Nov. 22, 1932. H. A. THOMPSON 1,888,706

TRAIN SIGNALING SYSTEM

Filed Jan. 6, 1932 3 Sheets-Sheet 1

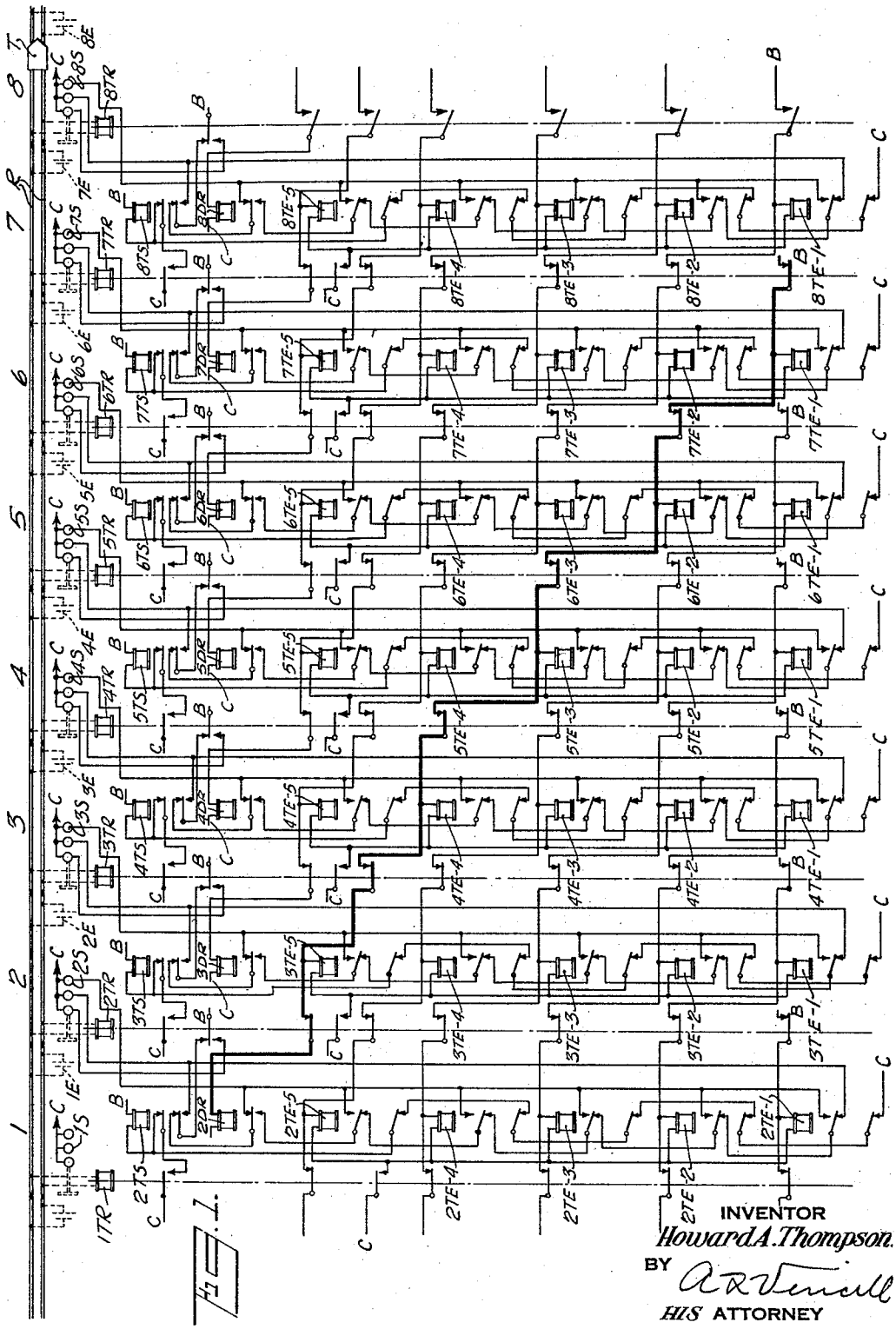

FIG. 1.

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Nov. 22, 1932. H. A. THOMPSON 1,888,706

TRAIN SIGNALING SYSTEM

Filed Jan. 6, 1932 3 Sheets-Sheet 2

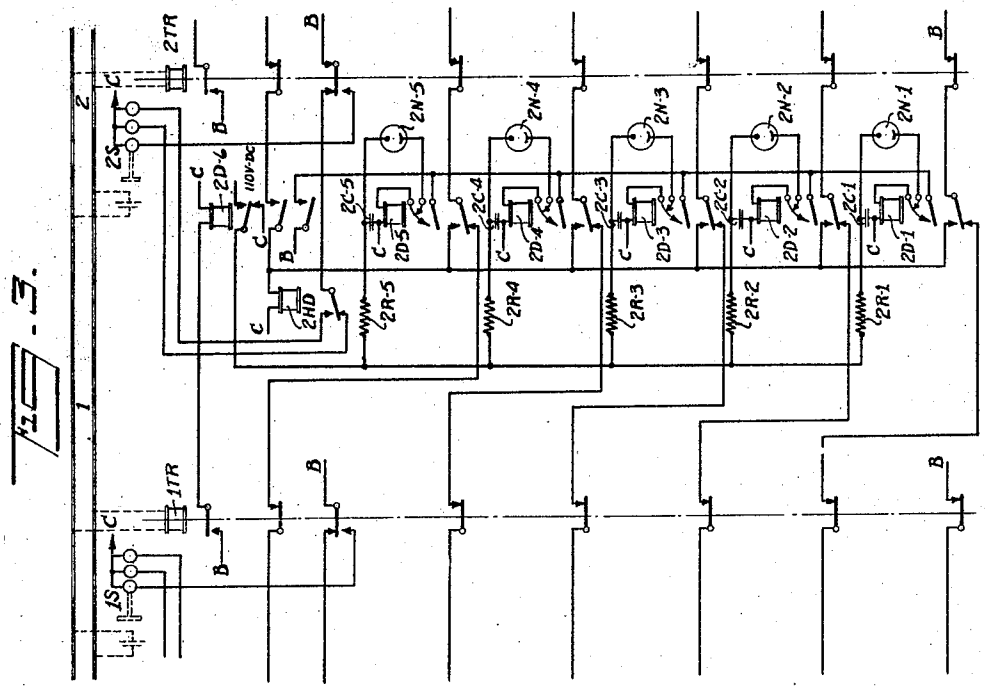

Fig. 3.

