Nov. 2, 1926. 1,605,524

C. S. BUSHNELL

SYSTEM OF TRAIN SPEED CONTROL

Filed March 23, 1922 3 Sheets-Sheet 1

FIG. 1.

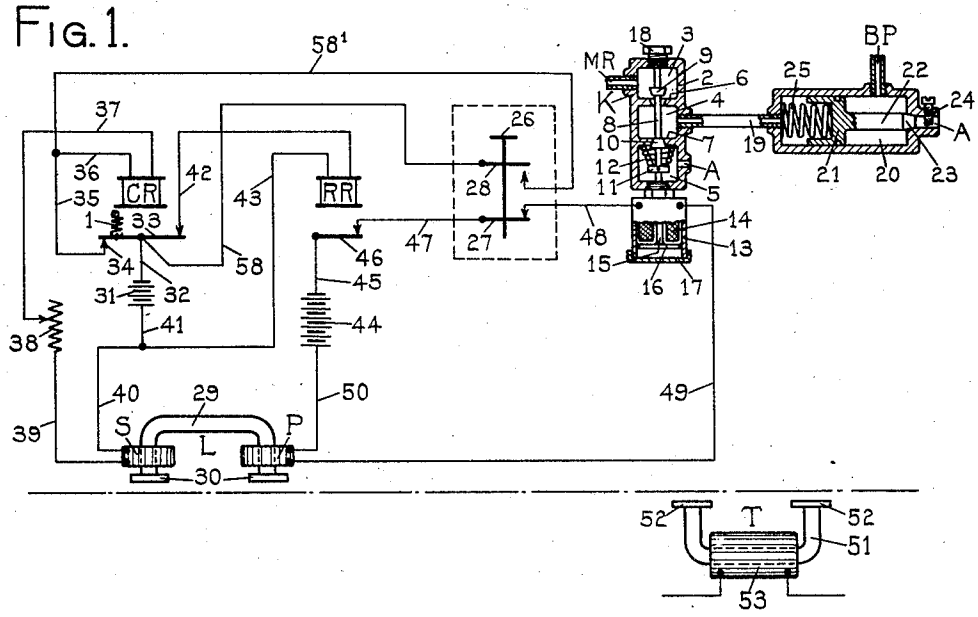
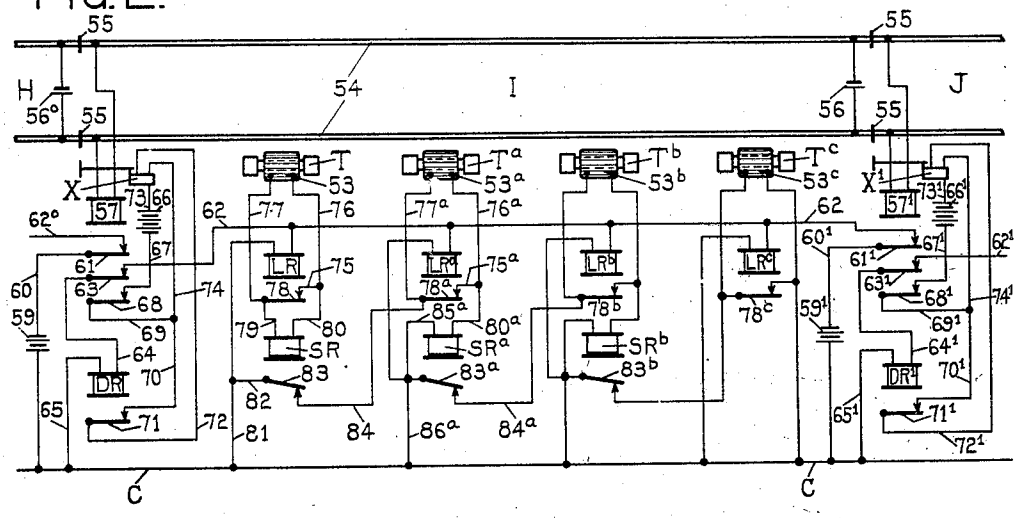


FIG. 2.



INVENTOR
Charles S. Bushnell,
BY
Neil D. Preston
his ATTORNEY

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C. S. BUSHNELL

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FIG. 3.

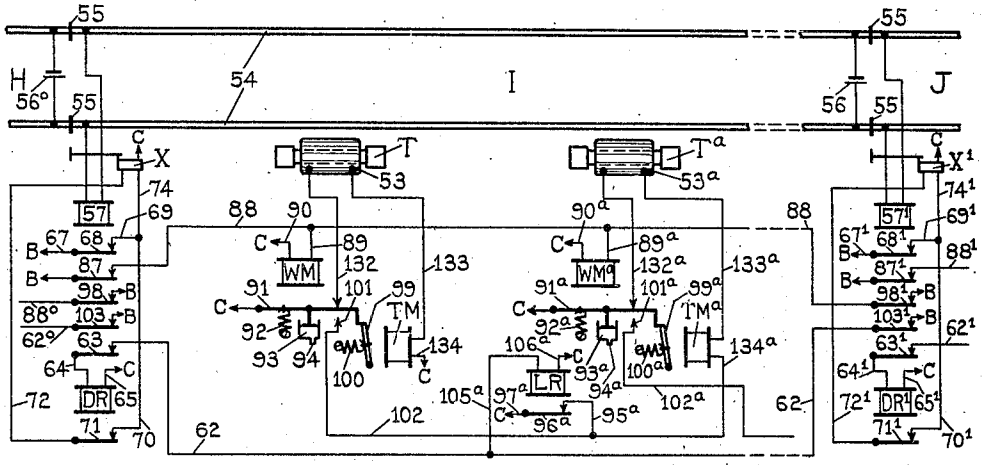


FIG. 4.

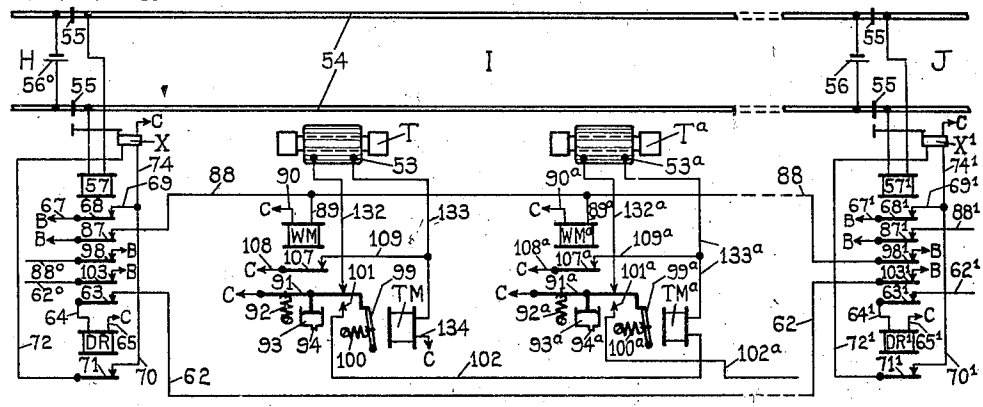
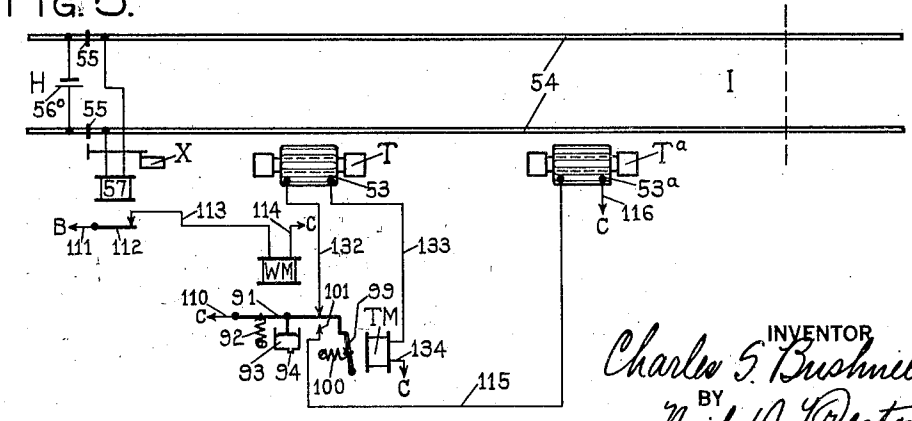


FIG. 5.



INVENTOR
Charles S. Bushnell,
BY
Neil W. Preston,
his ATTORNEY

Nov. 2, 1926. 1,605,524

C. S. BUSHNELL

SYSTEM OF TRAIN SPEED CONTROL

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FIG. 6.

