductiveness in the cores of the primary and secondary windings of the transformers 16^a, 16^b, 16^c or 16^d so that the high potential propulsion current that may be carried by the rails 10 has little or no effect on the A. C. signal control circuits 14.

In a typical installation where the length of a portion of track between the input leads 30 and the related transformer taps 32 of a circuit 14 is 2000 feet, the leads 30 may carry current of between 5 and 6 amperes and the transformer 16^a, 16^b, 16^c or 16^d is designed to step-up the residual voltage of between .058 and .068 of one volt, remaining after the voltage drop brought about by the resistance offered by the rails 10, to about .40 of a volt with a current strength of between 1.75 and 2 amperes. From this it is to be observed that the current transformation as distinguished from the pressure transformation is the factor with which the apparatus is primarily concerned.

Leads 33 extend from the secondary windings of the transformers 16^a, 16^b, 16^c and 16^d to the coils or windings 26 of the related relays 13. Suitable condensers 34 are interposed in the leads 29 to bring the track current in the windings 25 in proper relation to the current in the windings 26. It is preferred to connect a rectifier or filter 35 in shunt relation across the taps 32 of each transformer 16^a, 16^b, 16^c and 16^d to filter out all electrical impulses and direct current from the rails 10 that might interfere with the operation of the relay circuits 14 and the associated parts. A rectifier or filter 35 is illustrated diagrammatically in Fig. 5 of the drawings.

In accordance with the invention bonds 36 of low resistance are connected across the rails 10 at the outer ends of the portion of track having the series of guarded track portions or blocks. The bonds 36 may have a resistance of between .00017 and .00022 of an ohm. The bonds 36 are spaced outwardly or longitudinally from the adjacent transformer taps 32. The spacing of the bonds 36 from the adjacent transformer taps 32 is such that the bonds transmit little or no signal control current. In a typical installation the effective current of a circuit 14 in the rails 10 may extend from 45 to 85 feet beyond the set of transformer taps 32 of the transformer at the end of the series of blocks depending upon the setting of the resistance 31 in the circuit 14 and the bond 36 is located beyond this point.

Bonds 36^a are connected across the rails 10 at points between the sets of taps 32 of the transformers of adjacent circuits 14. Thus in the case illustrated there is a bond 36^a connected across the rails 10 between the taps 32 of the transformer 16^a and the taps of the adjacent unnumbered transformer of the adjacent circuit 14 and

a bond 36^a is connected across the rails 10 at a point spaced between the taps 32 of the adjacent spaced transformers 16^b and 16^c. In accordance with the invention the bonds 36^a have a resistance greater than the resistance of a typical truck of a car or train. In practice the bonds 36^a each have a resistance of about .003 of an ohm. The taps 32 of each transformer 16^a, 16^b and 16^c are connected to the rails 10 in diagonal relation and the bonds 36^a are diagonal with respect to the rails 10 and are substantially parallel with lines drawn between the points of connection of the adjacent taps 32 with the rails.

The bonds 36^a carry or transmit a certain amount of the current handled by the circuits 14 and sufficient current is supplied to the rails 10 by the transformers 15 to compensate for the current handled or taken by the bonds 36^a. In other words, the factors of the resistance of the rails 10, the resistance of the primary windings of the transformers 16^a, 16^b and 16^c, the resistance of the bonds 36^a and the current supplied by the transformers 15 are so related or balanced that sufficient current is normally delivered to the relays 13 to maintain them energized. The diagonal arrangement of the taps 32 and the bonds 36^a provides for the simultaneous or concurrent de-energization of the relays 13 of two adjacent circuits 14 when a train truck passes over a bond 36^a. Owing to the fact that a train truck has less resistance than the bonds 36^a the passage of a truck over a bond 36^a continues to shunt out the circuit 14 that it is leaving until it reaches or passes the center of the bond 36^a, at which time the truck shunts out the circuit 14 that it is entering and thus the passage of the truck over the bond 36^a causes concurrent actuation of the block signals of the adjacent blocks to provide the desired sequence of signal operation without interruption.