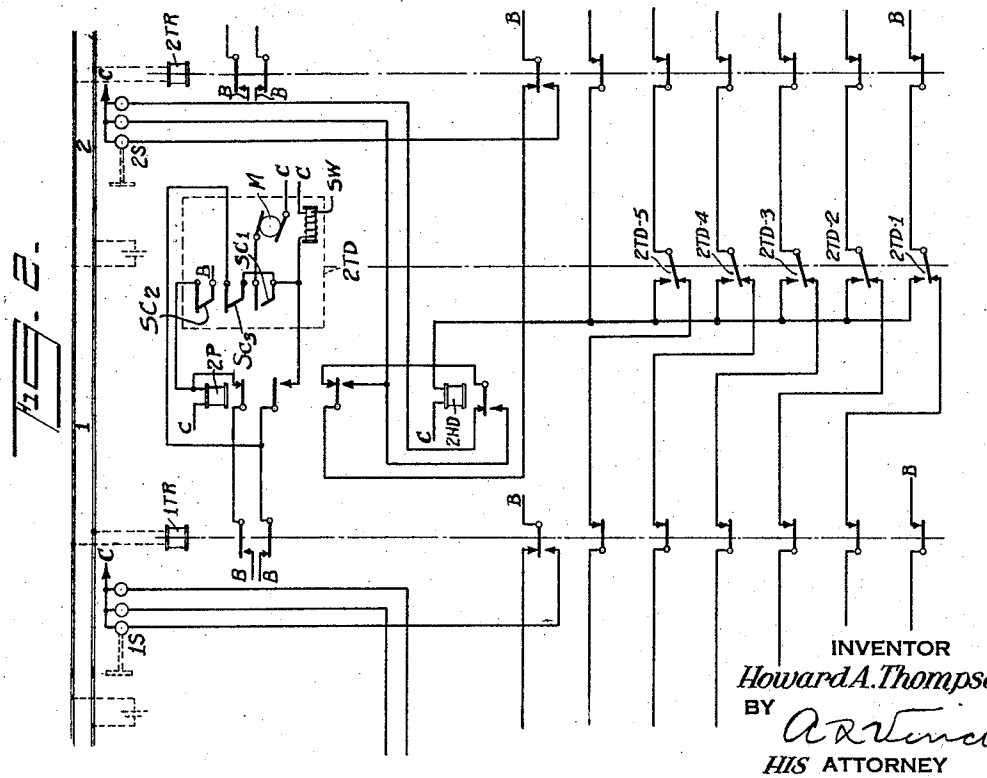

Fig. 2.

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Nov. 22, 1932. H. A. THOMPSON 1,888,706

TRAIN SIGNALING SYSTEM

Filed Jan. 6, 1932 3 Sheets-Sheet 3

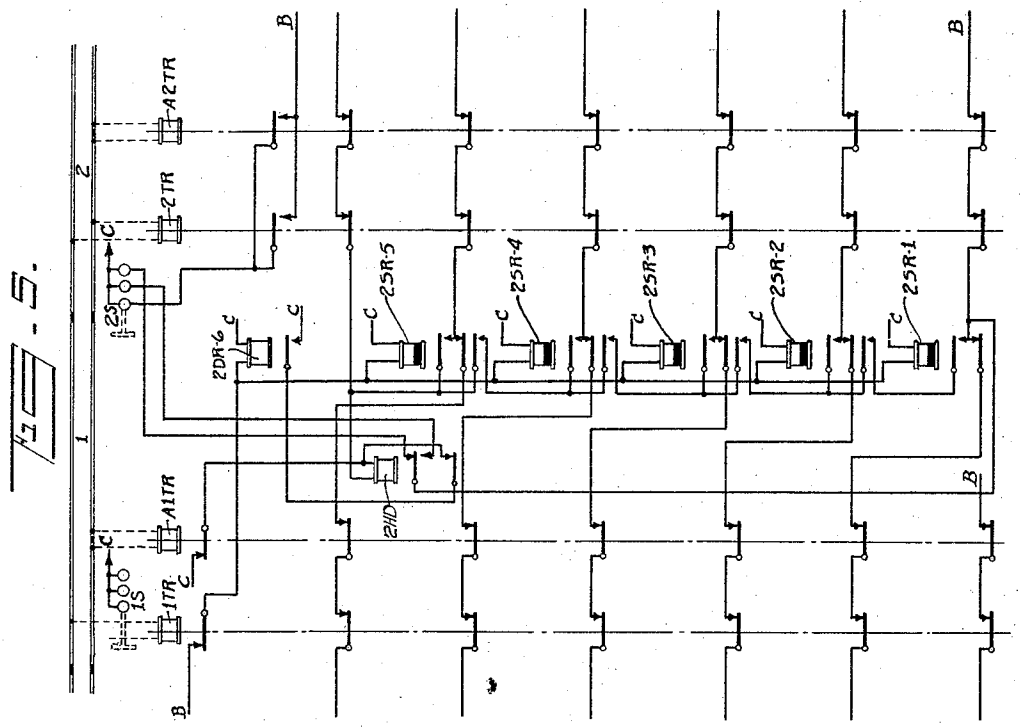

FIG. 5.