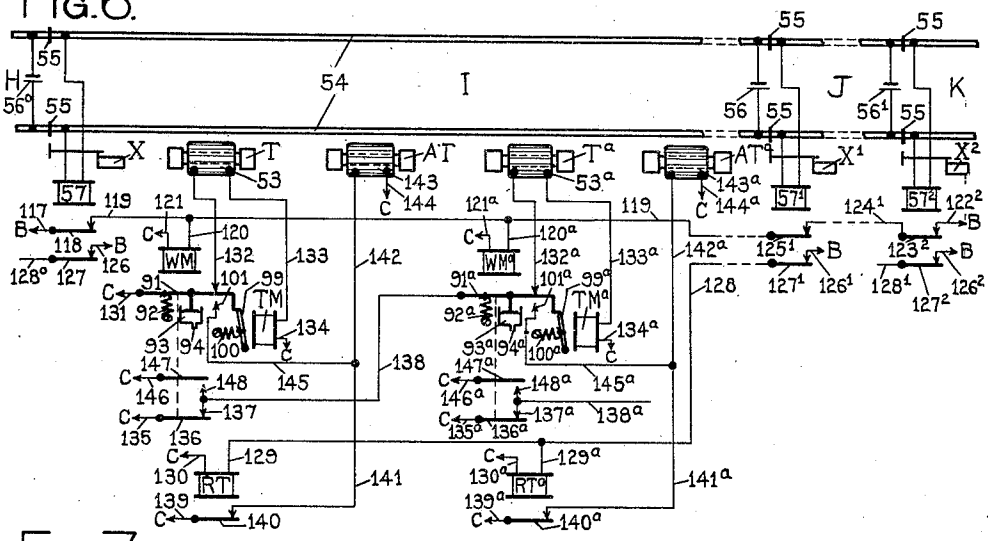


FIG. 7.

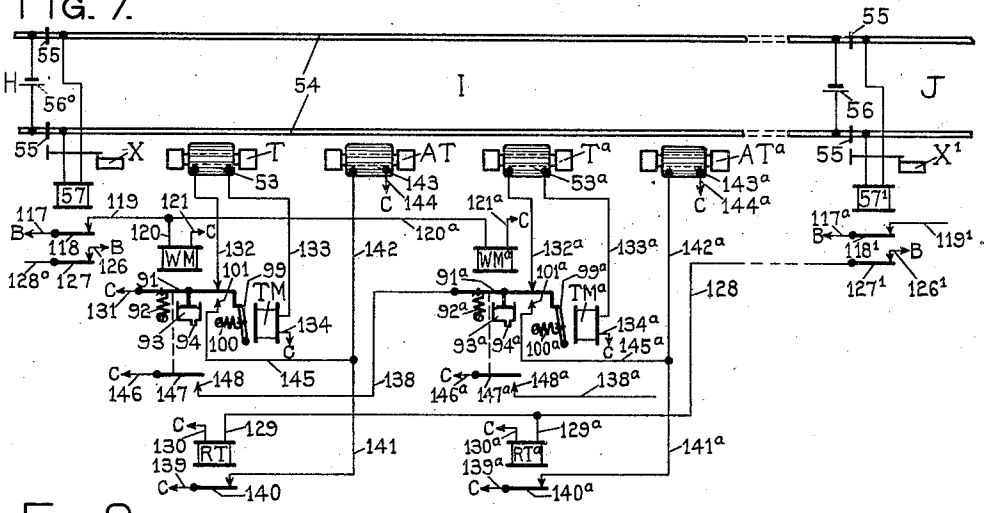
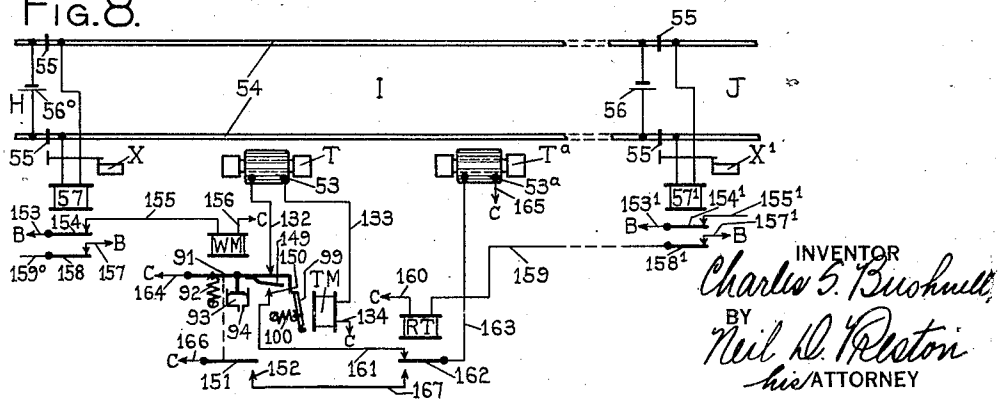


FIG. 8.



INVENTOR
Charles S. Bushnell,
BY
Neil M. Preston
his ATTORNEY

Patented Nov. 2, 1926. 1,605,524

UNITED STATES PATENT OFFICE.

CHARLES S. BUSHNELL, OF ROCHESTER, NEW YORK, ASSIGNOR TO GENERAL RAILWAY SIGNAL COMPANY, OF GATES, NEW YORK, A CORPORATION OF NEW YORK.

SYSTEM OF TRAIN-SPEED CONTROL.

Application filed March 23, 1922. Serial No. 546,100.

This invention relates to train control systems, and more particularly to the arrangement of parts and circuits for making an automatic brake application dependent upon the time taken by the train in passing between two control points.

In certain types of train control systems where it is desired to make the automatic control dependent upon the speed of the train, it has been proposed to utilize the time-distance interval principle for determining when the train speed is excessive and a brake application should be given. In this type of system, to which the present invention more particularly relates, a suitable timing mechanism is employed, preferably located along the trackway, and this timing mechanism is started or rendered effective as the train passes the first or initial control point, and automatically returns to its initial or normal condition after the lapse of a predetermined time interval.

The principal objects and purposes of the present invention are to provide automatic speed control by the time-distance interval principle at any desired point along the trackway, irrespective of the track circuits, by providing relatively closely spaced trackway devices, these devices cooperating with suitable car-carried devices so that a time element device located along the trackway will be set into operation by the passage of a train over such trackway device, and preferably also employing the same devices for transmitting a control influence to the vehicle when the permissive speed enforced at a particular point along the track is exceeded. The influences transmitted to set off, or initiate, such time controlled device as well as the influences transmitted to the vehicle, are characterized by being inductive and passing through an air gap and requiring no physical contact between car-carried and trackway devices for their transmission.

Various other objects and purposes of the invention will appear as the description progresses.

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

Fig. 1 shows in a simplified and diagrammatic manner parts and circuits of the car equipment, these parts and circuits being shown more with the purpose of facilitating explanation, than with the idea of showing the specific construction and arrangement of parts preferably employed in practice;

Fig. 2 shows in a simplified and diagrammatic manner one form of trackway apparatus embodying the present invention. In this particular embodiment, the energy for actuating time controlled devices along the trackway is derived from the passing train through an intervening air gap;

Figs. 3 and 4 show modified forms of the present invention in which the energy for actuating the time controlled devices is derived from a source of energy along the track;

Fig. 5 shows an application of the trackway devices illustrated in Figs. 3 and 4 for enforcing restrictive speeds at the approach to a permanent hazard;

Fig. 6 shows a modification of the trackway devices illustrated in Figs. 3 and 4, where two independent permissive speeds may be enforced, the enforcement of these speeds depending on traffic conditions ahead;

Fig. 7 illustrates substantially the same trackway devices as illustrated in Fig. 6, where only one of said restrictive speeds is controlled by traffic conditions ahead, the other speed being permanently enforced; and

Fig. 8 illustrates an embodiment of the present invention in which two independent permissive speeds may be enforced by a single pair of trackway devices.

In the embodiments of the invention illustrated, the desired control influences are transmitted from the trackway to the vehicle by track elements and coacting car elements, the track elements being at times controlled by the coacting car elements through an intervening air gap, and at other times coacting with said car elements to control them. In order to simplify the description of the invention as applied to various trackway systems and conditions, one particular embodiment of car apparatus adapted to function with any one of the trackway systems illustrated will first be described in detail, both as to structure and operation.

Car-carried structure.—The car-carried apparatus illustrated in Fig. 1 comprises several distinct devices connected in circuits to cooperate in a manner to apply the brakes of a railway vehicle if an influence of a pre-

determined character is received from the trackway. The several devices will first be separately described.

