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Pascoe

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[54] TRAIN DETECTION SYSTEM FOR RAILROAD GRADE CROSSING

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[52] **U.S. Cl.** .....**246/114,** 246/29 R

[51] **Int. Cl.** **B61l 23/00**

[58] **Field of Search**.....246/111, 112, 113, 125, 130, 246/29 R, 114, 115

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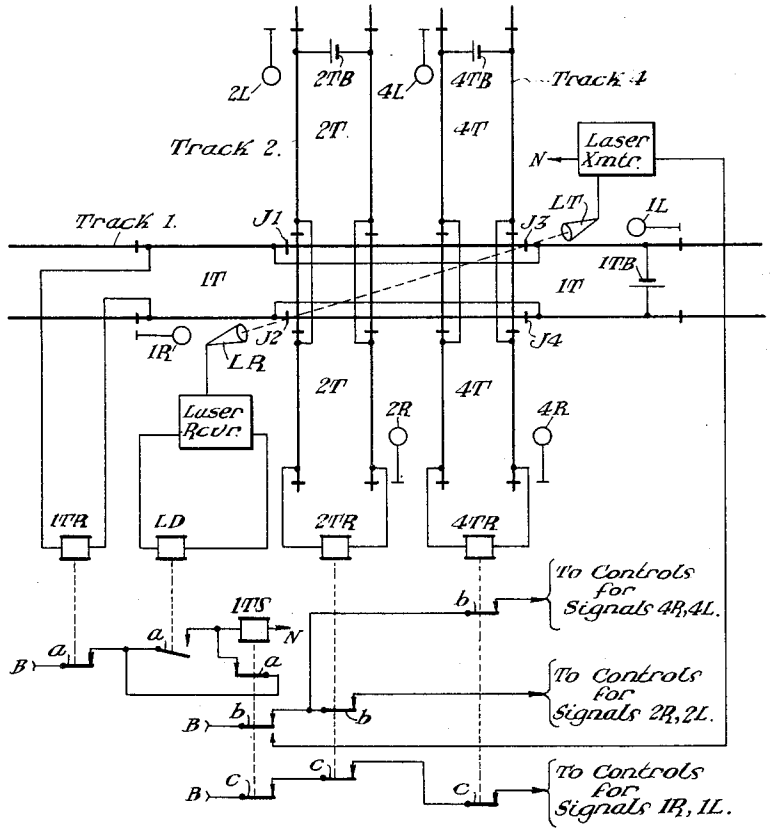
[57] **ABSTRACT**

Laser beam presence detection apparatus is positioned to detect a railroad car occupying any part of the crossing portion of a stretch of track which intersects other tracks in a railroad grade crossing. The laser detector thus checks the occupancy condition of the track portion which is insulated from the adjacent conventional track circuit on each side but is long enough to hold a complete car which does not then shunt the track circuit. The laser detector and the track circuit relay jointly control a stick relay normally held energized solely by the track relay. The laser apparatus is approach energized by the release of the stick relay when a train initially occupies either part of the adjacent track circuit. The stick relay is reenergized only when the track relay and the laser detector each record a non-occupied condition for the corresponding section of the crossing track. The stick relay controls the entering signal circuits for all possible conflicting routes through the crossing area but simultaneous parallel moves are permitted.