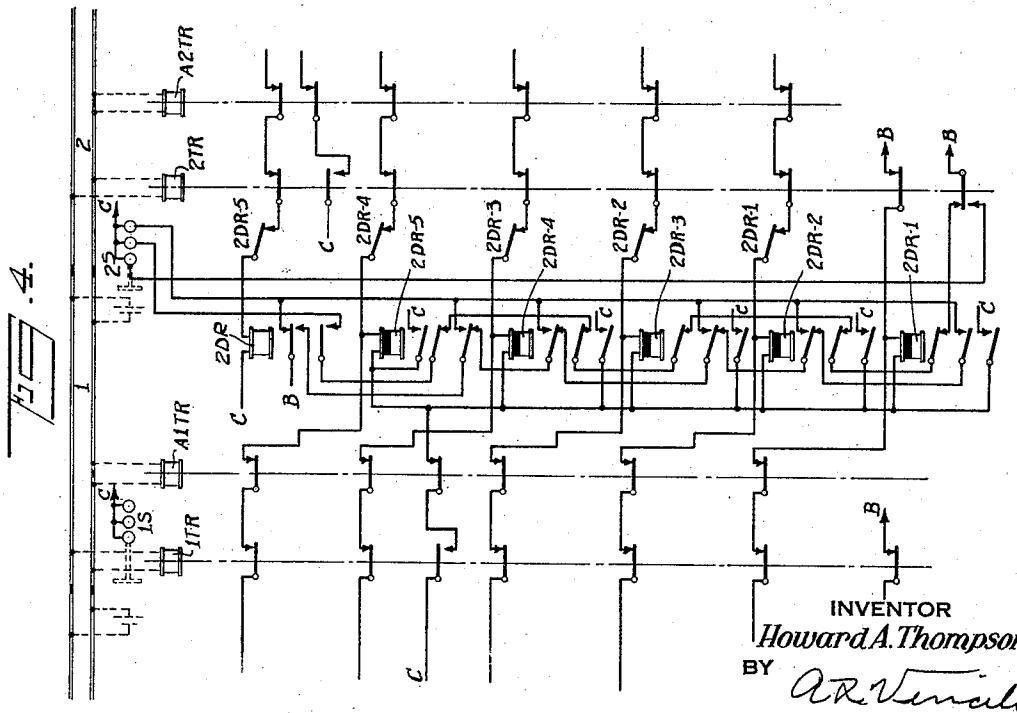

FIG. 4.

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TRAIN SIGNALING SYSTEM

Application filed January 6, 1932. Serial No. 585,044.

My present invention relates to a train signaling system for operation of block signals or the like arranged to display different signals to trains travelling at different speeds to the end that slow speed trains may be permitted to run closer together than trains operating at higher speeds. In accordance with the invention, a train of higher speed overtaking one travelling at a lower speed, will be obliged to reduce its speed to or below that of the first train in order to receive a proceed signal, and, if the approaching train is travelling at a high rate of speed, it will receive a restrictive signal a greater number of blocks behind the leading train than would a train approaching at a low rate of speed.

The present invention may be applied, for example, to insure that a train running at sixty miles per hour, or more, shall receive a caution indication unless there are at least six blocks clear ahead of it, that a train running between fifty and sixty miles per hour shall receive a caution signal unless there are at least five blocks clear ahead of it, a train running between forty and fifty miles per hour shall receive a caution signal unless there are at least four blocks clear ahead of it, and so on; the slowest trains receiving a caution signal when only one clear block is ahead. With such a system, a rapidly moving train, upon passing a first caution signal, could, by reducing its speed to that of the advance train, receive a proceed signal at the next block, but, if it then accelerated, would again receive the caution indication if it approached too closely to the preceding train.

For a better understanding of the invention reference may be had to the accompanying drawings, of which Fig. 1 illustrates diagrammatically a signaling circuit adapted to differentiate between trains running at six different speeds and utilizing time element relays for selectively operating the track signal in accordance with the speed of the approaching train and the number of clear blocks ahead. Fig. 2 illustrates diagrammatically a circuit similar to that of Fig. 1 but utilizing in place of the time element relays thereof a single automatically wound time release at each signal having a plurality of contacts adjusted for closure after different periods of time. Fig. 3 illustrates diagrammatically another circuit of the type of Fig. 1 but utilizing a plurality of glow discharge tube circuits and relays whose times of pick-up are controlled thereby in place of the time element relays of Fig. 1. Fig. 4 illustrates diagrammatically an alternative arrangement utilizing slow pick-up relays and additional series track relays. Fig. 5 illustrates diagrammatically another circuit of the type of Fig. 4 but utilizing slow release relays in place of the slow pick-up relays of Fig. 4.

In Fig. 1, the track R is shown as divided into eight sections 1, 2, 3, 4, 5, 6, 7 and 8 with a signal indicated diagrammatically at the entrance to each block, the signal at the entrance to block 1 being identified by the reference character 1S, that at the entrance to block 2 by 2S, and so forth. Block 8 is shown as occupied by a train T, which, for convenience may be considered as satisfactory. A track battery 1E for block 1 supplies current for the track relay 1TR which is connected across the rails R in the usual manner to be short circuited when the block is occupied. Similarly, battery 2E and track relay 2TR are associated with block 2, battery 3E and track relay 3TR with block 3, battery 4E and track relay 4TR with block 4, battery 5E and track relay 5TR with block 5, battery 6E and track relay 6TR with block 6, battery 7E and track relay 7TR with block 7, and battery 8E and relay 8TR with block 8.

As the system, in the particular embodiment illustrated, is to respond to six different zones of train speed, seven relays are associated with the control of each signal. These seven relays at signal 2 comprise a relay 2DR normally energized when at least six blocks in advance are clear; five time element relays, 2TE—1, 2TE—2, 2TE—3, 2TE—4 and 2TE—5 normally deenergized but adapted to be energized as a train approaches the signal; and an auxiliary relay 2TS which is used to insure that the time element devices 2TE—1, 2TE—2 etc. assume their full normal positions when deenergized. When relay 2DR is energized, battery, the positive terminal of which is indicated by the reference letter B,

is supplied over a front contact of relay 2TR, a front contact of relay 2TS, and a front contact of relay 2DR to the proceed indication or green light of signal 2S. When relay 2DR is deenergized and time relay 2TE—5, for example, energized and held energized long enough for the time controlled armature thereof to be raised, the circuit for the proceed indication of signal 2S is maintained over a back contact of relay 2DR and a front contact of time relay 2TE—5. If time relay 2TE—5 is deenergized and time relay 2TE—4 energized and has closed its top contacts, the circuit for the proceed indication of signal 2S is maintained over back contacts of relays 2DR and 2TE—5 and front contact of relay 2TE—4.

Similarly, at signal 3S, the circuit for the clear indication is from battery over a top contact of relay 3TR, a top contact of relay 3TS and a top contact of relay 3DR if this relay is energized; or over a back contact thereof when deenergized and a top contact of the highest numbered time element relay at that signal that has closed its top contacts, and over back contacts of higher numbered relays, if any, at that signal.