The control relay CR which has been conventionally illustrated comprises a sensitive electro-responsive device having a well balanced armature, which is held away from stationary contacts, when the device is deenergized, by a spring 1. The armature of the relay CR is not only well balanced but is also very light to make it immune to jars and vibration to a large extent. A repeater relay RR is provided which is constructed similar to the control relay CR. This relay is, however, more sturdy and provided with heavier contacts, and is used to repeat the actuation of the control relay CR, whereby a heavier current may be controlled to actuate still larger electro-responsive devices.

Another device used in combination with the car-carried apparatus is a brake applying device designated K, and comprises an electro-pneumatic valve and a pressure responsive device. The electro-pneumatic valve comprises in general a casing 2 having a compartment 3 connected to the main reservoir MR of the usual brake apparatus on railway vehicles, a compartment 4 connected to a pressure responsive device, and a compartment 5 connected to atmosphere through A. The partitions 6 and 7 between these compartments contain holes which are shaped to form valve seats. A valve stem 8 extends through the several compartments, and is provided with a valve 9 adapted to rest in the valve seat of the partition 6 when the electro-pneumatic valve is deenergized, and is provided with another valve 10 which rests in the valve seat in partition 7 when the electro-pneumatic valve is energized. In the compartment 5 the valve stem is provided with a collar 11 rigidly fastened thereto by a pin, and a compression spring 12 is inserted between this collar and the partition 7 which, by the aid of gravity, will move the valve stem 8 to seat the valve 9 when the electro-pneumatic valve is deenergized.

The operating mechanism of the electro-pneumatic valve comprises an iron clad electro-magnet having a magnetic shell 13 in which is housed a winding 14. The valve stem 8 has fastened thereto an iron core 15 extending through the winding 14, having a disc-shaped armature 16 connected at the bottom end thereof. The point of connection between the core 15 made of iron and the valve stem 8 constructed of suitable non-magnetic material, such as brass, is located at a point within the winding 14, thus providing a continually decreasing air gap between the core 15 and the upper part of the magnetic shell 13 as the armature 16 moves upward. The lower end of the magnetic shell 13 is closed by a cap 17, preferably of non-magnetic material. The top wall of the compartment 3 is also provided with a cap 18 to facilitate assembling of the apparatus.

The middle compartment 4 of the electro-pneumatic valve is connected to the pressure responsive device by a pipe 19. This pressure responsive device comprises a cylinder 20 having a piston 21 provided with an extension 22 terminating in a valve 23 normally closing a port leading to the adjustable outlet 24 connected with atmosphere A. On the opposite side of the piston is provided a compression spring 25 which urges the valve 23 against its seat under normal conditions. On the valve side of the piston 21, the cylinder 20 is tapped and provided with a pipe BP connected with the brake pipe of the usual automatic braking equipment.

Under normal conditions, as illustrated, main reservoir pressure is admitted into the compartment 3 and passes through the valve port of the partition 6 into the compartment 4 and through the pipe 19 back of the piston 21 into the cylinder 20. Brake pipe pressure is admitted on the opposite side of the piston, and since the main reservoir pressure, plus the pressure of the spring 25 predominates over the brake pipe pressure, the valve 23 will be seated in the port leading to atmosphere A. If now the electro-pneumatic valve is deenergized, the valve 9 will be seated in the valve port of the partition 6, thus cutting off main reservoir pressure; and the valve 10 will be unseated, thus allowing the pressure in back of the piston 21 to escape through the pipe 19, compartments 4 and 5 to atmosphere A. Under these conditions, the piston 21 is urged in one direction by the spring 25 and in the other direction by the brake pipe pressure. The spring 25 is designed and constructed to provide a sufficient force to maintain the valve 23 seated when the brake pipe pressure is below a predetermined value, for instance, such as 70 pounds per sq. in.

It is thus seen that if the electro-pneumatic valve is deenergized, thus releasing the main reservoir pressure from the back of the piston 21, the piston will be moved to unseat the valve 23 due to the brake pipe pressure (which has been assumed to be more than 70 pounds) until the brake pipe pressure falls to the predetermined value.

A release switch 26, which has been illustrated conventionally as a push button, has been provided. This release switch comprises a stem urged in one direction in any suitable manner (not shown), connected to a normally closed contact 27 and a normally open contact 28. This release switch may be located in a locked box, the key being held by some authorized person, such as the conductor, but is preferably mounted so that it is not accessible while the railway vehicle is in motion, for instance, by mounting it so

that it is only accessible to a person standing on the ground.

Another device of the car-carried apparatus comprises a car element L consisting of a U-shaped core 29 constructed of suitable magnetic material and terminating in pole pieces 30. The forward leg of the core 29 is provided with an exciting or primary coil P, and the other leg is provided with a receiving or secondary coil S. This car element L is preferably mounted on the car truck in order to assure a definite alignment with respect to the trackway. It is preferably mounted so that the pole pieces 30 are located in a plane several inches above the top of the rails. This is done to limit rail interference, that is, the generation of an E. M. F. in the secondary coil when the car element passes over intersecting track rails. The car element is preferably secured to the truck by suitable spring devices to protect the car element from severe jars and vibration.

Operation of car-carried apparatus.— Under normal conditions, that is, with a railway vehicle equipped with the apparatus illustrated in Fig. 1, and moving in a clear block and between control points of any one of the trackway systems illustrated in Figs. 2 to 8, the control relay CR is energized through a circuit which may be traced as follows: Beginning at the battery 31, wire 32, movable contact 33 of the control relay CR, front contact 34, wires 35 and 36, winding of the control relay CR, wire 37, adjustable resistance 38, wire 39, secondary coil S, wires 40 and 41 back to the battery 31.

With the control relay CR in its energized position, an energizing circuit for the repeater relay RR is completed, which may be traced as follows: Beginning at the battery 31, wire 32, movable contact 33, wire 42, winding of the repeater relay RR, wires 43 and 41 back to the battery 31.

The energization of the repeater relay RR closes a circuit, which may be traced as follows: Beginning at the battery 44, wire 45, front contact 46 of the repeater relay RR, wire 47, normally closed contact 27 of the release switch 26, wire 48, winding 14 of the electro-pneumatic valve, wire 49, primary coil P of the car element L, wire 50 back to the battery 44. With this latter circuit energized the electro-pneumatic valve will be in its raised position, thus closing the port A to atmosphere and opening the port leading to the main reservoir MR. This latter circuit also provides an exciting current for the car element L through the primary coil P.

The exciting current in the primary coil P sets up a magneto-motive-force which tends to cause a flux through the secondary coil S. This electro-motive-force is much stronger than the electro-motive-force caused by the current flowing in the secondary coil S due to the battery 31. The current normally flowing in the secondary coil S due to the battery 31 is very small, being by a small margin greater than the current necessary to maintain the control relay CR energized. On account of the large air gap between the pole pieces 30, very little flux passes through the core 29 due to the magneto-motive-force set up by the exciting current flowing in the primary coil P.

Assume now that the vehicle equipped with the car-carried apparatus illustrated in Fig. 1 in its normal condition as illustrated is passing along the trackway, and approaches a track element T. This track element T comprises a similar U-shaped iron core 51 terminating in pole pieces 52 and having a winding 53. As the car element L passes over the track element T with its winding 53 open circuited, the core 51 reduces the reluctance of the magnetic circuit including the core 29 of the car element, thereby causing a sudden increase of flux to a maximum which again decreases to its normal value as the car element recedes from the track element, this change of flux being partly due to a diversion of flux from leakage paths through the secondary coil S, and partly due to an increase of the total flux through the primary coil P. This sudden increase and decrease of flux through the car element L at speeds above which the apparatus is designed to function induces sufficient voltage in the secondary coil S, similar to that of a single cycle of alternating current, to momentarily deenergize the control relay CR. The battery 31 is so connected in the circuit including the secondary coil S that the first wave of the cycle of voltage generated is in a direction to oppose the voltage of the battery 31. This opposition to the voltage of the battery 31 causes a decrease in the current flowing in the control relay CR sufficient to cause it to drop its armature. Although this decrease of current is only momentary, the control relay CR will be permanently deenergized, because it is in a stick circuit which is interrupted when the front contact 34 is opened.

