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RAILWAY TRAFFIC CONTROLLING APPARATUS

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2 Sheets-Sheet 1

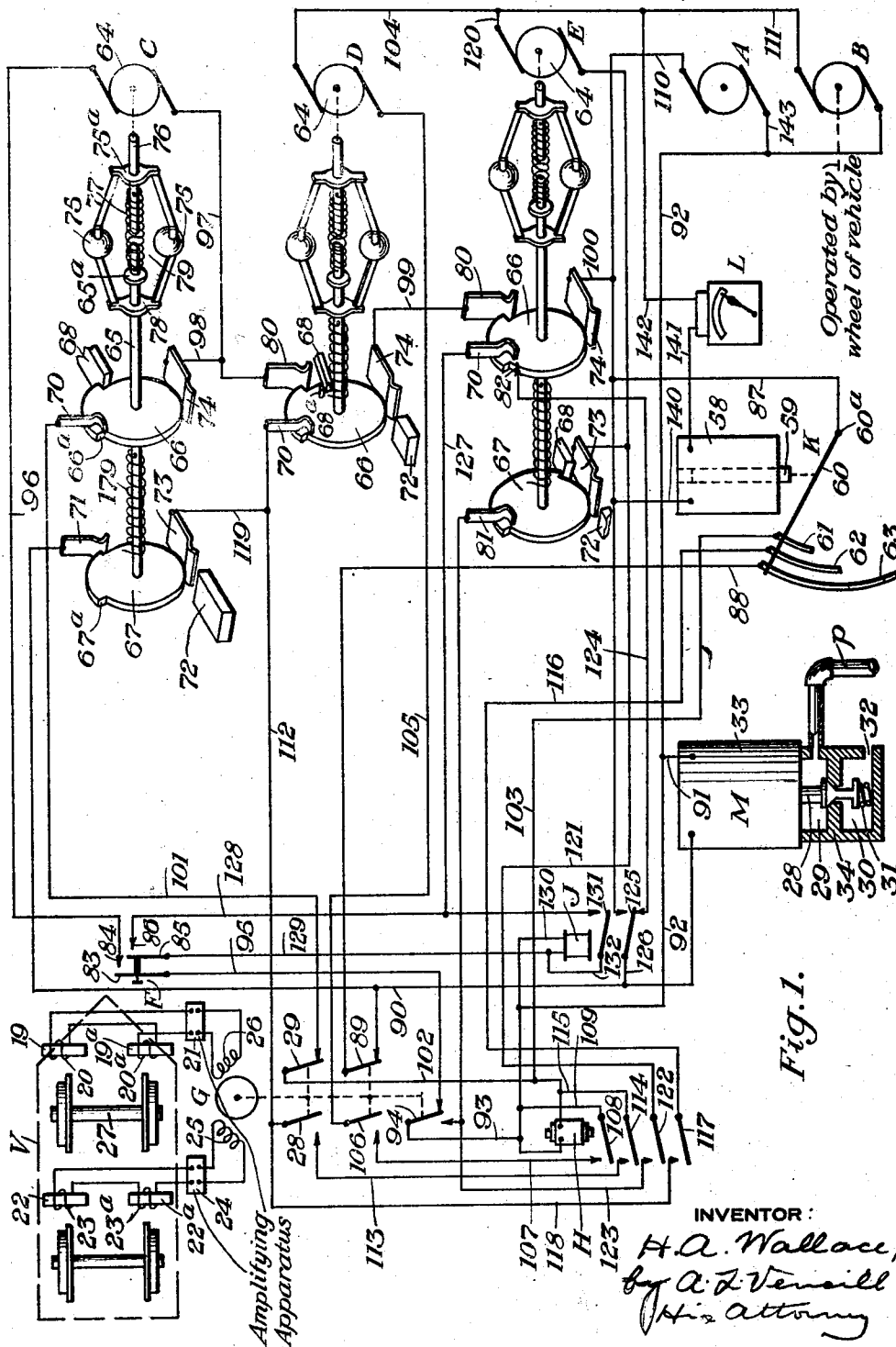


Fig. 1.