8 Claims, 2 Drawing Figures



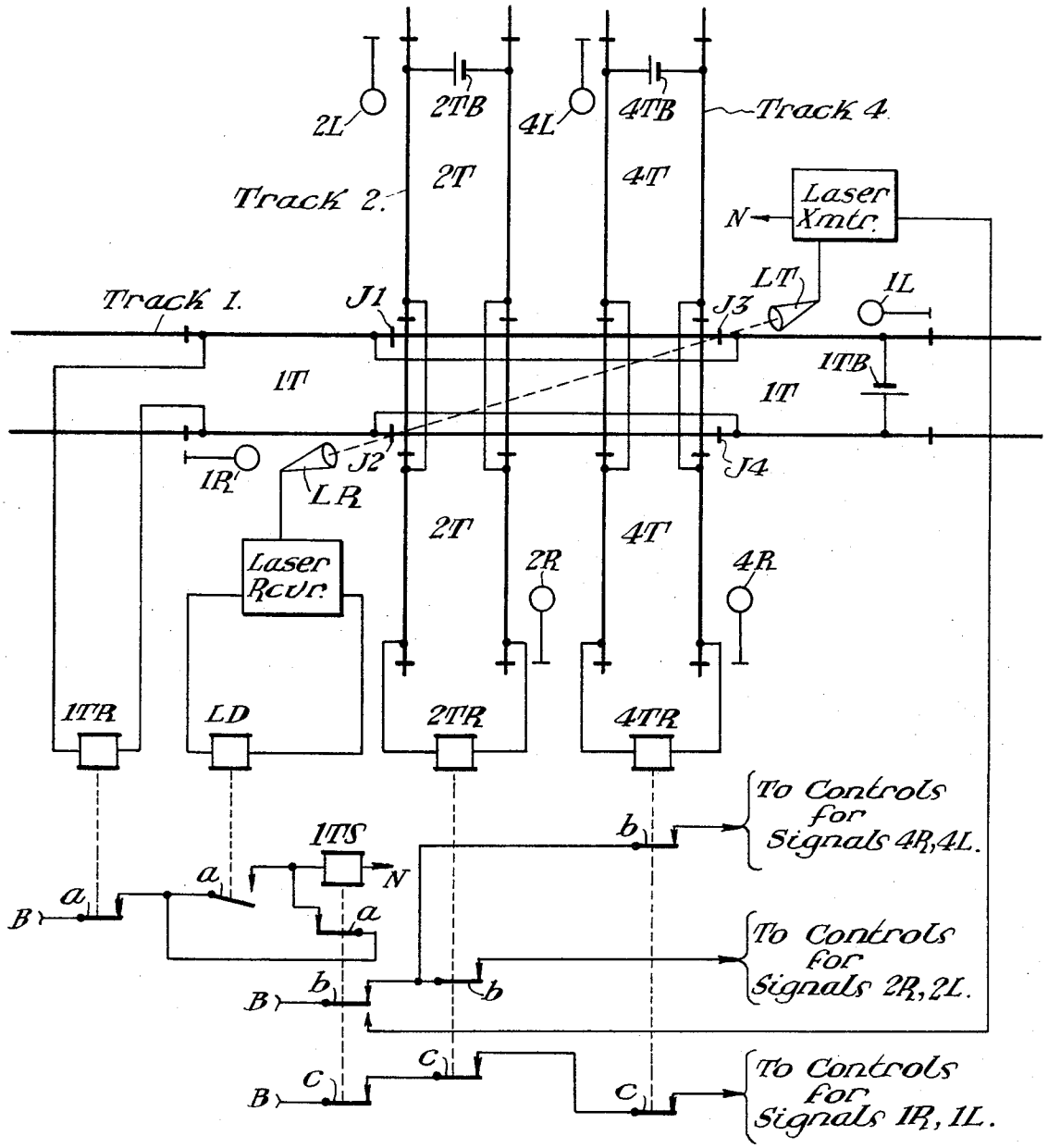


Fig. 1.

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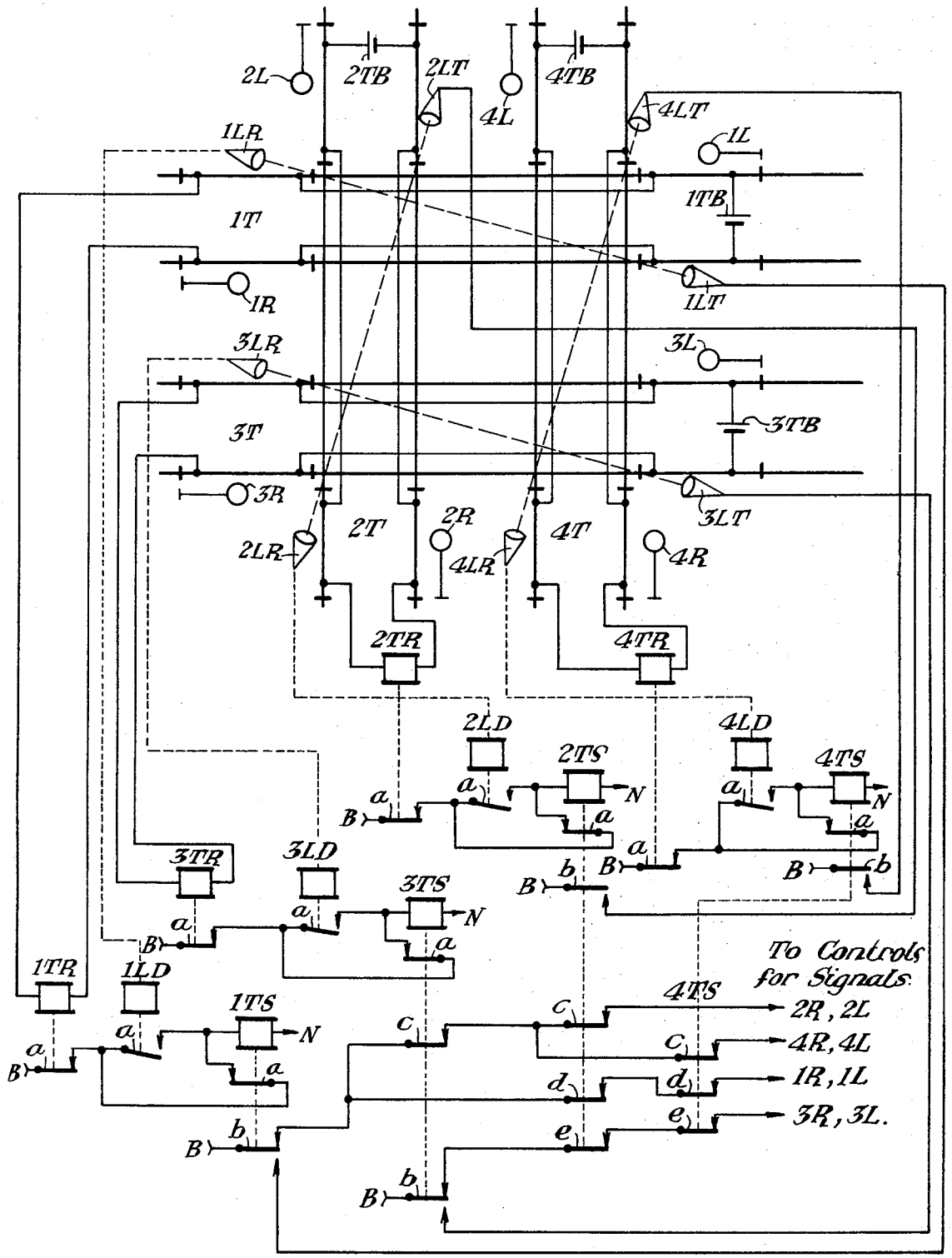

Fig. 2.