The deenergization of the control relay CR interrupts the energizing circuit for the repeater relay RR heretofore traced, thus causing the front contact 46 of the repeater relay RR to drop, thereby interrupting the energizing circuit for the electro-pneumatic valve of the brake applying device K. The interruption of current flow in the winding 14 causes the spring 12 to seat the valve 9 and unseat the valve 10, thus closing the passage between the compartment 4 and the main reservoir MR, and opening the passage between the compartments 4 and 5 leading to atmosphere through A. This causes the air pressure back of the piston 21 to drop to atmospheric pressure. The spring

25 not being strong enough to force the piston 21 against the opposing force, due to brake pipe pressure on the opposite side of the piston 21, allows the valve 23 to become unseated, thereby allowing brake pipe pressure to escape through the adjustable port 24 to atmosphere through A. As soon as the brake pipe pressure is reduced to a value so that the pressure due to the spring 25 slightly exceeds that due to the brake pipe pressure acting on the piston 21, the valve 23 will again be closed, thus preventing further escape of air from the brake pipe. The tension of the spring 25 is preferably so chosen that it will allow sufficient venting of the brake pipe to make a full service brake application under usual working conditions; and that it will prevent further venting after such a reduction has been made, thus preventing an unnecessary loss of pressure fluid.

Assume now that the brake application just described has brought the train to a stop and the engineer decides to proceed, the danger traffic condition having cleared up. The engineer may now operate the release switch 26, which is only accessible from the ground, by operating the push button, thus closing the normally open contact 28 and completing a pick-up circuit, which may be traced as follows: Beginning at the battery 31, wire 32, movable contact 33, wire 58, normally open contact 28 of the release switch, wires 58[1] and 36, winding of the control relay CR, wire 37, adjustable resistance 38, wire 39, secondary coil S, wires 40 and 41 back to the battery 31. The completion of this circuit causes the control relay CR to pick up and complete the stick circuit heretofore traced. The energization of the control relay CR causes the repeater relay RR to pick up and energize the electro-pneumatic valve of the brake applying device K, in a manner as heretofore explained.

It should be noted that the release switch 26 has not only been mounted in a manner to prevent its operation at any time and thereby defeat the purpose of the automatic train control apparatus, but has also been provided with a normally closed contact which is in circuit with the winding 14 of the electro-pneumatic valve, so that, this release switch may not be permanently tied down, for by so doing the brakes would remain on, regardless of whether the control relay CR and repeater relay RR were energized or not.

Assume now that the train is passing by a track element T having its winding 53 closed in a circuit of low resistance. Under this condition as the car element L passes over the track element T, very little change of flux will occur in the secondary coil S. This is believed to be due to the bucking action of the coil 53, that is, as the car element L passes over the track element, a small amount of flux will permeate the core 51 of the track element, thereby inducing a current in the winding 53 connected in a closed circuit of low resistance which will, by well-known principles of alternating current, be in a direction to oppose the flux producing it. This slight flux passing through the core 51 will produce a small change of flux in the core 29 of the car element, this change, however, being insufficient to generate sufficient voltage in the secondary coil to operate the control relay CR.

Assume now that the winding 53 is connected across the terminals of a suitable electro-responsive device to be more clearly described hereinafter. As a train equipped with the car apparatus in its normal condition as illustrated in Fig. 1 passes over the track element in this condition, no control influence will be transmitted to the control relay CR. Although a slight change of flux will take place in the car element L under these conditions, the several devices are so designed and proportioned that no control influence will be transmitted to the control relay CR, the electro-responsive device, to be presently described, being designed and constructed to respond to the current generated in the winding 53 by the slight change of flux just mentioned. The variable resistance 38 has been inserted in the secondary circuit of the car apparatus for the purpose of making the effectiveness of the control influence more nearly alike for the various speeds at which a train may travel, that is, this resistance is added to make the resistance component higher as compared with the reactance component of the impedance of the secondary circuit, thereby decreasing the current flowing in the control relay CR substantially to the same amount when passing over a track element having its winding 53 open circuited at any one of the usual train speeds.

Trackway devices.—Various types of apparatus for train control systems have been illustrated in Figs. 2 to 8, inclusive, each of which embodies the present invention and is adapted to cooperate with the car-carried apparatus shown in Fig. 1. These trackway systems include time control devices which are initiated by a passing vehicle, and which after a predetermined time change another track element from a danger to a clear condition. Various arrangements of trackway circuits suitable for this purpose may be employed, and it should be understood that the arrangement shown in Figs. 2 to 8 is only typical as far as the track circuits and associated equipment are concerned.

Referring to Figs. 2 to 8, the track rails

54 are divided by insulated joints 55 into blocks in the usual way, one block I with the adjacent ends of two other blocks H and J being shown. The parts and circuits associated with the various blocks are the same, and for convenience will be given like reference characters with distinctive numeral exponents, whereas the like parts associated with each block will be given the same reference characters with distinctive alphabetical exponents. Each of the blocks is provided with a track battery 56 and a track relay 57, the same as in ordinary block signal systems. My invention is preferably used in connection with the usual fixed signals, and I have illustrated such fixed signals X conventionally, without attempting to illustrate their well-known control circuits and devices.

Structure of Fig. 2.—Referring more specifically to the trackway apparatus illustrated in Fig. 2, each signal location is provided with a distant relay DR. The circuit for energizing this relay may be traced as follows: Beginning at the battery 59^1, wire 60^1, front contact 61^1 of track relay 57^1, line wire 62, front contact 63 of track relay 57, wire 64, winding of distant relay DR, wire 65, common return wire C connected to the battery 59^1. Under normal or clear traffic conditions, the signal X will be in its 90 degree position, both the 45 degree and 90 degree circuits being energized.

The 90 degree circuit may be traced as follows: Beginning at the battery 66, wire 67, front contact 68 of track relay 57, wires 69 and 70, front contact 71 of distant relay DR, wire 72, through suitable signal operating mechanism of the signal X (not shown), wire 73 back to the battery 66. With this circuit energized the signal X will assume its 90 degree position.

The 45 degree circuit of the signal X may be traced as follows: Beginning at the battery 66, wire 67, front contact 68 of track relay 57, wires 69 and 74, through suitable signal mechanism in the signal X, wire 73 back to the battery 66. This 45 degree circuit when energized will maintain the signal X in its 45 degree position, unless the 90 degree circuit is also energized under which condition the signal will be actuated to its 90 degree position. Thus far in the description of Fig. 2, only the usual track circuits and signal devices have been described.

In addition to these devices, line relays LR are connected in multiple between the line wire 62 and the common return wire C at various points in the block. These line relays LR are energized when the track relay 57^1 of the block in advance is energized, thereby closing a circuit of low resistance through the winding 53 of the track element T, which may be traced as follows: Beginning at the front contact 75, wire 76, winding 53 of track element T, wire 77, movable contact 78 back to the front contact 75. Under these conditions, that is, with the winding 53 of the track element T closed in a circuit of low resistance, no influence will be transmitted to the car-carried apparatus as heretofore explained.

Assume now that a railway vehicle equipped with the apparatus illustrated in Fig. 1 in its normal condition is entering the block I, and is passing over the first track element T. No control influence will be transmitted, because the track element T has its winding 53 connected in a circuit of low resistance. Since the same is true of each of the track elements T, T^a, etc., no control influence will be transmitted at any point in the block I. As the train moves into the block J, the track relay 57^1 will be deenergized, because it will be robbed of its current which will be flowing through the axles of the train, thereby deenergizing each of the line relays LR, LR^a, etc.

Assume now that another train is entering the block I with the line relay LR deenergized due to the presence of a train in the block J. As this another or second train passes by the track element T, a current will be induced in the winding 53 which will flow through the slow dropping relay SR through a circuit, which may be traced as follows: Beginning at the winding 53, wires 77 and 79, winding of the slow dropping relay SR, wires 80 and 76 back to the winding 53. This current is due to the slight change of flux caused by the car element L when passing over the track element T.

The passage of the car-carried apparatus over a track element T having its winding connected across the slow dropping relay SR will, however, induce insufficient voltage in the secondary circuit to affect the control relay CR. This induced current flowing in the winding of the slow dropping relay SR causes it to pick up its armature, thereby interrupting the normally closed circuit which may be traced as follows: Beginning at the common return wire C, wires 81 and 82, contact 83 of the slow dropping relay SR, wire 84, wire 77^a, winding 53^a of the track element T^a, wire 76^a, wire 80^a, winding of the slow dropping relay SR^a, wires 85^a and 86^a back to the common return wire C. The circuit just traced will remain open for a predetermined time at the contact 83 of the slow dropping relay SR, and if the train passes over the track element T^a before the contact 83 again completes said circuit, the train will be stopped by an actuation of the brake applying device K, in a manner as heretofore explained. The slow acting relay SR is constructed in a manner that it will quick-

ly pick up its armature when energized, but the armature will be retarded in the movement to its deenergized position. This may be done in any suitable manner well-known by those skilled in the art. The spacing between the successive track elements T, T^a, etc., and the adjustment of the various slow dropping relays SR, will be so chosen that a gradually decreasing speed limit will be enforced at the several points throughout the block to bring the train down to a predetermined low permissive speed at the end of the block.