The circuit for relay 2DR for convenience has been shown in heavy lines and is as follows: battery, over front contacts of track relays 7TR, 6TR, 5TR, 4TR, 3TR and 2TR, winding of relay 2DR to common. As all track relays controlling the above circuit over front contacts are energized, relay 2DR will be energized and a train in block 1 will receive a proceed or clear signal at the entrance to block 2, relay 2TS being energized as hereinafter described in connection with the corresponding relay at signal 3S. As the train enters block 2 it will shunt track relay 2TR causing common to be connected over a back contact of this relay to the windings of all time element relays at signal 3. As a train is in block 8 the circuit of relay 3DR will be open over a front contact of track relay 8TR. All time element relays at signal 3 will become energized by the connection of common over the back contact of track relay 2TR, battery being supplied to time element relay 3TE—5 over the circuit traced for relay 2DR and to the other time element relays at signal 3 by similar circuits including top contacts of track relays of progressively fewer blocks in advance of signal 3S. The closure of the circuits of the time element relays at signal 3 causes the back checking contacts of these relays to open immediately with consequent opening of a previously closed pick-up circuit for relay 3TS, as the circuit for relay 3TS is controlled over back checking contacts of time element relays 3TE—5, 3TE—4, 3TE—3, 3TE—2 and 3TE—1. Relay 3TS does not release, however, because an alternative circuit therefor is closed when the train shunts track relay 2TR, this alternative circuit being from common over a back contact 2TR, and a top contact of relay 3TS through the winding of the relay to battery.

The time element of relay 3TE—5 is so adjusted that the time controlled armature of this relay will be picked up only if the speed of an approaching train throughout block 2 is less than sixty miles per hour. The time element of relay 3TE—4 is so adjusted that the time controlled armature of this relay will pick up before a train travelling at less than fifty miles per hour through block 2 reaches signal 3S. Similarly, the time elements of relays 3TE—3, 3TE—2 and 3TE—1 are adjusted so that the armatures thereof will be picked up before trains travelling at less than 40, 30 and 20 miles per hour respectively reach signal 3S. Thus, if the train approaching signal 3S is travelling at 60 miles per hour, or faster, none of the time element relays of signal 3S will have had time to pick up their time controlled armatures and, consequently, a caution signal will be displayed at signal 3S, battery being supplied to the caution or yellow light of signal 3S over a front contact of track relay 3TR, a front contact of relays 3TS, back contact of relay 3DR and back contacts of all time element relays at this signal. If the train is travelling at less than 60 miles per hour, relay 3TE—5 will have picked up its time controlled armature between the time that track relay 2TR closed its back contact and the train reached signal 3S with the result that a clear signal will be given, battery being supplied to the signal over top contacts of relays 3TR and 3TS, a back contact of relay 3DR and a front contact of time element relay 3TE—5.

If the advance train had been in block 7 instead of block 8, the circuit for relay 3TE—5 would be open over the front contact of track relay 7TR and the approaching train, if running between 50 and 60 miles per hour, would have received a caution, instead of a proceed signal at signal 3S. A train running at less than 50 miles per hour would receive a clear signal as the circuit for time element relay 3TE—4 would be closed and the time controlled armature thereof would be raised to supply battery to signal 3S to hold it in clear position; the circuit being over back contacts of relay 3DR and of time element relay 3TE—5 and front contact of time element relay 3TE—4. Similarly, with the advance train in block 6, a train approaching signal 3, in order to receive a proceed signal, must be travelling at less than 40 miles per hour in order to give sufficient time for time-element relay 3TE—3 to have picked up its time controlled armature and, if the advance train were in block 5, or 4, speeds of less than 30 and 20 miles per hour respectively are required for the succeeding train to receive a proceed sig-

nal. A train at any speed receives a stop signal at signal 3S if the advance train is in block 3, battery being supplied over a back contact of track relay 3TR to the stop or red light of signal 3S and the circuits of all time element relays being open over top contacts of relay 3TR.

Also, if all time element relays at signal 3 had not been in their full normal position at the time the train entered track circuit 2, relay 3TS would have been deenergized and the closing of the back contact of relay 2TR could not have energized relay 3TS. A caution signal would therefore have been displayed being connected over a front contact of relay 3TR and a back contact of relay 3TS.

It will be understood that the time controlled armature of each of the time element relays do not open their back contacts and close their top contacts until after the particular period of time for which the relay is adjusted whereas the checking armatures of these relays open their back contacts immediately upon energization of the relays. No attempt has been made in Fig. 1 to separately identify these two types of armatures as relays of this type are well known and additional reference numerals would only confuse the drawing. It will be noted, however, the upper of each pair of armatures associated with each time element relay in Fig. 1 is intended as the time controlled armature and the lower armature of each pair as that controlling the checking contacts.

The above-described system thus displays signals tending to maintain trains travelling at 60 miles an hour at least six blocks apart, those travelling between 50 and 60 miles per hour five blocks apart, those between 40 and 50 miles per hour four blocks apart, those between 30 and 40, three blocks apart, those between 20 and 30, two blocks apart, and those at less than 20, one block apart. If the leading train is travelling at, for example, 40 miles per hour, a train approaching at 60 miles an hour would receive a caution signal upon entering the block five blocks in the rear of that occupied and, if it maintained its speed, would continue to receive a caution indication at the entrance to each block until it received a stop signal as it approached the occupied block unless it reduced its speed to that of preceding train, assumed to be 40 miles per hour and maintained four clear blocks between it and the advance train. If the first train is stationary, the approaching train, in order to continue to receive proceed signals at each block, must progressively reduce speed through each block until as it approaches the stop signal, it is travelling at less than 20 miles per hour.

In Fig. 2 a system substantially similar to that described in connection with Fig. 1 is illustrated. For convenience the system is shown as responsive to the same number of speed zones, but obviously the system lends itself to expansion or contraction of the number of zones as desired. The circuit of Fig. 2 differs from that of Fig. 1 primarily in that the time element relays at each signal are replaced by an automatically wound time release device having a plurality of differently timed contacts corresponding in function to the time controlled armatures of the time element relays of Fig. 1, and in that a separate relay, indicated by the reference letters HD with a different numeral prefixed according to the signal with which it is associated, is provided to directly control the signal. In Fig. 2 the circuit at signal 2S only is illustrated to avoid repetition at each signal of substantially identical apparatus and circuits. The time release device controlling signal 2S is indicated diagrammatically at 2TD as including a motor M, slot winding SW and three pair of slot contacts, SC1, SC2 and SC3, the first pair of which is opened when, and only when, the time release is fully wound, and the second and third pair of which are closed when and only when the time release is fully wound. Device 2TD when released picks up a series of contact arms 2TD—1, 2TD—2, 2TD—3, 2TD—4 and 2TD—5 after varying time intervals. The release of device 2TD occurs when the circuit of slot winding SW is opened and, as this circuit is controlled over a top contact of track relay 1TR and slot contacts SC3, it follows that the approach of a train into block 1 causes release of 2TD with consequent successive closure of the top contacts of arms 2TD—5, 2TD—4, etc. Arm 2TD—1 is arranged to close its top contact so slowly that, in order for it to be closed before a train reaches signal 2S, the train must have been travelling through block 1 at less than 20 miles per hour. Arm 2TD—2 is arranged to close its top contact before a train travelling at 30 miles per hour reaches signal 2S, and arms 2TD—3, 2TD—4 and 2TD—5 are similarly arranged to close their top contacts before a train travelling through block 1 at less than 40, 50 and 60 miles per hour respectively, reach signal 2S. As time release devices of the type indicated are well known, it has been considered unnecessary to indicate on the drawings the actual mechanisms controlling the movement of arms 2TD—1, 2TD—2, etc. These arms control a relay 2HD which in turn controls signal 2S as hereinafter described.