The operation of the apparatus thus far described will now be set forth. It will be assumed that the transformer taps 32 are located substantially 1600 feet from their related feeds or input leads 30, that the input leads 30 of adjacent circuits 14 are approximately 300 feet apart, that the resistance of the rails 10 is .000014 ohms per foot, and that the transformers 16^a, 16^b, 16^c and 16^d pick up current of approximately .0068 volts, and approximately 2 amperes from the rails 10. It is to be understood that the effective length of a circuit 14 on the track beyond the leads 30, and in the case of an "end" circuit 14 beyond the transformer taps 32, may be adjusted or varied by means of the adjustable resistance 31 of the circuit. It is important to note that the circuits 14 overlap on the track between their adjacent feed or input leads 30, that is, the effective lengths of the circuits 14 on the rails 10 lap one over the other between their adjacent leads 30.

Let it be assumed that the relays 13 are energized and that a car or train is moving along the track from the right to the left in Fig. 1. When the foremost truck of the train passes the center of the right hand bond 36^a about ten feet, the truck shunts out the transformer 16^a and therefore effects de-energization of the relay 13 connected with that transformer. De-energization of the relay 13 results in energization of the signals B¹ and B² at the ends of the track block. As the train proceeds along the track the circuit 14 handled by the transformer 16^a remains shunted out until the rear truck of the train is a considerable distance past or beyond the input leads 30 of that circuit 14. In a typical installa-

tion of the character mentioned above the rear truck of the train will reach a point substantially 285 feet beyond the input leads 30 before sufficient current builds up in the rails 10 behind the truck to energize the relay 13 through the medium of the transformer 16^a. It is to be understood that the distance traveled by the rear trucks past the points of current feed to the rails before the relay 13 is re-energized may be varied to suit the conditions of operation and installation by adjusting the related resistance 31. It is estimated that when the rear truck has reached a position 285 feet beyond the input or feed leads 30, that there is .00850 of an ohm resistance in the rails 10 between the truck and the point of feed and this resistance, together with the resistance of the truck is such that the truck is no longer effective as a shunt. Accordingly, the relay 13 supplied with current through the medium of the transformer 16^a is re-energized when the train reaches a point approximately 285 feet beyond the input feeds 30 of the circuit 14.

Prior to the re-energization of the relay 13 through the medium of the transformer 16^a the train will have caused de-energization of the relay 13 receiving its current from the transformer 16^b. In other words, when the rear truck of the train has reached a position 285 feet beyond the input leads 30 supplying current to the transformer 16^a it is within approximately 15 feet of the input leads 30 supplying current to the transformer 16^b and, therefore, is within the effective length of the circuit 14 of the transformer 16^b. Thus it will be seen that the transformer 16^b will have shunted out some time before re-energization of the relay 13 supplied with current through the medium of the transformer 16^a. De-energization or shunting out of the transformer 16^b results in de-energization of its related relay 13 and energization of the block signals B¹ and B². In the case where the block signals B¹ and B² are interconnected, as above described, the de-energization of the relay 13 supplied with current through the medium of the transformer 16^b may result in appropriate signal changes in the signals B¹ and B².

The transformer 16^b is energized to restore the related relay 13 when the rear truck of the train is some distance past its taps 32. This results from the above described relationship between impedances in the rails 10, the bond 36^a and the primary winding of the transformer 16^a, the impedance of said winding being so low that the rail current of the circuit 14, taking the course of least resistance or impedance, flows in the said winding to a sufficient extent to restore the related relay 13 when the train truck reaches a position where the impedance in the rail circuit to the left of the taps 32 of the transformer 16^a is greater than that of the said winding of the transformer. In practice the transformer 16^b remains shunted out until the rear truck reaches a position about 10 feet past the center of the diagonal bond 36^a. Where the bonds 36^a are diagonal as illustrated, the train or its trucks may cause concurrent shunting of the transformers 16^b and 16^c with the accompanying concurrent de-energization of their respective relays 13. Thus the block signals B¹ and B², B³ and B⁴ of two contiguous blocks are simultaneously energized during the passage of the train from one block to the other and a continuously operating signal system is provided. Upon the passage of the rear trucks of the train beyond the bond 36^a

between the transformers 16^b and 16^c the current from the rails 10 passes through the transformer 16^b and its voltage is stepped-up thereby to re-energize the associated relay 13. This de-energizes the block signals B¹ and B². The operation of the other circuits 14 and their related relays 13 is the same as described above.