It should be noted that the trackway apparatus shown in Fig. 2 just described, derives the energy for operating the slow dropping relay or time control device from the winding 53 of the track element associated therewith. In each of the devices illustrated in Figs. 3 to 8, the energy for actuating the time control device is supplied over a line wire and is derived from a suitable source of energy, such as a battery.

Structure of Fig. 3.—In the arrangement illustrated in Fig. 3, the several time control devices are wound up, so to speak, by a relay which serves both as a repeater track relay and as a winding electro-responsive device. This device is conveniently called a winding magnet WM. The winding magnets at the several control points in a block (only two being shown) are energized by two multiple circuits, which may be traced as follows: (1) Beginning at the terminal B of a battery, front contact 87 of the track relay 57, line wire 88, wires 89 to the several winding magnets WM, windings of said magnets, wire 90 back to the common return wire C; and (2) a circuit beginning at the terminal B of a battery, front contact 98^1, wires 88 and 89, windings of the winding magnets WM, wires 90 back to the common return wire C.

A normally closed circuit of fairly low impedance through the winding 53 may be traced as follows: Beginning at the common return wire C, movable contact 91 of the winding magnet WM, wire 132, winding 53 of the track element T, wire 133, winding of the trip magnet TM, wire 134 back to the common return wire C.

A normally closed circuit for the track element T^a may be traced as follows: Beginning at the common return wire C, movable contact 91^a of the winding magnet WM^a, wire 132^a, winding 53^a, wire 133^a, winding of the trip magnet TM^a, wires 134^a and 95^a, front contact 96^a, wire 97^a back to the common return wire C.

Assume now that the block J is occupied, thus causing the track relay 57^1 to drop. This also causes the front contact 103^1 to drop, thereby interrupting the circuit of the line relay LR, which may be traced as follows: Beginning at the terminal of the battery B, front contact 103^1, wires 62 and 105^a, winding of line relay LR, wire 106^a back to the common return wire C, thus causing the line relay to drop its front contact 96^a.

Assume further that a second train is entering the block I. As it enters the block I, the track relay 57 will be deenergized causing the front contact 87 to drop, thereby deenergizing the several winding magnets WM, WM^a, etc. As the train passes by the first track element T, a slight change of flux will take place in the track element, thus inducing a current in the winding 53 and the trip magnet TM which will cause the trip magnet TM to attract its armature, thereby moving the latch 99 from the movable contact 91. This causes the movable contact 91 to be moved by the spring 92 retarded by a suitable time control means, conveniently illustrated as a dash pot 93, having a restricted opening 94. A predetermined time after the trip magnet TM releases the latch 99 in opposition to the tension of the spring 100, a circuit of fairly low impedance will be completed, which may be traced as follows: Beginning at the common return wire C, movable contact 91 of the winding magnet, back contact 101, wires 102 and 134^a, winding of trip magnet TM^a, wire 133^a, winding 53^a, wire 132^a, movable contact 91^a back to the common return wire C. If the train reaches the track element T^a before this predetermined time has elapsed, it will pass over the track element T^a while its winding 53^a is open circuited, thereby applying the brakes in a manner as heretofore described. If, however, the train reaches the track element T^a after the circuit just traced has been completed, no control influence will be transmitted to the control relay CR, thereby making the track element T^a ineffectual to stop the train.

If now the train passes entirely out of the block I, the track relay 57 will again be energized, thereby closing its front contact 87, thus energizing the winding magnet WM, which will, so to speak, rewind the time control mechanism by raising the movable contact 91 to its raised position, where it will be held by the latch 99 until another train will pass through this block, while the block is in the caution condition.

It should be understood that any number of speed control devices may be located in each block, but for the purpose of simplifying the drawings and description of the invention, only one complete unit comprising an initiating track element T and a tripping or stopping track element T^a with their respective devices has been illustrated.

Description of Fig. 4.—The trackway equipment illustrated in Fig. 4 of the drawings is substantially the same as the one illustrated in Fig. 3 just described, and therefore like parts have been given the same reference characters. The principal

distinction between the two systems is that the winding magnet WM illustrated in Fig. 4 serves the double purpose of the winding magnet WM and the line relay LR illustrated in Fig. 3. This double function is accomplished by adding an unretarded front contact 107 to the armature controlled by the winding magnet WM. This front contact serves to maintain the winding 53 of the track elements in a closed circuit of low resistance when the line wire 88 is energized. This circuit of low resistance may be traced as follows: Beginning at the common return wire C, wire 108, front contact 107, wires 109 and 133, winding 53 of the track element T, wire 132, movable contact 91 of the winding magnet WM back to the common return wire C. Since the operation of the trackway system illustrated in Fig. 4 is substantially the same as that illustrated in Fig. 3, a description thereof is believed unnecessary.

Description and operation of Fig. 5.—In the practical operation of trains, it is often desirable to limit the speed at certain points along the track due to permanent hazards, such as bridges, sharp turns, station and yard limits, and the like; and the arrangement illustrated in Fig. 5 is particularly well adapted for this purpose. In the arrangement illustrated in Fig. 5, the winding 53 of the track element T is normally closed in a circuit of fairly low impedance, which may be traced as follows: Beginning at the common return wire C, wire 110, multiple contact 91 of the winding magnet WM, wire 132, winding 53 of track element T, wire 133, winding of the trip magnet TM, wire 134 back to the common return wire C.

The energizing circuit for the winding magnet WM may be traced as follows: Beginning at the terminal B of the battery, wire 111, front contact 112 of track relay 57, wire 113, winding of the winding magnet WM, wire 114 back to the common return wire C.

Assume that a train is entering the block I in which the speed should not exceed a certain limit. As the train enters the block, the track relay 57 will drop its armature, thereby opening the front contact 112 and deenergizing the winding magnet WM. As the train passes over the track element T, a current will be induced in the normally closed circuit through the trip magnet TM just traced. This current will cause the trip magnet to attract its armature, thereby moving the latch 99 from the movable contact 91, thus allowing the contact to move downward in accordance with the speed allowed by the retarding device 93. If the train reaches the second track element T^a before the movable contact 91 has reached its lower position, the train will be stopped, in the manner heretofore described, because the track element T^a has its winding 53^a open circuited. If, however, the train has reduced its speed below a predetermined amount, it will not reach the track element T^a until the winding 53^a has been closed in a circuit of low resistance, which may be traced as follows: Beginning at the common return wire C, wire 110, movable contact 91, back contact 101, wire 115, winding 53^a of track element T^a, wire 116 back to the common return wire C.

After the train has passed out of block I, the track relay 57 will again be energized, thereby completing the energizing circuit for the winding magnet WM, which will, so to speak, rewind the time control device by lifting the movable contact 91 to its latched position. It should be noted that no track circuits need be employed in this application of the invention, since the winding operation may be accomplished by each passage of a train in any suitable manner.

Structure of Fig. 6.—In Fig. 6 has been illustrated the trackway apparatus of a train control system embodying the present invention, that is, the principle of stopping a train when it passes certain points under certain conditions where the speed is determined by a time-distance interval. The particular trackway system illustrated in Fig. 6 comprises a track divided into shorter blocks than usual, and in which the blocks may be shorter than the braking distance of a train, it, however, being essential that two successive blocks should be longer than such braking distance. In systems of this kind, the usual signals are connected in circuits to cause them to indicate caution at the first and second blocks in the rear of an occupied block, instead of the usual arrangement in which only the block in the rear of an occupied block indicates caution.

In a system of this kind, it is desirable to enforce one of two independent permissive speeds in a caution block, dependent upon whether the next block in advance or the second block in advance is occupied. Two different permissive speed limits may be enforced at several points in a block by employing a trackway apparatus for controlling the train, similar to that illustrated in Fig. 3, which is modified by adding alternate auxiliary track elements, these auxiliary track elements being located closer to the track elements controlling them than are the regular track elements to the preceding regular track elements. Such alternate auxiliary track elements may be conveniently designated AT, and the system employing such auxiliary track elements may be termed a multiple spacing and single timing system. Suitable traffic control devices are preferably employed so that the next regular track element, or the next auxiliary track element, will be made effective when passing

over a preceding regular track element, dependent upon whether the next block or the second block in advance is occupied.