The circuit of the proceed indication for signal 2S is over a top contact of track relay 2TR; a top contact of a relay 2P and a top contact of relay 2HD.

One end of the winding of relay 2P is connected to common and the other end of the winding is normally connected to battery over slot contacts SC_2. The circuit for the caution indication for signal 2S is over a top

contact of relay 2TR and a back contact of relay 2P or over top contacts of relays 2TR and 2P and a back contact of relay 2HD. The circuit of the stop indication for signal 2S is over a back contact of track relay 2TR. If there are six clear blocks ahead of signal 2S, relay 2HD will be energized over a circuit similar to that described for relay 2DR of Fig. 1. This normal circuit for relay 2HD is over top contacts of track relays six blocks in advance of signal 2S and over back contacts of successively higher numbered contact arms of the time release devices at the five signals immediately in advance of signal 2S. There are five other alternate circuits for relay 2HD each including a top contact of one of the arms 2TD—1, 2TD—2, etc. The circuit including the top contact of arm 2TD—1 is over a top contact of track relay 2TR; that including the top contact of arm 2TD—2 is over top contacts of the track relays associated with block 2 and the succeeding block and over a back contact of the lowest contact arm associated with the time release device at signal 3. Similarly, the other alternate circuits for relay 2HD include top contacts of a progressively increasing number of track relays and back contacts of contact arms at a progressively increasing number of signals.

In order to understand the operation of the circuits of Fig. 2, assume first that there are six unoccupied blocks ahead of signal 2S. As a train enters block 1 it shunts track relay 1TR and thereby opens the circuit for slot winding SW and causes time release 2TD to begin to unwind with consequent successive lifting of arms 2TD—5, 2TD—4, etc.; and also closes a circuit, battery over a back contact of track relay 1TR and a top contact on relay 2P to the winding of that relay to hold it energized after the opening of contact SC_2. As six clear blocks were assumed and consequently relay 2HD already energized, the first-mentioned result is of no importance at this time. Assume, however, that but five blocks ahead of signal 2S were clear. Then, before the approaching train entered block 1, relay 2HD was deenergized over the top contact of the track relay six blocks ahead. If the approaching train travels through block 1 at 60 or more miles per hour, then the top contact of arm 2TD—5 will not have had time to close before the train reaches signal 2S and consequently the caution signal will be displayed; the circuit being, as above described, over a top contact of relay 2P, a back contact of relay 2HD and over a top contact of track relay 2TR. If, however, the approaching train is running at less than 60 miles per hour through block 1, top contact of arm 2TD—5 will close, energizing relay 2HD over the longest of the above-described alternative circuits. A clear signal will then be displayed at signal 2S. If there are but four clear blocks ahead this longest alternative circuit will be open over the top contact of the track relay five blocks ahead and the train, in order to obtain a clear signal, must travel through block 1 at less than 50 miles per hour in order to give time for arm 2TD—4 to close its top contacts. Similarly, with but three or two clear blocks ahead, the speed of the approaching train must be correspondingly less in order to obtain a clear signal. If block 2 is occupied, a train travelling through block 1 at any speed will receive a stop signal as the clear and caution circuits will be opened over the top contact of relay 2TR and the stop circuit for the signal closed over the back contact of relay 2TR.

When the approaching train clears block 1, track relay 1TR becomes energized and opens the stick circuit of relay 2P, deenergizing that relay.

The closure of the top contacts of relay 1TR connects battery over a back contact of relay 2P to slot winding SW and also over contact SC_1 to the motor M causing it to begin to rewind the device. When fully wound, slot contacts SC_1 open, stopping motor M, and also contacts SC_2 close energizing relay 2P. Battery is also connected over a top contact of relay 1TR and contacts SC_3 to winding SW to hold the device wound up after opening of the motor circuit and reenergization of relay 2P.

If device 2TD is not completely wound up, relay 2P cannot again become energized and the signal will consequently display a caution indication. This arrangement insures that should the motor fail to rewind device 2TD, leaving all or a part of the top contacts 2TD—5, 2TD—4, etc., closed, the circuits for the proceed indication of signal 2 will be broken over the front contact of relay 2P and hence a false proceed indication will be avoided. Also when relay 2P is deenergized upon vacating the track circuit, and should a following train enter the track circuit, which might easily occur from a siding switch, before device 2TD is fully wound, relay 2P will not become energized. This insures that device 2TD must be fully energized or wound before it can be deenergized to imitate the measuring of a time interval. Correct time measurements under all conditions is thus assured.

In Fig. 3, a signal control system using glow discharge tubes, condensers and resistance elements to effect different delay periods in the pick-up time of a plurality of relays at each signal is illustrated. The relays at each signal correspond to the time element relays of Fig. 1. These relays, together with an additional relay whose time of pick-up is not affected by the flow discharge tube circuits, control a signal controlling relay at each signal corresponding to the HD relay

of Fig. 2. As in Fig. 2 the circuit at but one signal is illustrated for convenience.

In Fig. 3 the signal indication circuits for signal 2S are substantially the same as in Fig. 2. The circuit for the proceed indication is over top contacts of track relay 2TR and of relay 2HD; that for the caution indication over top contact of relay 2TR and back contact of relay 2HD; and that for the stop indication over back contact of relay 2TR. When there are six clear blocks ahead of signal 2S, a relay 2D—6 controls the circuit for relay 2HD over a top contact; the remainder of the circuit being, as described in connection with Fig. 2, over top contacts of track relays of the next preceding six blocks and over back contacts of one of the other relays at each of the five next signals. The five alternative circuits for relay 2HD are also just as in Fig. 2 except, of course, that back contacts of the relays at each signal are substituted for back contacts of the time release device of Fig. 2. The relays at signal 2S controlling the alternate circuits for relay 2HD are indicated by the reference letters 2D—1, 2D—2, 2D—3, 2D—4, 2D—5. In series with the winding of relay 2D—1 is a resistance 2R—1, a glow discharge tube 2N—1 and a continuity transfer contact of that relay. A capacity 2C—1 is connected across the winding of the relay, continuity transfer contact and glow discharge tube 2N—1. Battery is supplied to this circuit, preferably from a source of 110 volts D. C. over a top contact of relay 2D—6, when the latter is energized; common being connected to the other side of the winding of relay 2D—1. When relay 2D—1 picks up its armatures, due to the closure of the above-described circuit at the top contact of relay 2D—6, the fifth alternative circuit for relay 2HD is completed and a stick circuit for relay 2D—1 is closed, disconnecting elements 2R—1 and 2N—1. The continuity transfer contact insures closure of the circuit through these elements until after closure of the stick circuit.