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TRAIN DETECTION SYSTEM FOR RAILROAD GRADE CROSSING

This invention pertains to a train detection system for railroad grade crossings. More specifically, my invention is an arrangement using a combination of laser beams and track circuits to continuously detect the presence of a train or a single railroad car occupying any portion of a track within the outer or interlocking limits of a crossing, at grade, of two or more railroad tracks.

The continuous detection of trains at or within locations where two or more railroad tracks cross each other at grade has historically been a problem requiring special measures to overcome. The problem arises because the physical structure of the crossing rails creates permanent shunt paths which prevent the use of the well known track circuit type of detection. Various arrangements of regular track circuits, check in and out apparatus, special track circuit connections, and special insulated joint arrangements have been used to provide complete and reliable detection of a train within the crossing area, in order to control safely other trains desiring to traverse the crossing area. That is, other trains must be prevented from entering the crossing area when a train or any portion of a train, such as a single car, is already occupying one of the intersecting tracks. These prior art arrangements have deficiencies which must be overcome by special operating rules. Such rules, of course, depend upon human observance and obedience and accidents have occurred because of human failure to obey and/or understand completely the operating rules. Thus an arrangement which assures the continued detection of a train or railroad car occupying any portion of a railroad crossing is needed to prevent the existence of an unsafe operating condition.

Accordingly, an object of my invention is an improved train detection system for railroad grade crossings.

Another object of the invention is a train detection system for railroad crossings using a combination of track circuits and optical detectors, such as laser beams, for continuous detection of any part of a train positioned within the crossing limits.

A further object of my invention is a laser beam detection arrangement for use in railroad grade crossing track layouts to detect the occupancy of the crossing track portion by railroad cars.

Still another object of this invention is a combined arrangement of track circuits and laser beam detectors to provide continuous detection of a railroad train or single car moving along or occupying any part of a particular track at a crossing between two or more railroad tracks.

It is also an object of my invention to provide a laser beam detection arrangement for railroad grade crossing locations which operates jointly with conventional track circuits to provide continuous detection of train or car located within the crossing limits.

A still further object of my invention is a train detection and signaling system for railroad grade crossings which provides continuous detection of trains moving or standing within the crossing limits to prohibit conflicting train movements, yet allows simultaneous moves along parallel routes through the crossing area.

Other objects, features, and advantages of my invention will become apparent from the following specification when taken with the accompanying drawings and appended claims.

In the system of my invention, I make use of the conventional track circuits for detecting the presence of trains outside the actual crossing portion of the intersecting tracks. These track circuits, one for each track involved, are insulated from the permanent shunts created by the physical rail structure within the crossing portion. The track circuits then detect the occupancy of the track sections within the signaling or interlocking limits which protect the movement of trains over the railroad crossing. In addition to these track circuits, optical detection means are positioned to detect the presence of any part of a car occupying the crossing portion of the associated track along which the detector means is positioned. The so-called crossing portion of the track, to be explained in detail later, briefly is that portion of a track which a car occupies as it traverses the actual crossing with the intersecting track and which is electrically isolated from all detector track circuits. Each optical detector means is specifically shown as laser beam presence detection apparatus. The transmitter and receiver units of each detector set are positioned longitudinally along the corresponding track, but on opposite sides of the rails. These units are sighted so that the laser beam from the transmitter is received by the receiver unit only when no car is occupying any part of the crossing portion of the track. The laser beam is thus relatively parallel to the track on which the presence of a car is to be detected with only a small angle of divergence between the track and the laser path.

The track circuit and the laser detector means are used jointly to detect the occupancy of the stretch of the associated track extending through or between the crossing limits. A track stick relay, normally held energized by the track circuit relay, records or indicates the occupancy condition of this stretch of track. An approaching train releases the track relay and thus the track stick relay to indicate an occupied track. This latter relay can then only be reenergized through joint control by the track relay and the laser detector means. A train moving through the crossing stretch occupies the crossing portion and interrupts the laser beam which thus detects the presence of this particular train at that point. If the train or a single car continues to occupy only the crossing portion, the laser beam is held interrupted, and thus holds the track stick relay released to continue to record the track occupied indication. When a train moves through the crossing stretch and clears the crossing limits completely, both the track relay and the laser detector means will indicate a non-occupied condition. Under this condition, the track stick relay is reenergized to record a non-occupied indication, and subsequently hold the non-occupied condition as the track circuit remains clear. This stick circuit arrangement permits the laser beam to be approach controlled and thus active only when a train is closely approaching the crossing site. The track stick relay exercises the basic control of the signal or interlocking circuit arrangement so that conflicting train moves through the crossing location cannot be authorized as long as any part of a train, e. g., a single car, occupies any part of the corresponding track.