In this system winding magnets WM are provided which are energized unless the block, such as the block I, for instance, and either or both of the next two blocks in advance are occupied. The two circuits for energizing these winding magnets may be traced as follows: (1) Beginning at the terminal of a battery B, wire 117, front contact 118 of the track relay 57, line wire 119, wires 120, windings of the winding magnets WM, wires 121 back to the common return wire C; and (2) beginning at the terminal of a battery B, wire 122^2, front contact 123^2 of the track relay 57^2, line wire 124^1, front contact 125^1 of track relay 57^1, line wire 119, wires 120, windings of the winding magnets WM, wires 121 back to the common return wire C.

Each of the control points is provided with a repeater track relay RT. The circuit for energizing these repeater track relays may be traced as follows: Beginning at the terminal of the battery B, wire 126^1, front contact 127^1 of the track relay 57^1, line wire 128, wire 129, winding of the repeater track relay RT, wire 130 back to the common return wire C.

Under normal conditions, that is, with neither of the two blocks in advance of the block I occupied, each of the track elements T and AT is closed in a circuit of rather low impedance. The normally closed circuit for the first track element T may be traced as follows: Beginning at the common return wire C, wire 131, movable contact 91 of the time control device, wire 132, winding 53 of the track element T, wire 133, winding of the trip magnet TM, wire 134 back to the common return wire C.

The normally closed circuit for the second regular track element T^a may be traced as follows: Beginning at the common return wire C, wire 135, movable contact 136 of the time control device, front contact 137, wire 138, front contact 91^a, wire 132^a, winding 53^a of the track element T^a, wire 133^a, winding of the trip magnet TM^a, wire 134^a back to the common return wire C.

Each of the auxiliary track elements AT is provided with a normally closed circuit, which may be traced as follows: Beginning at the common return wire C, wire 139, front contact 140 of the repeater track relay RT, wire 141, wire 142, winding 143 of the auxiliary track element AT, wire 144 back to the common return wire C.

Operation of Fig. 6.—Assume that the trackway apparatus is in its normal condition as illustrated in Fig. 6, as has just been described and that a train is approaching in the block H. As the train enters the block I, the track relay 57 will drop its armature, thereby opening front contact 118. As the train passes through the block I, no restricted speed will be enforced, because each of the regular track elements T and the auxiliary track elements AT has its winding closed in a circuit of low impedance.

Assume now that the train enters the block J, thereby deenergizing the track relay 57^1 causing the front contact 127^1 to drop, thereby opening the circuit to the several repeater track relays RT. This will cause them to drop their armatures, thereby opening front contacts 140 and interrupting the normally closed circuits of the auxiliary track elements AT. The deenergization of the track relay 57^1 will also drop the front contact 125^1, thereby interrupting one of the energizing circuits for the winding magnets WM; and since the other circuit thereof has been opened at the contact 118 when the train entered block I, the winding magnets of the block I will be deenergized. As the rear end of the train passes out of block I, the track relay 57 will again be energized, thereby closing its front contact 118, and again energizing the winding magnets WM.

With the first train in the block J as has just been explained, let us assume that a second train is entering the block I, thereby again deenergizing the track relay 57, thus causing the winding magnets WM to be deenergized. As the second train passes through the block and the car element L passes over the track element T, a current will be generated in the closed circuit through coil 53 of the track element T, this current being due to a change of flux through the track element T caused by the magneto-motive-force in the car element L.

As heretofore explained, the control relay CR of the car-carried equipment will not be affected by the passage of the car element over a track element connected in a circuit of low impedance. The current generated in the coil 53 of the track element T will cause the trip magnet TM to attract its armature, thereby actuating the latch 99, thus allowing the movable contact 91 to be moved downward by the force of the spring 92 retarded by the time control device 93. The winding 143 of the auxiliary track element AT being open circuited, because the repeater track relay RT is deenergized, will stop the train in a manner as heretofore described if said train is moving at such a high speed that it reaches said auxiliary track element AT while this circuit is open, the predetermined time having not yet expired. If, however, the train is not moving at an excessive speed and the predetermined time elapses, the movable contact 91 will contact with the back contact 101, thus closing another circuit through the winding 143 of the auxiliary track element AT, which may be traced as follows: Beginning at the

common return wire C, wire 131, movable contact 91 of the time control device, back contact 101, wires 145 and 142, winding 143 of the auxiliary track element AT, wire 144 back to the common return wire C. If the train now passes over the auxiliary track element AT with the circuit just traced closed, no control influence will be transmitted to the car-carried apparatus for reasons heretofore explained.

Assume now that the first train has passed entirely through the block J and enters the block K, thus causing the track relay 57^2 to be deenergized and thereby opening the front contact 123^2. As the train passes entirely out of the block J, the track relay 57^1 will again be energized, thereby picking up the front contact 125^1. This will, however, not affect the winding magnets WM, because the circuit controlled by this front contact 125^1 is open at the front contact 123^2. The energization of the track relay 57^1 will, however, also close the front contact 127^1, thereby energizing the repeater track relays RT, thus closing the circuit of low resistance for the auxiliary track elements AT, which has heretofore been traced.

Under this condition, let us assume that the second train is moving in the block I and is passing over the track element T. The passage of the car element L over the track element T induces a current in the trip magnet TM, in a manner as heretofore described. This causes the latch 99 to be disengaged, thereby causing the movable contact 91 and the movable contact 136 connected thereto to start on their downward movement limited in their rate of movement by the time control device, as heretofore described.

Assume now that the train proceeds in the block I and passes over the auxiliary track element AT. No stopping influence will be transmitted by this auxiliary track element AT, regardless of the speed of the train, because the winding 143 of the auxiliary track element AT is closed in a circuit of low resistance through the front contact 140 of the repeater track relay RT.

Assume now that the train proceeds in the block I and reaches the second regular track element T^a before the predetermined time for which the time control device is adjusted has elapsed. As the car element L passes over the track element T^a, a control influence will be transmitted to the car-carried apparatus, because the track element T^a has its winding 53 open circuited, because the circuit of low impedance for this track element T^a heretofore traced is open at the movable contact 136 of the time control device. The transmission of a stopping control influence to the car-carried apparatus will apply the brakes in a manner as heretofore explained, thus bringing the train to a stop.

Assume that the train has consumed more time than that for which the time control mechanism associated with the track element T^a has been adjusted. Under this condition, a circuit through the winding 53^a of the track element T^a will be closed, which may be traced as follows: Beginning at the common return wire C, wire 146, movable contact 147 of the time control device, back contact 148, wire 138, movable contact 91^a, wire 132^a, winding 53^a of the track element T^a, wire 133^a, winding of the trip magnet TM^a, wire 134^a back to the common return wire C. The completion of this circuit allows the train to pass over the track element T^a and proceed in the block.

Description of Fig. 7.—In Fig. 7 has been illustrated the trackway apparatus for a train control system, which is substantially the same as that illustrated in Fig. 6, in which two spacings and a single timing are employed to enforce two different speeds. In the system illustrated in Fig. 6, the two different speeds are enforced at a control point in a block, dependent upon whether the next block in advance, or the second block in advance, are occupied; whereas in the system illustrated in Fig. 7, the higher permissive speed of the two speeds mentioned is always enforced, regardless of traffic conditions on account of a permanent hazard some distance in advance of the control point; and the other permissive speed of said two speeds is enforced when the block in advance is occupied.

As is obvious from the drawings, the several winding magnets WM are energized and the movable contacts 91 are latched up each time the block in which they are located becomes clear, and also that each passing train unlatches and releases the time element device so that it may run down, in turn allowing the movable contact 91 to open the circuit including the winding 53 of the track element T. Consequently, if a second train passes into a block already occupied by another train, the track elements T, T^a, etc. encountered by the second train will be in their active condition and will stop the train regardless of the time taken to travel from the next preceding track element.

In general, the trackway apparatus illustrated in Fig. 7 is the same as that illustrated in Fig. 6, and therefore like parts have been designated by the same reference characters. The principal distinction of this system from that shown in Fig. 6 is that the winding magnet WM is only controlled from the block in which it is located, so that the higher of the two permissive speeds at least is always enforced. Since the higher of the two permissive speeds is always enforced,

there is no need of providing the movable contact 136 of the time control device, and therefore this movable contact 136 and associated parts have been omitted.