Similarly, elements 2R—2, 2C—2 and 2N—2 are associated with relay 2D—2, controlling the fourth alternative circuit for relay 2HD, and are disconnected when the stick circuit for relay 2D—2 is closed. Correspondingly identified elements are associated with each of relays 2D—3, 2D—4 and 2D—5. When a train enters block 1 it deenergizes track relay 1TR and thereby causes relay 2D—6 to pick up its armatures, the circuit for relay 2D—6 being from battery over a back contact of relay 1TR. The closure of the top contacts closes the above described pick-up circuits of relays 2D—1, 2D—2, 2D—3, 2D—4 and 2D—5, causing these relays to pick up their armatures after periods of time depending upon the particular resistance, capacity and glow discharge tube elements associated therewith. Elements 2N—1, 2R—1 and 2C—1 are so chosen as to cause relay 2D—1 to close its top contacts before a train travelling at less than 20 miles per hour through block 1 reaches signal 2S. Elements 2N—2, 2R—2 and 2C—2 are so chosen as to cause relay 2D—2 to close its top contacts before a train travelling at less than 30 miles per hour through block 1 reaches signal 2S. Similarly, the elements associated with relays 2D—3, 2D—4 and 2D—5 are so chosen as to cause these relays to close their top contacts before trains travelling at less than 40, 50 and 60 miles per hour respectively reach signal 2S. The condensers 2C—1, 2C—2, 2C—3, 2C—4 and 2C—5 are all connected to common over a back contact of relay 2D—6 when that relay is deenergized to insure that the condensers are fully discharged each time the track circuit is vacated to insure accurate timing.

The control of signal 2S in accordance with the number of unoccupied blocks in advance of signal 2S and with the speed of the approaching train will be clear from the description already given in connection with Figs. 1 and 2. If there are six or more unoccupied blocks, relay 2HD is energized, irrespective of the speed of the approaching train, over a top contact of relay 2D—6. If there are but five unoccupied blocks, the speed of the train must be less than 60 miles per hour in order to cause closure of the first alternative circuit of relay 2HD, the normal circuit therefor being broken over a top contact of the track relay six blocks ahead of the signal. If there are but four clear blocks, the first alternative circuit is open and the train, to receive a clear signal, must travel through block 1 at less than 50 miles per hour. Similarly, with but three, two and one unoccupied blocks, the approaching train must travel at less than 40, 30 and 20 miles per hour, respectively, in order to receive a proceed rather than a caution indication.

Unlike the circuit of Fig. 2, that of Fig. 3 is partially approach controlled; that is, in Fig. 3 a caution indication is normally displayed at each signal. As the timing devices of Fig. 3 do not involve mechanical parts which are subject to failure it is not necessary to provide the checking features of Figs. 1 and 2.

In Figs. 4 and 5 alternative systems of the same type but utilizing relatively cheaper slow pick-up (Fig. 4) or slow release (Fig. 5) relays are substituted for the time element relays of Fig. 1, the time release devices of Fig. 2 and the glow discharge tube circuits of Fig. 3. The use of such relatively cheaper relays requires an additional series track relay for each block, which additional relays are indicated by the same reference letters and numbers as are the standard track relays but with the letter A prefixed thereto.

As in Figs. 2 and 3, the circuits of Figs. 4 and 5 are illustrated for signal 2S only.

In Fig. 4 relay 2DR corresponds in function to the similarly identified relay of Fig. 1, and relays 2DR—1, 2DR—2, 2DR—3, 2DR—4 and 2DR—5 to the correspondingly numbered time element relays of Fig. 1. When relay 2DR is energized, the circuit for the proceed indication of signal 2S is closed over a front contact of this relay; when relay 2DR is deenergized and one or more of the other relays at this signal has closed its top contacts, the circuit for the proceed indication is closed over a back contact of relay 2DR, top contact of the highest numbered relay which has raised its armatures and back contacts of higher numbered relays, if any. If the armatures of all relays at signal 2S are down and block 2 unoccupied, the circuit for the caution indication of signal 2S is closed over a top contact of track relay 2TR and back contacts of all DR relays, and if relay 2TR is shunted, the circuit for the danger indication of signal 2S is closed over a back contact of this relay.

Relay 2DR is normally energized over a circuit like that indicated in heavy lines for this relay in Fig. 1 but including also top contacts of all of the ATR relays in the six blocks in advance of the signal and including also, for checking purposes, a back contact of relay 2D—5 and back contact of progressively lower numbered relays at the four signals in advance of signal 2S. Common is connected over a back contact of track relay 1TR and a top contact of series track relay A1TR to one side of the windings of each of the slow pick-up relays 2DR—1, 2DR—2, 2DR—3 and 2DR—4 and 2DR—5; battery being normally connected to the other sides of these relays over circuits similar to that of relay 2DR but including contacts of relays at progressively fewer blocks and signals in advance of signal 2S. Relay 2DR—5 when energized long enough for its armatures to be raised, is held energized by a stick circuit over its own armature, common being connected to a top contact. Similar stick circuits are provided for each of relays 2DR—4, 2DR—3, 2DR—2 and 2DR—1. Relay 2DR—5 is so chosen that it will pick up its armatures and close its stick circuit between the closing of the back contacts of track relay 1TR and the opening of the top contacts of relay A1TR caused by a train travelling through the first or timing section of block 1 at a rate less than 60 miles per hour. Relay 2DR—4 will pick up its armature to close its stick circuit if the approaching train is running at less than 50 miles per hour in the timing section, relay 2DR—3 will pick up its armature if the approaching train is running at less than 40 miles per hour, relay 2DR—2 will pick up its armature if the approaching train is running at less than 30 miles per hour, and relay 2DR—1 if the train is running at less than 20 miles per hour.