I shall now describe in greater detail the train detection arrangement for a railroad grade crossing embodying the features of my invention and shall then point out the novel features thereof in the appended claims. During the following description, reference will be made from time to time to the accompanying drawings in which:

FIG. 1 shows in partly schematic, partly diagrammatic manner a single detection arrangement embodying the basic concept of my invention.

FIG. 2 illustrates in a similar manner an expanded arrangement incorporating several basic systems for use where two sets of several parallel tracks cross at grade.

In each of the drawings, similar reference characters designate similar parts of the apparatus. Also in each illustrated arrangement, a source of direct current energy is assumed, of any well known type, having proper voltage for the apparatus in use and sufficient capacity to completely operate this system. The actual source of energy is not shown since the use of such is conventional, but connections to its positive and negative terminals are designated by the references B and N, respectively. It will thus be understood that, where either of these reference characters appear in the drawings, a connection to the corresponding terminal of the direct current source is indicated.

Referring now to FIG. 1, a stretch of single railroad track, shown horizontally and designated as track 1, is illustrated as intersecting two parallel tracks, shown vertically, designated as track 2 and track 4. Each rail of these tracks is shown by a conventional single line representation. It is assumed that the spacing of tracks 2 and 4 is such that at least some of the railroad cars which normally traverse track 1 can occupy the crossing portion of this track without also occupying the conventional track circuits, to be discussed, which lie outside the crossing portion but within the overall crossing limits. In this basic showing, it is assumed that a similar problem of train detection does not exist for trains and cars moving along on either track 2 or track 4. The so-called crossing portion of the stretch of track 1 is that bounded by the insulated joints illustrated by conventional symbols and designated as J1, J2, J3, and J4. Similar crossing portions exist in each of the intersecting tracks, but the insulated joints shown conventionally are not specifically designated. As previously mentioned, within the bounding joints of the crossing portion, permanent electrical shunts exist between each set of parallel rails due to the physical structure of the rail crossings.

Each stretch of track also includes an insulated section on each side of the crossing portion. The outer limits of these track sections are established by insulated joints and correspond in the illustration to the location of the signals controlling train movement from that direction through the crossing area. Specifically, track 1 includes a track section 1T which is divided into two parts, one on each side of crossing portion of this stretch of track. In tracks 2 and 4, track sections 2T and 4T, respectively, exist on each side of the corresponding crossing portion. At each outer limit along track 1, as defined by insulated joints, that is, at each end of section 1T distant from the crossing, a signal 1R or 1L controls the movement of trains along track 1 to the right and to the left, respectively. At the similar outer limits along tracks 2 and 4 are located signals 2R, 2L and 4R, 4L, respectively, which likewise control the movement of trains in opposite directions along each of these tracks.

Each of the listed track sections is provided with a track circuit, which may be of any conventional type but is specifically shown as being a direct current, neutral track circuit including the rails of the section, a track battery, and a track relay. For example, for track section 1T, track battery 1TB is connected across the rails at the right hand end of the section. At the left end, track relay 1TR is similarily connected across the rails adjacent the insulated joints marking the outer limits of the crossing area. However, different from the conventional track circuit in a normal stretch of track, special bond connections are required to connect the rails of the two parts of this track section and thus bypass the permanent rail shunts existing within the crossing portion of track 1 which are insulated from the remainder of the track by the insulated joints J1, J2, J3, and J4. When no part of a train occupies either part of track section 1T, so that no shunt exists across or between the rails, relay 1TR is energized with current from track battery 1TB and holds in its picked up position. The presence of an axle shunt of a train or car anywhere within section 1T deenergizes relay 1TR which then releases to indicate the occupancy of the section. The track circuit for track section 2T includes battery 2TB and relay 2TR as well as the rails of this track section and special bypass connections while the circuit for section 4T includes battery 4TB, relay 4TR and the corresponding rails and bypass connections. It will be obvious from this description that, within the crossing portion of each illustrated track, there is no train detection by track circuit.

In order to provide train detection for the crossing portion where a track circuit can not be used, my invention provides laser beam apparatus. However, since the insulated crossing portion of tracks 2 and 4 is so short that a railroad car can not possibly be contained completely between the insulated joints, laser apparatus is only required in connection or associated with track 1. Any standard laser apparatus can be used and thus the laser detector is illustrated by conventional symbols. At the right, a laser transmitter unit to develop the signal is illustrated by a block, and a symbolic beam antenna designated by the reference LT is connected therewith. The path of the laser beam across the crossing portion of track 1 is designated conventionally by the dashed line. At the left, to receive the beam, an antenna device designated by the reference LR is schematically shown connected with a laser receiver block which detects the signal from the transmitter and provides an output when this signal is present. Such power supply as may be needed for operation of the laser receiver unit is assumed although not shown in the drawing. That for the laser transmitter unit will be discussed shortly. When the laser receiver unit produces an output, it is applied to the winding of a laser detector relay LD which, thus energized, picks up to close its front contacts. Since the transmitter unit is normally deenergized, except upon the approach of a train, relay LD is shown as normally occupying its released position. The laser apparatus is so positioned that the resulting beam is interrupted by some part of any car that is solely standing within this crossing por-