It is to be particularly noted that the current employed in the track circuits or control circuits 14 has just sufficient voltage to overcome the resistance or ohmage of the rails 10 and the resistance of and loss across the bonds 36^a with a very small residual voltage that is taken and stepped-up by the transformers 16^a, 16^b, 16^c and 16^d to normally maintain their related relays 13 energized. This low voltage current does not under any circumstances leak from the rails 10, short between the rails 10, or travel on down the track beyond the blocks of the respective circuits 14. In actual practice it has been found that submersion of the track, changes in the character of the roadbed, atmospheric changes, changes in temperature, and the like, have no effect whatsoever upon the low voltage current employed in the system of the invention. The overlapping of the control circuits 14 in the rails 10 between the spaced adjacent feed or input leads 30 and the diagonal bonds 36^a provide for the de-energization of one relay 13 prior to the re-energization of an adjacent relay 13 so that the track is continuously under the control of the block signal system. The longitudinal extent or effective range of a circuit 14 in the rails 10 may be readily varied by means of the adjustable resistances 31 and in practice the system may be adjusted to provide for signal operation by the shunting effect of a train truck at any given point on the track with an accuracy of within a very few feet.

The operating circuit 17 for the traffic signals or intersection signals S may include a lead 40 extending from one conductor of the power line 20 to the signals S. In the drawings I have shown the signals S grounded, it being understood that a return conductor may extend from the signals S to the other conductor of the power line 20. The conductor 40 extends to the two control relays 18 and is governed or controlled by the relays 18, as will be subsequently described.

The relays 18 are normally energized and are under the control of the circuits 14 of the adjacent block signals. The relays 18 may be similar to the relays 13 and each comprises a movable element 41 and two windings 42 and 43 normally energized to hold the element 41 in the up or normal position. Conductors or leads 44 may extend from the power supply leads 29 of the adjacent relays 13 to the coils 42 so that the coils 42 are energized at all times. The coils 43 of the relays 18 may be connected with associated transformers 19, receiving current from the track rails 10, or may be connected in the leads 33 from the adjacent or related transformers 16^c and 16^d. In the particular arrangement shown in the drawings the coil 43 of one relay 18 is connected with the transformer 19 by leads 45 and the winding 43 of the other relay 18 is connected with the leads 33 extending from the transformers 16^c. Suitable condensers 46 may be provided in the leads supplying the windings 42 so that the windings 42 are properly related to the windings 43. Each relay 18 further includes two contacts 47 connected in the lead 40 of the signals S. Upon de-energization of a re-

lay 18 its element 41 falls to cooperate with a pair of contacts 47 to close the circuit to the signals S.

In accordance with the invention the relays 18 are interlocking relays so that the signals S are de-energized following the passage of the train over the intersection or road R, that is, following the movement of the train from one circuit 14 to the other circuit 14. As best illustrated in Fig. 3 of the drawings the element 41 of a relay 18 is operatively connected with a segment-like member 50 pivoted or turnably supported at 48. The members 50 operate through the medium of suitable linkages 49 to move the contactors or elements 41 against the contacts 47 and the other contacts of the relays 18. The improved interconnecting means of the invention includes a pin 51 on each member 50 and a pivoted latch 52 for cooperating with each pin 51. Pivot pins 53 support the latches 52 at their lower ends and posts 54 are adapted to limit the pivotal movement of the latches in one direction and to normally support the latches in reclining positions. When the latches 52 rest against their posts 54 they are out of the paths of the pins 51. The upper portions of the latches 52 have notches 55 for cooperating with or receiving the pins 51.

The interlocking means further includes solenoid coils 56 for actuating or shifting the latches 52. The coils 56 operate when energized to move their respective latches 52 to positions where their notches 55 receive the pins 51 so that the latches prevent falling or downward movement of the members 50 and their elements 41. The circuit of one coil 56 comprises a conductor or lead 57 connected with a suitable power lead such as a lead 44 and a lead 58 extending to the other relay 18. The lead 58 has two spaced contacts 59 in the said other relay 18 to be contacted or closed by its element 41. The other coil 56 has a lead 60 connected to a power lead such as one of the leads 29 and has its second lead 61 extending to the other relay 18. The lead 61 is provided with spaced contacts 62 controlled or engaged by the element 41 of the said other relay 18.