Structure of Fig. 8.—The trackway systems described in connection with Figs. 6 and 7 enforce two different speeds with substantially the same apparatus by employing two spacings and a single timing. The system illustrated in Fig. 8 enforces two different permissive speeds by employing a single spacing and two timing intervals. The time control device for closing one circuit a predetermined time after the time control device is initiated, and closing another circuit a longer time after said time control device has been initiated, is conventionally illustrated. The time control device is substantially the same as that described in connection with Figs. 3 to 7, the principal difference being that a spring contact 149 secured to the movable contact 91 is provided which is spaced closer to the back contact 150, than a rigid movable contact 151 is spaced from a stationary contact 152. Consequently, when the winding magnet WM is deenergized and the latch 99 is tripped, the movement of the contact 91 downward will cause the spring contact 149 to be engaged a predetermined time after the time control device is initiated, and the rigid movable contact 151 will contact with the stationary contact 152 a longer period of time after the time control device is initiated.

The circuit for energizing the winding magnet WM may be traced as follows: Beginning at the terminal of a battery B, wire 153, front contact 154 of track relay 57, line wire 155, winding of the winding magnet WM, wire 156 back to the common return wire C.

The circuit for energizing the repeater track relay RT may be traced as follows: Beginning at the terminal of a battery B, wire 157^1, front contact 158^1, line wire 159, winding of the repeater track relay RT, wire 160 back to the common return wire C.

Operation of Fig. 8.—Assume that a train is approaching in the block H. As it enters the block I the track relay 57 will be deenergized in the usual manner, thus causing the front contact 154 to be opened, thereby interrupting the circuit at the winding magnet WM. As the train proceeds through the block I and passes the first track element T, the passage of the car element L thereover induces a current in the circuit including the winding 53 of the track element T, thereby energizing the trip magnet TM causing its armature to release the latch 99, thus initiating the operation of the time control device through a circuit heretofore traced.

Assume that the train is moving at a rate of speed so that it will reach the second track element T^a before the spring contact 149 reaches the stationary contact 150, that is, before the smallest interval of time allowed by the time control device has elapsed. Under this condition the train will be stopped when passing over the second track element T^a, because its winding 53^a is open circuited.

Assume now that the train is passing at a slower speed than the permissive speed under clear traffic conditions, thus allowing the spring contact 149 to complete its movement, thus closing a circuit, which may be traced as follows: Beginning at the common return wire C, wire 164, movable contact 91 of the time control device, spring contact 149, stationary contact 150, wire 161, front contact 162 of the repeater track relay RT, wire 163, winding 53^a of the second track element T^a, wire 165 back to the common return wire C.

Assume now that the train is passing from the block I into the block J. This will cause the track relay 57^1 to be deenergized, thereby dropping its front contact 158^1 causing an interruption of the energizing circuit for the repeater track relay RT. The deenergization of this repeater track relay RT causes the movable contact 162 to fall to its lower position. As the train passes entirely out of the block I, the track relay 57 will again be energized, thereby energizing the winding magnet WM through the circuit heretofore traced, causing it, so to speak, to rewind the time control device.

Assume now that a second train is entering the block I with the first train in the block J. This causes the track relay 57 to be again deenergized, thereby deenergizing the winding magnet WM. As the train passes through the block I, the moment the car element L passes over the track element T, a current will be generated in the circuit including the coil 53 and the trip magnet TM, thus causing the latch 99 to be tripped thereby initiating the movement of the time control device. Since the repeater track relay RT is deenergized, due to the presence of the first train in the block J, a longer period of time will elapse before the winding 53^a of the second track element T^a will be closed, because a greater movement of the time control device will be necessary to cause the movable contact 151 to connect with the stationary contact 152. If the train reaches the second track element T^a before this longer period of time has elapsed, the circuit through the coil 53^a will still be open and the train will be stopped when passing by the second track element T^a in the usual manner. If, however, the train consumes a longer period of time in running between the track element T and the second track element T^a than the time necessary for the movable contact 151 to connect with stationary contact 152, the

train will not be stopped, because the winding 53^a will be closed in a circuit of low resistance, which may be traced as follows:—Starting with the common return wire C, wire 166, movable contact 151, stationary contact 152, wire 167, movable contact 162, wire 163, winding 53^a of the second track element T^a, wire 165 back to the common return wire C.

Although the trackway apparatus of a speed control system has been illustrated and described in Fig. 8 which employs a single set of track elements and a timing device having two time intervals for allowing a certain permissive speed under clear traffic conditions, and allowing another lower speed under danger traffic conditions, it should be understood that this general scheme of arrangement may likewise be employed for a trackway system having overlapped blocks, such as illustrated in Fig. 6. If desired, any number of control points may be provided in a block, only one having been illustrated to simplify the description thereof. Further, if a plurality of control points are provided, the track element at any of the intermediate points may be used as a stopping track element for the preceding control point, and also be used as an initiating track element for the following control points, similar to the system illustrated in Figs. 3 and 4.

While the trackway devices have been illustrated as comprising a sequential series of devices, it should be understood that such devices may be located along the trackway in relatively closely spaced pairs, thereby causing the average speed traveled between two consecutive devices to be very nearly equal to the actual speed at the second one of said devices.

In connection with each of the forms of the invention illustrated, except the form illustrated in Fig. 5, it should be noted that if a train is running in a caution block and is limited in its speed by the trackway and car-carried devices in a manner as described, and danger traffic conditions clear up, such restrictions are immediately released; and further, if a train should enter a clear block and thereafter a danger condition should occur in the next block in advance, such as, a train backing into the block, a broken rail, or the opening of a switch, such permissive speed is immediately enforced, thereby stopping the train as soon as possible. The devices illustrated in Fig. 2 may be equally as well applied to track sections having permanent hazards. In such application of this form of the invention, no track circuit is necessary to carry out its function, since no restoring or resetting energy is supplied from the trackway.

In the various embodiments of the invention in which the time element devices along the track are restored or wound up by a trackway source of energy (see Figs. 3 to 8), failure of the devices to be wound up or restored, due to breakage of wires, depreciation of the current sources, or any other cause, is automatically detected by reason of the fact that the circuit of low impedance for the coils of the track elements includes a contact which is closed only if the corresponding time element device is in its wound up condition. Consequently, if any one of these time element devices should for any reason fail to be restored or wound up, the circuit for the corresponding track element is interrupted, so that the passing train will receive a stopping control at that track element irrespective of the time consumed in moving from one track element to another. It should also be noted that if any one of the time element devices fails to latch up properly, it will start to run down as soon as the train enters the block, with the result that the train will be stopped, perhaps at a speed lower than otherwise would occur, this also being true when the time element devices have been run down by another train ahead in the same block, thus affording occupied block protection (see Fig. 7). Consideration of other likely breaks or failures of the devices and circuits shown demonstrate that the equipment of this invention is constructed in conformity with the principle of failure on the side of safety.

Having thus shown and described several embodiments of my invention, I desire to have it understood that such embodiments have been shown in a simplified and diagrammatic manner for the purpose of making it easy to understand their principal features of construction and mode of operation, rather than with the view of illustrating particular parts and circuits preferably employed in practice; and that various changes, modifications and adaptations thereof may be made dependent upon the particular system to which the invention is to be applied, without departing from the spirit and scope of the present invention.

What I claim as new and desire to secure by Letters Patent, is:—

1. In an automatic train control system, the combination of means partly on the vehicle and partly along the track operating inductively through an intervening air gap for inititiating a time controlled device located along the track, a trackway device at a subsequent point along the track for transmitting a control influence to apparatus on the vehicle to stop the train, and means actuated by said time controlled device for making said trackway device ineffectual.

2. In an automatic train control system, the combination of a series of trackway devices in a block, each of which after the first one in a series being in its danger condi-

tion, and means for changing said track devices to the clear condition a predetermined time after a train has passed the next preceding track device.

3. In an automatic train control system comprising, means partly on the vehicle and partly at a certain point along the trackway at successive points in a block for releasing a normally wound up time controlled device located along the trackway, an influence transmitting device located a distance in advance of said point, and means for rendering said influence transmitting device ineffectual when said time controlled device has completed a certain cycle.

4. Trackway apparatus for automatic train control systems comprising, a normally energized time controlled device located along the trackway, means adapted to reenergize said time controlled device by the clearance of a section of trackway, and means acting through an intervening air gap for initiating said time controlled device by the passage of a train under dangerous traffic conditions ahead.

5. Trackway apparatus for automatic train control systems comprising, a time controlled device, means controlled by track circuits adapted to restore said time controlled device to normal, means for holding said time controlled device in its normal position effective only when said device has been restored, and means governed by a passing train for releasing said last mentioned means.

6. Apparatus for automatic train control systems comprising, a track element adapted to transmit a control influence to a passing train inductively through an intervening air gap, means partly on the vehicle and partly along the trackway for permitting said track element to assume its effective condition, and means acting inductively through an intervening air gap for changing said track element to its ineffective condition before a train passes it provided said train has not exceeded a predetermined average speed during a certain distance of movement.