tion of track 1 and is not shunting the track circuit of section 1T. Under these conditions, of course, the detection of the occupancy of the stretch of track is solely dependent upon the laser apparatus. To eliminate continuous operation of the laser apparatus, the transmitter is approach controlled. In other words, operating energy is normally disconnected and is supplied at times from the direct current source, i. e., terminals B and N, over back contact *b* of a track stick relay 1TS which will be shortly defined. This procedure of approach supply of operating energy to the laser transmitter also prevents an inadvertent detection operation, i.e., interruption of the beam, by persons or objects other than a train or railroad car.

A recording or indication of the occupancy condition of track 1 is provided by the previously mentioned track stick relay 1TS which, similar to a track relay, indicates an occupied track when released and a non-occupied track when picked up. This relay is normally held energized, that is, when no train is moving along track 1, by a stick circuit including the relay winding and its own front contact *a* and front contact *a* of track relay 1TR, the energy being supplied by the direct current source. The pick up or energizing circuit for relay 1TS extends from terminal B over front contact *a* of relay 1TR, front contact *a* of relay LD, and the winding of relay 1TS to terminal N. Thus both relay 1TR and relay LD must be picked up, each indicating a non-occupied condition of the particular section of track 1 with which it is associated, before relay 1TS can pick up to complete its stick circuit above traced.

Relay 1TS controls the operation of the various signals which authorize train movements through the crossing area. The signal control circuit networks are shown only partially, that is, only that part controlled by the illustrated train detection apparatus. Other safety checks and manual or automatic controls will also be included in each signal control circuit as will be understood by those familiar with railroad interlocking art. For example, the control circuits for signals 1R and 1L include a common circuit path which, as illustrated, extends, in series, over front contacts *c* of relays 1TS, 2TR, and 4TR. Thus, before either of the signals 1R or 1L can be cleared for train movement, a track occupancy check is made that section 1T and the corresponding crossing portion of track 1 and track sections 2T and 4T of the intersecting tracks are all clear, that is, are not occupied by any part of a train. The control circuit network for signals 2R and 2L includes front contact *b* of relay 1TS and front contact *b* of relay 2TR, thus checking the occupancy condition of track 1 and track 2 as included within the crossing limits. In a similar manner, the controls for signals 4R and 4L include a check over front contact *b* of relay 1TS and front contact *b* of relay 4TR. It will be obvious that the control circuits for the signals for track 2 and track 4 do not check the occupancy of the associated parallel track since there is no conflict between simultaneous movements along the two parallel tracks.

I shall now describe the operation of the train detection arrangement illustrated in FIG. 1. The apparatus is shown in its normal condition, that is, the at-rest condition when no train is occupying any portion of the tracks illustrated. Since all track circuits are clear, all track relays TR are in their picked up condition. Relay 1TS is also held energized by its stick circuit, as previously described. The laser apparatus is turned off since the transmitter energizing circuit is open at back contact *b* of relay 1TS. Thus relay 1D is in its released condition, as illustrated, since no laser signal is being received by the laser receiver unit. The portions of the signal control circuit networks illustrated are all complete since the track relays and relay 1TS are all picked up. However, no signal is cleared until other controls are actuated to effect such operation. It will now be assumed that signal 1R is cleared for a train approaching along track 1.

As this train moves along track 1, it enters section 1T, shunting the rails and thus deenergizing relay 1TR which releases. Relay 1TR opens its front contact *a* to interrupt the stick circuit for relay 1TS which releases to record or indicate a track occupied condition for track 1. The opening of front contact *a* of relay 1TS at this time interrupts the stick circuit for this relay so that it can only be reenergized when its regular energizing circuit is complete. The closing of back contact *b* of relay 1TS completes the energizing circuit for the laser transmitter. The beam is transmitted along the illustrated path and is initially received by the receiver unit so that relay LD is energized and picks up. However, the closing of front contact *a* of relay LD will not reenergize relay 1TS since front contact *a* of relay 1TR remains open. Shortly the train interrupts the laser beam as it advances along track 1 and relay LD again releases. The release of relay 1TS to open its front contacts *b* and *c* interrupts the signal control circuits so that no conflicting train movement may be authorized at this time.

The train then proceeds along track 1 over the railroad crossing and, being a complete train, retains the track circuit shunted at all times so that relay 1TR remains released. It is to be noted, however, that this train does not shunt the track circuits in the two intersecting tracks so that relays 2TR and 4TR remain picked up. However, signals, 2R, 2L and 4R, 4L can not be cleared to allow a train movement since, as previously mentioned, their control circuits are open at front contact *b* of relay 1TS. As the rear of the train clears the crossing track portion, the laser beam is again received by receiver unit LR and relay LD is energized and picks up. Subsequently, when the train clears track section 1T, relay 1TR is reenergized and picks up. The closing of front contact *a* of relay 1TR, with front contact *a* of relay LD already closed, reenergizes relay 1TS. This latter relay picks up, closing its front contact *a* to complete its previously traced stick circuit. Relay 1TS also opens its back contact *b* to deenergize laser transmitter LT so that the beam is shut off and relay LD once again is deenergized and releases. However, since the stick circuit for relay 1TS is already complete, the opening of front contact *a* of relay LD has no effect on relay 1TS. The signal circuits, that is, the portions shown, are now complete and control of any of the signals, remotely or automatically, is now possible to authorize other train movements through the crossing area.