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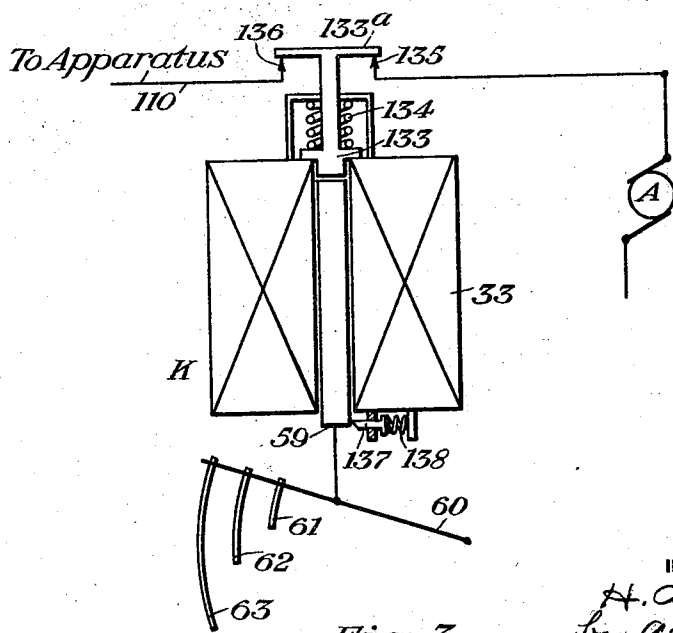
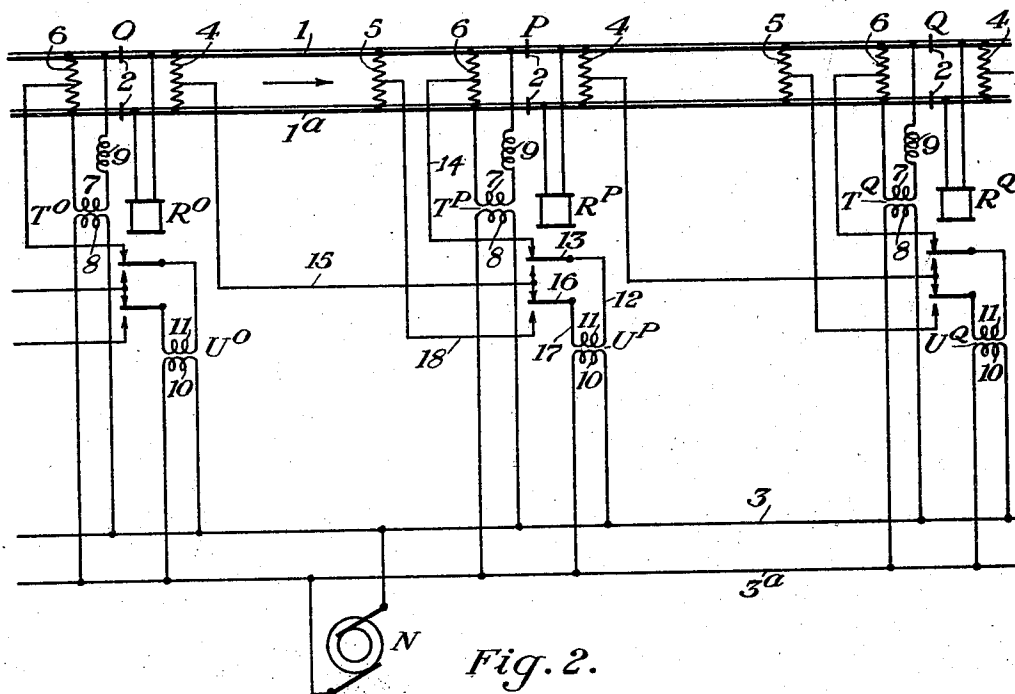
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RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Oct. 20, 1923

2 Sheets-Sheet 2



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RAILWAY-TRAFFIC-CONTROLLING APPARATUS.

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My invention relates to railway traffic controlling apparatus, and particularly to apparatus of the type comprising train carried governing means controlled by energy in the trackway.

I will describe one form and arrangement of apparatus embodying my invention, and will then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a view, partly diagrammatic, showing one form of train carried governing apparatus embodying my invention. Fig. 2 is a diagrammatic view showing one form of trackway apparatus adapted to co-operate with the governing apparatus shown in Fig. 1. Fig. 3 is a detail view showing a modification of the device K shown in Fig. 1.

Similar reference characters refer to similar parts in each of the views.