It will be seen that the de-energization of one relay 18 results in energization of the coil 56 of the other relay 18 to move the related latch 52 to a position to stop the falling or to prevent the falling of the element 41 of the said other relay 18. In practice the slight movement of a relay element 41 to engage its pin 51 in a latch notch 55 is insufficient to close the contacts of the relay. Accordingly, the interconnecting means is such that de-energization of one relay 18 prevents the subsequent closing of the contacts of the other relay 18. The pins 51 and the notches 55 are formed and related so that the re-energization of a relay 18 results in the restoration of its latch 52 to an inactive position. In practice the re-energization of a relay 18 is accompanied by slight upward movement of its member 50 and element 41 and during this upward movement the pin 51 cooperates with the notch 55 of the adjacent latch 52 to return the latch to its released position.

The relay 18 whose winding 43 is supplied with current from the track circuit leads 33 is operable simultaneously with the associated relay 13. Thus in the case illustrated in the drawings the shunting out of the transformer 16^c by a train truck causes simultaneous de-energization of the related relay 13 and the related relay 18 so that the block signals B³ and B⁴ and the signals S

are simultaneously energized. Accordingly, the circuit 14 embodying the transformer 16^c governs both a set of block signals and the traffic signals S and the current carried by the rails 10 is the controlling or energizing medium of this circuit.

The transformer 19 receives low voltage and high amperage current from the rails 10 and delivers current of substantial voltage to its related relay 18 to normally hold the same energized. The transformer 19 is preferably similar in construction and operation to the transformers 16^a, 16^b, 16^c and 16^d described above. The transformer 19 has its primary connected across the rails 10 by taps 65 and has its secondary connected in the above mentioned leads 45. The taps 65 are connected across the rails 10 at a point between the taps 32 of the transformer 16^d and the input leads 30 of the adjacent transformer 15. In this connection it will be observed that the transformer 16^d and the transformer 19 are both supplied with current from a single set of input leads 30. A filter or rectifier 66 similar in character to the rectifiers 35 is connected between or across the taps 65 to prevent the transmission of foreign current to the transformer 19.

The relationship between the transformers 16^d and 19 and the resistance in the track rails 10 is such that the transformers receive current of substantially the same voltage and amperage. The resistance across the rails 10 offered by the transformer 19 is greater than that offered by the transformer 16^d and the transformers 16^d and 19 are balanced with the resistance of the rails 10 so that the two transformers receive substantially the same voltage. It will be seen that the current or energy delivered to the rails 10 by the transformer 15, the resistance of the portion of track between the input leads 30 and the taps 65, and the resistance of the rails 10 between the taps 65 and the taps 32 of the transformer 16^d must be determined and related to provide for the above-mentioned balanced condition of the transformers 16^d and 19. It is to be understood that the taps 65 of the transformer 19 may be connected with the track at any desired point between the transformer taps 32 and the input leads 30. The variable resistance 31 of the circuit 14 may be set or adjusted to provide for the transmission of energy of the desired voltage and amperage to the transformers 16^d and 19.

The operation of the circuits for controlling the intersection signals S is as follows. It will be assumed that a train is moving along the track and is passing over the bond 36^a between the adjacent transformers 16^b and 16^c. The foremost truck of the train shunts out the transformer 16^c when it reaches a certain point spaced from the transformer taps 32, said point being about 10 feet past the center of the diagonal bond 36^a. When the transformer 16^c is shunted out its relay 13 is de-energized and the relay 18 whose winding 43 receives current from the transformer 16^c is likewise de-energized. De-energization of the relay 13 results in actuation of the block signals B³ and B⁴ and de-energization of the associated relay 18 results in actuation of the signals S. De-energization of the said relay 18 also causes closing of the contacts 62 so that the coil 56 of the other relay 18 is energized. The energized coil 56 moves the adjacent latch 52 to a position where its notch 55 is adapted to receive the pin 51 on the relay member 50. When the forward portion of the train reaches and passes the intersection of the road R with the track the

train trucks shunt out the transformers 19 and 16^d. The current of the two circuits 14 overlaps on the rails 10 at the intersection of the road R and the track so that the transformer 16^c remains shunted out some time after the transformers 16^d and 19 have been shunted out as above described. With the typical data given above, the transformer 16^c remains de-energized or shunted out until the rear truck of the train reaches a position about 15 feet from the taps 30 of the transformer 15 supplying current to the transformers 16^d and 19.