It should be noted also that the passage of a train along track 2 or track 4 releases the corresponding track relay 2TR or 4TR, respectively. The release of either of these track relays opens, at the corresponding

front contact *c*, the control circuits for signals 1R and 1L so that authority for a conflicting movement can not be given or established. However, it will be also noted that, if relay 2TR is released by a train in that track, the control circuit for signals 4R and 4L is still complete and, conversely, the control circuit for signals 2R and 2L remains complete if relay 4TR is released. Thus simultaneous moves along these parallel tracks through the crossing area is possible, as long as track 1 remains clear of a train.

For further explanation of the operation, it is assumed that a train is doing switching work along track 1 in the area, moving back and forth over the railroad crossing. As this train enters section 1T from either direction, it causes the apparatus to operate as previously described for the through train movement. In other words, the control circuits for clearing signals 2 and 4 in either direction are interrupted. If this train, during its switching work, leaves a car standing in the crossing portion of track 1, that is, in the portion insulated from the track circuit of section 1T, this car will hold the laser beam interrupted and relay LD thus remains released. If the remainder of the train then clear section 1T, the track circuit will function to record a not-occupied indication for the track section so that relay 1TR picks up. This is possible, of course, since the crossing portion, that is, the rails of track 1 bounded by insulated joints J1 to J4, is not part of the conventional track circuit and the bypass connections around the permanent rail shunts in the crossing portion complete the track circuit for the flow of energy to relay 1TR. However, relay 1TS can not be reenergized since its control circuit is open at front contact *a* of relay LD as long as a car is occupying the crossing portion. Since front contact *b* of relay 1TS remains open to interrupt the control circuit network, signals 2 and 4 in either direction can not be cleared even though the track circuit for section 1T does not detect the car occupancy. The invention arrangement thus provides protection against a car occupying a portion of the crossing area and yet not shunting the conventional track circuit used for train detection. In other words, detection of the car by the laser apparatus retains the safety features necessary in any railroad interlocking including such crossing area.

Referring now to FIG. 2, an expanded form of the arrangement of my invention is shown applied to a railroad crossing which involves two sets of tracks, each set comprising two parallel tracks. In this arrangement, the crossing portion of each track is assumed to be long enough that some cars moving along that track will not span the isolated portion between the bounding insulated joints and thus will not shunt the adjacent track circuit. Thus in addition to the track circuit detection, each track is provided with an optical detector in the form of the previously described laser beam apparatus. For simplicity, the laser apparatus is shown very conventionally using only the symbols from FIG. 1 designating the transmitter and receiver antennas. Each transmitter antenna is designated by the reference LT and each receiver by the reference LR, each reference with a prefix number in accordance with the associated track section. The approach energizing circuit for each transmitter is shown only partially, including that portion from terminal B over back contact *b* of the corresponding track stick relay TS. The control of each laser detector relay LD by the associated receiver is designated by a conventional dotted line, this energizing circuit having been fully described in connection with FIG. 1. It is further noted that, in each track, the conventional track circuit is provided adjacent to the crossing portion including as before a track battery TB, a track relay TR, and the necessary bypass connections around the insulated area within the crossing portion. As before, each track relay TR is energized and picked up when no part of the corresponding track section is occupied by a wheel and axle element of a train.

The apparatus for each track also includes an associated track stick relay TS which has pick up and stick circuits similar to that described for relay 1TS in FIG. 1. In other words, each relay TS is energized over front contacts *a* of the associated track relay TR and laser detector relay LD while its stick circuit includes its own front contact *a* and front contact *a* of the associated relay TR. By way of specific example, the energizing circuit for relay 4TS associated with track section 4T includes front contacts *a* of relays 4TR and 4LD. The stick circuit for relay 4TS includes, in addition to the relay winding and its own front contact *a*, only front contact *a* of relay 4TR. Each relay TS is held normally energized by its stick circuit. With a relay TS associated with each track, the portion of the signal control circuit network shown in this figure includes only contacts of the various relays TS and no contacts of the track relays TR are here used.

In describing the operation of this expanded arrangement, it is assumed that a train is moving along the first track through section 1T. As this train enters section 1T, it shunts the track circuit and relay 1TR is released. It will be noted that, as this train proceeds along or through section 1T, it will not shunt the track circuits for sections 2T and 4T so that relays 2TR and 4TR, respectively, do not release. The opening of front contact *a* of relay 1TR deenergizes relay 1TS by interrupting its stick circuit and this latter relay releases. The closing of back contact *b* of relay 1TS energizes transmitter unit 1LT and the laser beam is transmitted over the associated path, again shown by a dashed line. Since this path is initially unobstructed by the train, the beam is received by unit 1LR and relay 1LD is energized. However, the closing of front contact *a* of relay 1LD has no effect upon relay 1TS since its energizing circuit is already open at front contact *a* of relay 1TR. The laser beam is shortly interrupted as the train moves through the track section and occupies the crossing portion so that relay 1LD releases. It should be noted that transmitters 2LT and 4LT are not at this time energized since the associated TS relays do not release and thus no laser beams are transmitted along those tracks to be interrupted or obstructed by the train moving in section 1T.