7. In an automatic train control system comprising, car-carried apparatus adapted to transmit and receive control influences, and spaced trackway devices, all located in the same path along the trackway adapted to receive an influence from the vehicle and transmit another influence to said vehicle if said vehicle exceeds a predetermined average speed when passing between said trackway devices.

8. In an automatic train control system of the type in which control influences are transmitted between the trackway and moving vehicles inductively comprising, car-carried apparatus adapted to transmit and receive control influences, and spaced trackway devices adapted to receive an influence from the vehicle and transmit another influence to the same vehicle if said vehicle takes less than a predetermined time in passing between said trackway devices.

9. In an automatic train control system, the combination of successive track elements each constituting a mass of iron when in its active condition and having a coil thereon connected in a circuit of low impedance when in its inactive condition, trackway timing means governed by voltage induced in said circuit, and car-carried apparatus adapted to transmit influences to said track elements when in their inactive condition and adapted to receive control influences therefrom when in their active condition.

10. In an automatic train control system, the combination of successive track elements each constituting a mass of iron when in its active condition, trackway apparatus for putting said track element into its inactive conditon a predetermned time after a control influence is received by the next preceding track element, and car-carried apparatus governable by said track elements when in their active condition.

11. Trackway apparatus for automatic train control systems comprising, a series of track elements each consisting of an iron core having a winding thereon, time controlled electro-responsive devices connected to said windings and each adapted to be initiated by voltage induced in its corresponding winding when a vehicle passes said element, and means for controlling the next succeeding track element by said electro-responsive devices.

12. Trackway apparatus for automatic train control systems comprising, a time controlled device, means for initiating said time controlled device including a track element influenced inductively from a source of energy on a passing vehicle, and traffic controlled means for controlling one or more of several succeeding track elements by said time controlled means.

13. The method of controlling the speed of trains which consists in employing devices spaced along the track which will be initiated inductively through an intervening air gap from a source of energy on a passing vehicle, and which will transmit a control influence to said vehicle through an intervening air gap inductively if it takes less than a predetermined time in passing between said devices.

14. The method of controlling the speed of trains which consists in initiating trackway apparatus inductively from an electrical energy source on a vehicle at one point along the track, and transmitting a control influence inductively to said vehicle at a succeeding point if said vehicle exceeds a predetermined average speed in traveling between said points.

15. In an automatic train control system of the intermittent type in which control influences are transmitted inductively from the trackway to the vehicle and in which the vehicle may be limited in the speed at which it may travel depending on the location thereof in a block and on the extent of unoccupied track ahead comprising, car-carried apparatus for restricting the movement of the train in accordance with the condition of trackway apparatus including an influence receiving coil adapted to have a voltage induced therein upon passage of the vehicle by an active trackway device; and of trackway apparatus including a plurality of influence communicating trackway devices at each of a plurality of points in each block which apparatus may be conditioned to restrict the movement of the vehicle to a maximum speed if traffic conditions ahead are clear, may be conditioned to restrict the vehicle to an intermediate speed dependent on the location of the point in a block when the next block in advance is occupied and may be conditioned to restrict the vehicle to a minimum speed when the same block is occupied by another train ahead equipped with similar car-carried apparatus.

16. In an automatic train control system, the combination with car-carried apparatus adapted to automatically restrict the movement of the train as a result of the transmission of a control influence inductively from the trackway to this apparatus during passage of said apparatus by an active trackway device, and also adapted to transmit a control influence inductively to an inactive trackway device from this apparatus, a plurality of trackway devices spaced suitably along the trackway to receive and transmit such control influences respectively, and means including a time element device for allowing a trackway device to assume its active influence transmitting condition for a predetermined time only after the train passes a preceding trackway device.

17. Trackway apparatus for automatic train control systems of the type in which a trackway influence communicating means is maintained in an active condition for a predetermined time after a railway vehicle passes a point a predetermined distance in the rear of said trackway device including, a plurality of time element devices in each block, adapted to assume a normal and an abnormal condition, means for automatically restoring to normal all of said time element devices by a train passing out of one block into a succeeding block, and separate means for each time element device effective under adverse traffic conditions ahead for holding such time element device in its normal condition until a following train passes a certain point along the trackway.

18. In an automatic train control system for railways divided into blocks, the combination of car-carried apparatus adapted to automatically apply the brakes of the train when passing by an active track element at a speed above which the apparatus functions, and trackway apparatus including track elements spaced along the track which enforce certain speed limits under clear traffic conditions, enforce more restrictive speed limits under caution traffic conditions and enforce an absolute stop for speeds above which the apparatus functions when the block in which the train is moving is occupied by another train ahead.

19. An automatic train control system for railways divided into blocks comprising, car-carried apparatus including a brake control device which applies the brakes of the vehicle if a control influence is transmitted from a suitable track element to said apparatus, and a plurality of suitably spaced track elements controlled partly in accordance with traffic conditions ahead, some of which are active for a time after the train in question passes a point a predetermined distance in the rear of such elements when the block in question is not occupied by another train and the next block in advance is unoccupied, some of which are active for a time after the train in question passes a predetermined point in the rear of such elements when the next block in advance of the block in question is occupied and some of which are permanently active when the block in question is occupied by another train ahead.

20. In an automatic train control system of the time-distance interval type for railways divided into blocks each provided with the usual track circuit, the combination of car-carried apparatus including an influence receiving device and a brake control device, said brake control device being adapted to apply the brakes of the vehicle if a control influence is received by said influence receiving device from the trackway; and trackway apparatus comprising, a series of track devices adapted to transmit control influences to a moving vehicle when in their active condition, and means for placing a certain track device in its active condition for a predetermined period of time after a train passes a preceding track device and for placing the next succeeding track device in its active condition for a predetermined period of time after said certain track device is passed, whereby the time in which the train runs from one track device to the next succeeding track device of a series in combination with the distance between such devices are used as factors in determining when the brakes of the vehicle shall be automatically applied as a result of excessive speed.

21. In an automatic train control system of the time-distance interval type for railways divided into blocks each provided with the usual track circuit, the combination of car-carried apparatus including an influence receiving coil and a brake control device, said brake control device being adapted to apply the brakes of the vehicle if an inductive control influence is received by said influence receiving device from the trackway; and trackway apparatus including track devices for inductively transmitting control influences to the car-carried apparatus, and time controlled means for placing said track devices in their active condition for a predetermined time comprising a winding magnet which if energized places said time controlled device in its normal wound up condition, means for holding said time controlled means in its wound up condition, and means for releasing said last mentioned means effective if actuated momentarily.

22. In an automatic train control system of the time-distance interval type for railways divided into blocks each provided with the usual track circuit, the combination of car-carried apparatus including an influence receiving device and a brake control device, said brake control device being adapted to apply the brakes of the vehicle if a control influence is received by said influence receiving device from the trackway; and trackway apparatus comprising, spaced track elements each consisting of a core of magnetic material having a winding thereon, said devices being active when said winding is open circuited but being inactive when said winding is in a closed circuit of low resistance, and means for placing said track elements in their active condition for a predetermined time after an approaching train passes a point a predetermined distance in the rear of such track element.

23. In an automatic train control system of the time-distance interval type for railways divided into blocks each provided with the usual track circuit, the combination of car-carried apparatus including an influence receiving device and a brake control device, said brake control device being adapted to apply the brakes of the vehicle if a control influence is received by said influence receiving device from the trackway; and trackway apparatus including a series of alternate regular and auxiliary track devices and associated timing apparatus, whereby the passage of said car-carried apparatus by one of said regular track devices places a succeeding regular track device in its active condition for a predetermined time, and places the next auxiliary track device in its active condition for the same predetermined time under different traffic conditions ahead.

24. An automatic train control system comprising, car-carried apparatus including a car element consisting of a core having a primary and a secondary winding thereon, and a brake control device which applies the brakes of the vehicle if a control influence is received by said secondary winding; and trackway apparatus comprising a pair of track devices, the first of which is in its inactive condition and places the second track device in its active condition for a predetermined time when said car element passes by said first track device, and the second element when in such active condition transmits a control influence to said secondary coil if said car element passes thereby before said time has elapsed, whereby the brakes of the vehicle are applied if the train consumes less than a predetermined time in moving from the first to the second track device.

25. The method of controlling the speed of trains which consists in initiating trackway apparatus by a magnetic flux emanating from a vehicle carried device at one point along the track, and transmitting a control influence to said vehicle at a succeeding point if said vehicle exceeds a predetermined average speed in traveling between said points.

In testimony whereof I hereby affix my signature.

CHARLES S. BUSHNELL