The operation of the circuits of Fig. 4 is so similar to that already described in connection with Fig. 1 that a separate description thereof would be superfluous.

In Fig. 5 the slow release relays for signal 2 are indicated as 2SR—5, 2SR—4, 2SR—3, 2SR—2 and 2SR—1. An additional relay 2DR—6 corresponding in part to relay 2D—6 of Fig. 3 except that it is normally energized irrespective of the number of clear blocks ahead controls a stick circuit for relay 2HD. Relay 2DR—6 and the SR relays are all normally energized over a top contact of track relay 1TR, the circuit for relays 2DR—6, 2SR—5, 2SR—4, 2SR—3, 2SR—2 and 2SR—1 being through the windings of these relays to common.

The release of each of the SR relays at signal 2S is initiated upon the opening of the top contact of relay 1TR due to a train travelling through block 1.

Relay 2HD is normally energized over a circuit similar to that traced for relay 2DR of Fig. 1, but including also the front contacts of the series track relays in each of the six track sections, in advance of signal 2S and for checking purposes a front contact of one of the slow release relays at each of the five signal locations in advance of signal 2S. The circuit for relay 2HD continues through the winding of that relay to common over a front contact of series track relay A1TR. An auxiliary stick circuit connection from the winding of relay 2HD to common is made over a front contact of relay 2HD and a back contact of relay 2DR—6 which relay is deenergized upon deenergization of relay 1TR when a train enters track circuit 1. Under normal traffic conditions this auxiliary stick circuit is closed before the opening of the first connection to common over the front contact of relay A1TR.

If less than six track sections in advance of signal 2S are unoccupied, one of five alternative circuits may energize relay 2HD. If, for example, five track sections in advance of signal 2S are clear and if the approaching train is travelling less than 60 miles per hour, relay 2SR—5 will have closed its back contact before the opening of the front contact of relay A1TR. This connects the first alternative circuit which includes the front contacts of the track relays of five track sections in advance, over a back contact of relay 2SR—5, then the winding of relay 2HD to common over a front contact of relay A1TR. The stick circuit connection to common, formerly traced, will be closed immediately upon energization of relay 2HD, so that a proceed indication will be displayed by signal 2S under these conditions. If the approaching train is exceeding 60 miles per

hour, relay A1TR will have opened its front contact before relay 2SR—5 closes its back contact. The pick-up circuit is therefore not closed and relay 2HD remains deenergized causing a caution indication to be displayed. The second, third, etc. alternative circuits are similarly available to energize relay 2HD over back contacts of relays 2SR—4, 2SR—3, etc. The timing of the speed of trains, as in Fig. 4, is thus measured between the deenergization of relay 1TR and A1TR. The release time of relays 2SR—5, 2SR—4, etc. is chosen to measure speeds of 60, 50, 40, etc., miles per hour, respectively as in the previous figures.

In each of Figs. 4 and 5 the alternative circuits for controlling the proceed indication of the signals have been shown and described as controlled over top contacts of the series track relays as well as over the ordinary track relays. Inasmuch as the ordinary track relay of any block will drop its armatures if any portion of that block is occupied and the series track relay will only drop its armatures if the latter portion of the block is occupied, it is apparent that the control of these alternative circuits over the top contacts of the series track relays is not essential. Such control is advisable, however, as a safety feature, for it provides a check upon the condition of the series track relays. It will be apparent that the speed of trains may be timed at or near the exit end of each block in Figs. 4 and 5 by the use of an additional series track relay.

The invention has now been described in connection with five embodiments thereof. In all embodiments, for ease of comparison, the same number of speed zones and the same speed limits therefor were assumed but it will be readily appreciated that in any actual installation the particular number of zones, and the particular limits thereof, would be selected by the railroad officials, the circuits of the invention lending themselves readily to modification in this respect. Also, in each embodiment of the invention no maximum speed limit was assumed when there were six clear blocks ahead of a signal. If such a maximum limit were desired, only slight modifications of the various circuits would be required. In Fig. 1, for example, a time element relay having the proper period of pick-up would be substituted for each DR relay. In Fig. 2 the normal circuit of each HD relay would be carried over a front contact of an additional contact arm of the time release device. In Fig. 3 an additional glow discharge tube circuit having the elements thereof suitably adjusted would be provided to control relay 2HD. In Fig. 4 the DR relay would be made slow in picking up and in Fig. 5 an additional slow release relay would be provided to control relay 2HD. Only slight modification would be required to make the signal of each of the embodiments approach controlled as in Fig. 3. If semaphores instead of the indicated lights are to be employed, no change in the circuits is required and the circuits for the danger indications could be omitted.

If but two indication signals rather than three indication signals were desired, the circuit in each embodiment described as controlling the caution indication could be employed to control the danger indication instead of the caution indication; the circuit described for the danger indication being also retained if desired, or battery being permanently connected to a back contact of the slowest acting relay or contact arm with consequent discontinuation of the control of the danger indication over back contacts of the track relays. Also a separate aspect such as yellow over green might be displayed instead of green when less than six blocks are clear if the train is proceeding at reduced speed in proportion to the number of clear blocks. Obviously, many features of one embodiment could be combined with features of another embodiment and various elements could be omitted or modified without departing from the spirit of the invention.

The following is claimed:

1. A railway block signaling system comprising in combination, a signal at the entrance to each block adapted to give a proceed indication and at least one other more restrictive indication, a plurality of alternative controls for each signal responsive to track conditions over a different number of blocks in advance of the signal, and means responsive to the rate at which a train approaches a signal for selecting which of said alternative controls will be effective to operate the signal; the selection being such that a train travelling at any speed will receive a proceed indication if a number of blocks proportional to the speed of the train unoccupied ahead of the signal, wherein said signals are adapted to give three indications corresponding to proceed, caution and stop and wherein each of said alternative controls for each signal is adapted when selected by said speed responsive means to cause the signal to display a proceed indication when the required number of blocks in advance of the signal are unoccupied and to cause the signal to display a caution indication when less than the required number of blocks in advance of the signal are unoccupied, and means independent of said controls and of the speed of an approaching train for causing the signal to display a stop indication under certain traffic conditions.

2. An automatic railway block signaling system comprising in combination, a signal at the entrance to each block adapted to give a proceed indication and at least one other more restrictive indication, a plurality of al-

ternative controls for the proceed indication, each of said controls requiring a different number of unoccupied blocks in advance of the signal, means initiated by the approach of a train and responsive to the speed thereof for selecting which of said controls is to be active in controlling the signal, said last-mentioned means selecting for fast moving trains controls requiring the greater number of unoccupied blocks in advance of the signal, and means independent of the speed of the approaching train but responsive to track conditions for causing the signal to display a more restrictive indication under certain conditions.