The opening of front contact *b* of relay 1TS interrupts the control circuits for signals 2R, 2L and 4R, 4L. It will be noted that these control circuits each also include front contact *c* of relay 3TS and for signals 2, front contact *c* of relay 2TS, and for signals 4, front contact *c* of relay 4TS. Since the circuit path is interrupted at front contact *b* of relay 1TS, no signal authorizing a move conflicting with that of the train

moving through section 1T can be established at this time. However, it will be noted that the circuit for signals 3R, 3L remains complete since it includes front contact *b* of relay 3TS and front contacts *e* of relays 2TS and 4TS. Thus a signal may be cleared at this time to authorize a simultaneous parallel train movement through section 3T. Such a train movement may, of course, be made with complete safety at the same time as the first train is moving through section 1T since the tracks are parallel. It will be obvious from an inspection of the drawings that a train movement through section 2T will interrupt the circuits for signals 1 and 3, thus blocking the authorization of any movement along the corresponding tracks. This is true since the circuits for signals 1 and signals 3 each include a front contact of relay 2TS. However, with a train occupying section 2T, the circuit for signals 4R, 4L remains complete, since no front contact of relay 2TS is included in this control circuit, and thus again a simultaneous parallel move may be authorized.

Returning to the assumed train movement through track section 1T, as the train proceeds its rear first clears the crossing portion so that the laser beam transmission is unobstructed. Receiver 1LR receives the beam and energizes relay 1LD, which picks up. When the rear of the train clears section 1T, and thus the the crossing limits, relay 1TR again is energized from track battery 1TB and picks up. Relay 1TS is now reenergized since front contacts *a* of both relays 1TR and 1LD are closed. Relay 1TS picks up to close its front contact *b* and thus restores the illustrated portion of the control circuits for signals 2 and 4. Relay 1TS also completes it stick circuit by closing its own front contact *a* so that, when the opening of its back contact *b* deenergizes laser transmitter 1LT, the subsequent release of relay 1LD does not interrupt the energization of relay 1TS.

If this train should happen to leave a car within the crossing portion, that is, within the track portion that is insulated from track section 1T, either inadvertently or in disregard of operating rules, the laser beam transmission is not restored, that is, is not received by unit 1LR. Thus relay 1LD is not energized and, when relay 1TR picks up when track section 1T is cleared, the circuit for relay 1TS remains interrupted at front contact *a* of relay 1LD and relay 1TS can not pick up. Front contact *b* of relay 1TS remains open to retain interrupted the control circuits for both signals 2 and signals 4. This inhibits the authorization of any conflicting move as long as the car is occupying the crossing portion of track 1. Thus the detection of the car standing in this crossing portion of the first track by the laser apparatus provides for safe operation of the crossing signal system even through, inadvertently, the operating rules governing movements through the crossing have been disregarded by the train crew.

Similar operation of the control arrangement will occur in response to train movements along the other tracks through the crossing area, controlled by the corresponding detection apparatus in each case. The operation under these conditions will be obvious from the drawings and from the previous description and detailed description, being redundant, is not included herein. If simultaneous moves are authorized through track sections 1T and 3T, the controls for signals 2 and 4 are interrupted until both relay 1TS and relay 3TS pick up again to close, respectively, their front contacts *b* and *c*. In other words, not only track sections 1T and 3T must be cleared by the train, but the laser beam from each transmitter 1LT and 3LT must be received by the corresponding receiver units 1LR and 3LR, respectively. It will be noted that, if either laser beam apparatus fails during the operating time, the failure of the corresponding laser detector relay LD to pick up results in a safe condition even though an apparatus fault condition exists. The same safety will result if any laser apparatus is inoperative when a train enters the crossing area since, upon the train departure, the corresponding relay LD will not be energized and the signal for conflicting moves will be blocked until a check is made as to the reason for the failure.

The arrangement of my invention thus provides a safe and efficient control for train movements through a railroad grade crossing where the possibility exists that a car obstructing the crossing may not shunt the conventional track circuit and thus avoids conventional detection. The laser apparatus provides the additional detection of track occupancy needed for the insulated portion at the actual crossing itself. The stick relay eliminates any inadvertent operation of the detection system by persons or by objects other than a train or car prior to the time that the train actually enters the crossing area. This is accomplished, once the area has been determined to be clear of a train, by holding the laser apparatus inoperative and thus ineffective to detect the extraneous objects. This random, only-when-needed operation of the laser apparatus also results in longer life of the laser apparatus and thus a more economical installation. Further, full fail-safe operation is assured since any failure of the detection apparatus results in a safe condition until proper operation can be restored.