Shunting out of the transformers 16^d and 19 results in de-energization of the associated relays 13 and 18. De-energization of this relay 13 keeps the block signals B³ and B⁴ energized and de-energization of the relay 18 is accompanied by falling of its member 50 and element 41. However, due to the fact that the latch 52 of the said relay 18 is held in its active position by the adjacent coil 56 the member 50 falls only a short distance until its pin 51 is received in the notch 55. The cooperation of the pin 51 with the notch 55 limits the down travel of the element 41 and stops the element before the contacts of the relay 18 are closed. It is to be observed that the relay 18 governed by current from the transformer 19 is de-energized prior to the re-energization of the other relay 18 and that its latch 52 is held in the active position until the member 50 has dropped, as just described. The latch 52 cooperating with the pin 51 holds the element 41 in the inactive position and thus prevents a second or a continued energization of the signals S at the intersection or road R following the movement of the train beyond the intersection. When the train reaches a position where its rearmost truck is some distance beyond the taps 65 of the transformer 19 sufficient current reaches the transformer 19 to effect the re-energization of its relay 18. Re-energization of this relay 18 is accompanied by a slight upward movement of its member 50 and the pin 51 on the member 50 cooperates with the notch 55 to move the latch 52 to its released or normal position against the post 54. Thus the relays 18 are restored to their normal condition when the train has passed the taps 65 of the relay 19.

The block signals B³ and B⁴ remain energized until the rear truck of the train reaches a position past or beyond the taps 32 of the transformer 16^d. When the rear truck of the train has reached a position say 85 feet beyond the taps 32 of the transformer 16^d sufficient current reaches the transformer through the rails 10 to cause re-energization of the related relay 13. The operation of the signal control circuits for governing the block signals as well as the intersection signals S is the same during train travel or movement in both directions on the track.

When the train or car travels from the left to the right in Fig. 1 the transformer 16^d is shunted out as described above when the train reaches a given position, but the transformer 19 does not become shunted out until the train reaches a position to the right of the transformer 16^d. In practice the transformer 19 may remain energized until the train reaches a position of, say, 60 feet from the transformer 19 at which point the train truck shunts out the transformer. Thus the transformers 16^d and 19 are independently and successively de-energized or controlled when the train travels from the left to the right.

Having described only a typical preferred form and application of my invention I do not wish to be limited or restricted to the specific details

herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art, or fall within the scope of the following claims.

5 Having described my invention, I claim:

1. A control for signal means at the intersection of a highway and a track having conductively continuous rails, comprising relays for governing the signal means, two transformers connected across the rails at longitudinally spaced points and adapted to step up low voltage current from the rails to current of higher voltage and each delivering the current to one of said relays to control the same, the transformers being at 10 opposite sides of the intersection, and two current supply means connected with the rails at spaced points spaced between the transformers, each of said current supply means delivering current of just sufficient potential to overcome the said rail resistance between it and the nearest transformer with a residual voltage transmission to its nearest transformer for the control of the relay connected therewith and to provide a circuit in the rails capable of being shunted out by a train truck within a known limited zone extending in one direction beyond the point of feed to the rails and extending in the other direction beyond the point of connection of the said nearest transformer with the rails, the said circuit zones of the 15 current supply means overlapping throughout a zone on the track crossing the highway whereby both circuits may be simultaneously shunted out by a truck moving across the intersection in either direction.

2. In combination with a track having conductively continuous rails and a circuit to be controlled, relays for governing the circuit, two transformers connected across the rails at longitudinally spaced points and adapted to step up low voltage current from the rails to current of higher voltage and each delivering the current to one of said relays to control the same, two current supply means connected with the rails at spaced points spaced between the points of connection of the transformers with the rails, and low impedance bonds connecting the rails at points spaced beyond the transformers, each of said current supply means delivering low voltage current to the rails of sufficient potential to control a relay through the medium of the nearest transformer and related to the rail and bond resistances to provide a current flow circuit zone extending along the rails in one direction from its point of connection with the rails to the closest of said bonds and extending along the rails in the other direction toward the point of the connection of the other current supply means with the rails and being a zone within which a train truck may shunt out the circuit to affect the relay supplied with current by said supply means, said zones of the spaced current supply means overlapping in a portion of the track between the points of connection of the spaced current supply means with the track whereby both relays may be concurrently affected by a truck on the track between said current supply means, the rails being electrically independent except for said bonds and the said transformer and power supply means connections.