3. The combination according to claim 2 wherein said selecting means include a plurality of time element relays each requiring a different period in which to pick up its armatures and the circuits for which are controlled in response to track conditions over a different number of blocks in advance of the signal and are normally opened when no train approaches the signal; the relay having the shortest period of pick-up being controlled over the longest number of blocks, and so on, whereby the approach of a train causes completion of all of the circuits of said relays except those which may be open due to traffic conditions ahead, the alternative controls being over top contacts of said time element relays.

4. An automatic railway block signaling system comprising in combination, a signal at the entrance to each block adapted to give a proceed indication and at least one other more restrictive signal, a relay associated with each signal, said relays being adapted to be energized when a predetermined number of blocks in advance of the signal associated therewith are unoccupied, a plurality of other relays at each signal each being normally deenergized when the block preceding the signal is unoccupied and each having a different pick-up period for the armatures thereof, that one of said last mentioned relays having the shortest pick-up period being energized upon the approach of a train to the signal associated therewith if one less than the predetermined number of blocks required for energization of the first mentioned relays is unoccupied, that one of said last mentioned relays having the next shortest period of pick-up being energized upon the approach of a train if still one less number of blocks in advance of the signal are unoccupied and the others of said last mentioned relays being similarly energized according to their time of pick-up by the approach of a train if progressively less number of blocks in advance of the signal are unoccupied, the circuit for said proceed indication at each signal being closed whenever that one of said first mentioned relays is energized or when the same is deenergized and top contacts of any other one of the relays associated with the same signal are closed and the circuit for a more restrictive indication at that signal being closed when the back contacts of all of the relays associated therewith are closed.

5. The combination according to claim 4 wherein said normally deenergized relays are time element relays and wherein a track relay associated with each block controls over a back contact the circuits of all of said time element relays associated with the signal at the entrance to the succeeding block, each track relay also controlling over a top contact the circuit of that one of said relays having the longest period of pick-up and associated with the signal at the entrance to the preceding block and the circuit of that one of said relays having the next longest period of pick-up and associated with the signal at the entrance to the second preceding block and correspondingly controlling the circuits of one of the others of said time element relays at progressively preceding signals.

6. The combination according to claim 4 wherein said normally deenergized relays are slow pick-up relays each of which is provided with a stick circuit over its own top contacts and wherein a track relay and a series track relay associated with each block control over a back contact of the former and top contact of the latter the circuits of all of said slow pick-up relays associated with the signal at the entrance to the succeeding block whereby only those relays which have had time to close their top contacts between the closing of the back contact of the preceding track relay and the opening of the top contact of the preceding series track relay due to the approach of a train toward the associated signal will remain energized after the series track relay of the block preceding the signal has been shunted.

7. In an automatic railway block signaling system, the combination comprising a signal at the entrance to each block adapted to give a proceed indication and at least one other more restrictive indication, a relay at each signal adapted when energized to close the circuit for the proceed indication at said signal, a plurality of alternative circuits for said relay each controlled in response to traffic conditions over a different number of blocks in advance of the signal, a plurality of switches associated with each signal normally maintaining said alternative circuits open, and means responsive to the approach of a train toward the signal for closing successively after intervening periods of time first that one of the switches controlling the longest of said circuits, then that controlling the next longest circuit, and so on until the train reaches the signal or until all switches are closed.

8. The combination according to claim 7

wherein a time release mechanism associated with each signal controls said switches, said mechanism including a slot winding normally energized when the block preceding the signal is unoccupied, and deenergized upon the approach of a train, said winding, when energized, preventing the release of the mechanism and consequent operation of said switches, said mechanism further including means for rewinding the same after release and after the block preceding the signal has become unoccupied, and means associated therewith for preventing closure of the circuit for the proceed indication during rewinding of the mechanism.

9. The combination according to claim 7, including a plurality of relays associated with each signal and each energized upon the entrance of a train into the block preceding the signal, and each having as an armature the movable member of one of said switches, said relays each having a resistor, a glow discharge tube, and a capacity of such characteristics and so associated therewith as to delay the pick-up thereof and cause the specified successive closure of said switches upon an approach of a train.

10. The combination according to claim 7, including a plurality of normally energized slow release relays associated with each signal and each having a different release period, that one of said relays having the shortest release period having as an armature the movable member of that one of said switches controlling the longest of said alternative circuits and each of the other of said slow release relays having as an armature, according as the length of period of release, another of said switches, said slow release relays, upon the approach of a train being all deenergized and, after a period of time varying with the speed of the train, so many thereof as had not released being reenergized to hold open the switches controlled thereby.

11. A railway block signal system comprising in combination, a plurality of circuits associated with the control of the proceed indication for each signal, each of said circuits being controlled in response to track conditions over a different number of blocks in advance of the signal, and each being normally open at the signal location when no train is approaching that signal, means initiated by the approach of a train for closing at that signal location first the longest of said circuits and then successively after periods of time each of the other circuits, any one of said circuits when completed at the signal location and if not interrupted at any other point due to a train in one of the blocks to which it is responsive being adapted to cause the signal to give a proceed indication, whereby if a train approaches the signal at a rate so great as to have given time for the longest only of said circuits to be closed it can only receive a proceed indication if the greatest number of blocks in advance of the signal are unoccupied whereas, a slower running train permitting a shorter one of said circuits to be closed will receive a proceed indication when there is a correspondingly fewer number of unoccupied blocks.

12. A railway block signaling system comprising in combination, track relays for each block, a plurality of relays and a plurality of switches at each signal location, each of said relays having a different operating period and each controlling one of said switches, a plurality of circuits each adapted when closed to cause the signal to give a proceed indication, each of said circuits being controlled over top contacts of track relays a different number of blocks in advance of the signal and the longest of said circuits being normally opened at the switch controlled by that one of said relays which has the shortest period of operation, the next longest circuit being normally open at the switch controlled by that one of said relays which has the next shortest period of operation, and so forth, and means initiated by the approach of a train for causing successive operation of said relays to close said switches after different periods of time to successively close first the longest of said circuits, then the next longest, and so forth, whereby the faster moving trains require a greater number of unoccupied blocks in order to receive a proceed indication.

In testimony whereof I affix my signature.

HOWARD A. THOMPSON.