Although I have herein shown and described but two embodiments of the features of my invention, further modifications and changes may be made therein within the scope of the appended claims without departing from the spirit and scope of the invention.

Having thus described my invention, what I claim is:

1. Train detection apparatus, for a stretch of first railroad track intersecting at grade one or more other railroad tracks, the crossing portion of said first track being longer than the wheel span of at least some cars traversing said track, comprising in combination,

a. track circuit means for detecting the occupancy condition of a selected length of said first track adjacent to each end of and insulated from said crossing portion,

b. laser beam presence detection apparatus positioned for detecting the presence of a railroad car occupying any part of the crossing portion of said first track,

c. a detector relay controlled by said laser beam apparatus to a first and a second position as the presence of a car in said crossing portion is not detected and detected, respectively, and,

d. train occupancy recorder means,

1. jointly controlled by said track circuit means and a first position contact of said detector relay for recording and retaining a track occupied indication when any part of a train occupies any

part of said first track stretch between the distant ends of said selected lengths,

2. further jointly controlled by said track circuit means and said first position contact of said detector relay for recording a non-occupied track indication when all parts of a train traversing said first track stretch clear all parts of said first track stretch between said distant ends, and,

3. controlled solely by said track circuit means for retaining a non-occupied track indication once recorded until another train enters one of said selected lengths.

2. Train detection apparatus as defined in claim 1 in which,

a. said track circuit means includes the rails of said selected track lengths, a source of energy, and a track relay operable between a first and a second position as said selected lengths are non-occupied and occupied, respectively, by a train,

b. said train occupancy recorder means is a relay having a stick circuit controlled by a first position contact of said track relay and an energizing circuit jointly controlled by said first position track relay contact and said first position contact of said detector relay.

3. Train detection apparatus as defined in claim 1 in which,

a. said train occupancy recorder means includes a relay having a stick circuit and an energizing circuit,

b. said stick circuit is controlled by said track circuit means for holding the occupancy recorder relay energized while said stretch of first track is non-occupied by a train between said distant ends of said selected lengths,

c. said energizing circuit is jointly controlled by said track circuit means and said first position contact of said detector relay for reenergizing said occupancy recorder relay after said stick circuit is interrupted only when said track circuit means detects said selected lengths again non-occupied and said laser beam apparatus detects said crossing portion non-occupied by any part of a train.

4. Train detection apparatus as defined in claim 1 further including,

a. a signal control circuit for said stretch of first track and for each said other track for authorizing train movement along the corresponding track,

b. each signal control circuit being controlled by said train occupancy recorder means for inhibiting another train movement over said crossing when a train is occupying any part of said first track stretch between the distant ends of said selected lengths.

5. Train detection apparatus as defined in claim 2 further including,

a. a signal control circuit for said stretch of first track and for each said other track for authorizing train movement along the corresponding track,

b. each signal control circuit being controlled by a contact of said occupancy recorder relay open when that relay is deenergized for interrupting the signal control circuit to inhibit the authorizing of another train movement over said crossing when a train is occupying any part of said first track stretch between the distant ends of said selected lengths.

6. Train detection apparatus, for a railroad grade crossing, in which a first set of one or more tracks crosses a second set of one or more tracks, each track including a crossing portion in which it intersects all tracks of the other set, each crossing portion being longer than the wheel span of at least some cars which traverse that track, comprising in combination,

a. a track circuit means for each track for detecting the occupancy condition of a selected length of the corresponding track adjacent to each end of and insulated from the corresponding crossing portion,

b. laser beam presence detection apparatus for each track positioned for detecting the presence of a railroad car occupying only the crossing portion of the associated track,

c. a detector relay for each track controlled by the corresponding laser beam apparatus to a first and a second position as the absence and presence, respectively, of a car occupying the corresponding crossing track portion is detected, and

d. a track occupancy indication means for each track controlled only by the associated track circuit means for recording the initial occupancy of the selected lengths of the corresponding track by a train,

e. each track occupancy indication means jointly controlled by the associated track circuit means and the associated detector relay, after a train occupancy is initially recorded, for recording a subsequent non-occupied condition of said corresponding track only when both said associated track circuit means and the associated laser beam apparatus detect a non-occupied condition for the corresponding selected lengths and crossing portion, respectively.

7. Train detection apparatus as defined in claim 6 in which,

a. each track circuit means includes the rails of the corresponding selected track lengths, a source of energy, and a track relay operable between a first and a second position as said corresponding selected track lengths are non-occupied and occupied, respectively, by a train, and

b. each track occupancy indication means is a relay having a stick circuit controlled by a first position contact of the associated track relay and an energizing circuit jointly controlled by said first position track relay contact and a first position contact of the associated detector relay.

8. Train detecting apparatus as defined in claim 7, further including,

a. a signal control circuit for each track for authorizing a train movement along the corresponding track over its crossing with the other set of tracks,

b. each signal control circuit controlled by an energized position contact of the corresponding occupancy indication relay and an energized position contact of each occupancy indication relay for said other set of tracks, for inhibiting the authorization of a train movement along said corresponding track when another train is occupying said corresponding track between the distant ends of its selected lengths or is occupying one of said

other set of tracks between the distant ends of its selected lengths.

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