3. A signal system for use in connection with a track having electrically conductive rails comprising signals arranged along the track to guard blocks thereof, and control systems for the several blocks each comprising two relays for controlling the signals, a transformer connected with 75

the rails in spaced relation to each end of the block for delivering control current to one of said relays, the transformers being operable to receive very low voltage current from the rails and convert it to current of sufficient voltage for the control of the relays, and two current supply means connected with the rails at spaced points spaced between the transformers and each delivering low voltage current related to the rail resistance to provide for the control of the relays through the medium of the nearest transformer and to create a zone on the rails extending toward the input of the other supply means in which a train truck may shunt out the said nearest transformer, the said zones of the spaced supply means overlapping along the rails in a portion of the track between the two current supply means, and low resistance bonds connecting the rails at points between the transformers of adjacent blocks, the rails being conductively continuous throughout the series of blocks.

4. In combination, a track having conductively continuous rails, a plurality of signal means, a relay for governing each signal means, two transformers connected across the rails at points spaced longitudinally of the track and each capable of receiving low voltage current from the rails and stepping up the voltage for the control of a relay, two current supply means connected with the rails at spaced points and between the points of connection of the transformers with the rails, each of said means supplying current to the rails of low voltage to energize the nearest of said transformers and to create a zone extending along the rails toward the other supply means in which a train truck will shunt out the said transformer, the said zones of the two supply means overlapping in a portion of the track between the spaced supply means, and a third transformer connected across the rails at a point between one of the first named transformers and a supply means receiving track current supplied by the last named means and controlling a relay, the resistance of the third transformer across the rails being greater than the resistance of the adjacent first named transformer to be affected by train truck movement along a zone on the rails shorter than the rail zone controlling said adjacent first named transformer.

5. A signal system for use in connection with a track having conductively continuous rails comprising signals arranged along the track to guard blocks thereof, and control systems for the several blocks each comprising two relays for controlling the signals, a transformer connected with the rails in spaced relation to each end of the block, each transformer delivering control current to one of said relays, the transformers being operable to receive low voltage current from the rails and convert it to current of sufficient voltage for the control of the relays, and two current supply means connected with the rails at spaced points spaced between the transformers and each delivering low voltage current related to the rail resistance to provide for the control of the relays through the medium of the nearest transformer and to create a zone on the rails extending toward the input of the other supply means in which a train truck may shunt out the said nearest transformer, the said zones of the spaced supply means overlapping along the rails in a portion of the track between said supply means, and low resistance bonds connecting the rails at points between the transformers of adjacent blocks, the points of connection of each 75

of said bonds with the rails being in diagonal relation to the rails and each bond having a resistance greater than that of the train truck shunt which comprises said truck and the portions of the rails between said truck and the points of connection of the adjacent transformer with the rails when said truck is between the center of the bond and the adjacent transformer, the points of connection of the transformers with the rails being in diagonal relation to the rails and being so related that lines drawn through them are in substantially parallel relation to the adjacent bonds whereby the adjacent transformers are both shunted out when the truck passes over the bond.

6. A signal system for use in connection with a track having electrically conductive rails comprising signals arranged along the track to guard blocks thereof, and control systems for the several blocks each comprising two relays for controlling the signals, a transformer connected with the rails in spaced relation to each end of the block for delivering control current to one of said relays, the transformers being operable to receive very low voltage current from the rails and convert it to current of sufficient voltage for the control of the relays, and current supply means connected with the rails between the transformers and delivering low voltage current related to the rail resistance to provide for the control of the relays through the medium of the transformers, and bonds connecting the rails at points between the transformers of adjacent blocks, the

points of connection of the bonds with the rails being in diagonal relation to the rails and the impedances of the primaries of the transformers and the aggregate impedance of the adjacent bonds and the rail portions between the bonds and the adjacent transformers being so related that the passage of a car truck over a substantial portion of the track between the ends of a diagonal bond causes concurrent de-energization of the relays supplied by the two adjacent transformers during such passage of the truck.

7. A circuit controlling system for use in connection with a track having conductively continuous rails comprising two relays for the control of said circuits, a low resistance bond connecting the rails, and control circuits for the relays, each control circuit including input leads connected with the rails at points spaced from the bond and delivering low voltage current to the rails, the input leads of said control circuits being connected with the rails at opposite sides of the bond and each control circuit including a transformer connected with the rails between the bond and the input leads of its control circuit operable to receive low voltage current from the rails and convert it into current of sufficient voltage for the control of a relay, the points of connection of the bond with the rails being in diagonal relation to the rails whereby both relays are shunted out when a train truck is passing over the bond.

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