Referring first to Fig. 2, the reference characters 1 and 1^a designate the track rails of a railroad over which traffic normally moves in the direction indicated by the arrow. These rails are divided, by means of insulated joints 2, into a plurality of successive track sections O—P, P—Q, etc. Each such section is provided with a source of track circuit current here shown as a track transformer designated by the reference character T with an exponent corresponding to the location and having its secondary 7 constantly connected across the rails adjacent the exit end of the section. The primary 8 of each such transformer T is constantly supplied with alternating current from some convenient source, such as an alternator N, over line wires 3 and 3^a. Interposed between one rail 1 and the secondary 7 of each track transformer is an impedance 9 one function of which is to limit the output of the transformer when its terminals are short-circuited by the wheels and axles of a train. Each section is further provided with a track relay here designated by the reference character R with a suitable exponent and connected across the rails adjacent the entrance end of the section. Each section is thus provided with a track circuit comprising the secondary 7 of a track transformer T, an impedance 9, a track relay R, and the rails of the section in series.

Means are also provided for supplying

to the rails of each section in parallel a current which I will hereinafter term a "local" current. For this purpose each section is provided with an impedance 4 connected across the rails adjacent the entrance end of the section, a similar impedance 6 connected across the rails adjacent the exit end of the section, and a third similar impedance 5 connected across the rails at an intermediate point in the section. The immediate supply of local current for each section is the secondary 11 of a local transformer designated by the reference character U with an exponent corresponding to the location and the primary 10 of which is constantly supplied with alternating current from alternator N over line wires 3 and 3^a.

Referring particularly to section O—P, one local circuit passes from secondary 11 of local transformer U^P, through wire 12, front contact 13 of track relay R^P, wire 14, impedance 6 in section O—P, through the rails of the section to impedance 4, thence by wire 15, front contact 16 of track relay R^P and wire 17 back to transformer U^P. This circuit is closed, of course, only when relay R^P is energized. When this relay becomes de-energized a second local circuit is closed and local current flows from secondary 11 of local transformer U^P, through wire 12, back contact 13 of track relay R^P, wire 15, impedance 4 in section O—P, through the rails of the section to impedance 5, thence by wire 18, back contact 16 of track relay R^P and wire 17 back to transformer U^P. It is therefore clear that section O—P is supplied with local current of one relative polarity, which I will term "normal" relative polarity, throughout the length of the section, or with local current of the other relative polarity, which I will term "reverse" relative polarity, between impedances 4 and 5, depending upon whether relay R^P is energized or de-energized, that is, depending upon whether section P—Q is occupied or unoccupied.

For purposes which will appear hereinafter, it is desirable to displace the phases of the track circuit current and the local current with respect to each other. This may be conveniently accomplished by making impedances 9 reactive impedances, thus causing the track circuit current to lag behind the voltage applied to the rails by the asso-

ciated track transformers T, and making the impedances 4, 5 and 6 non-inductive resistances, thus causing the local current to be substantially in phase with the voltage applied by the associated local transformers U. Since the local transformers and the track transformers are energized from the same source, the result is that the local current and track circuit current are displaced in phase.

Referring now to Fig. 1, the reference character V designates a railway vehicle which may be either a locomotive or a train. Located in front of the forward axle 27 on this vehicle are two magnetizable cores 19 and 19^a, which are disposed above the two track rails respectively. These two cores are provided with windings 20 and 20^a, respectively, and these windings are so connected that the voltages induced in these windings by current flowing in opposite directions in the two track rails are additive. These two windings I shall refer to collectively as a "track coil." At some other point, such as in the rear of the axle 27, are two other magnetizable cores 22 and 22^a located above the track rails and provided with two windings 23 and 23^a, respectively. These two windings are so connected that the voltages induced therein by current flowing in the same direction in the track rails are additive. These windings I shall refer to hereinafter as the "local coil."

The track coil is connected, through a suitable amplifying device 21, with one winding 26 of a three-position two-element relay G, which I shall call for purposes of convenience, the "main" relay. The local coil is connected, also through a suitable amplifying apparatus 24, with the second winding 25 of main relay G. The relay G comprises a plurality of contact fingers 28, 29, etc. These contact fingers are responsive to the current or currents in windings 25 and 26 of relay G in the following manner: When the train is on a stretch of track which is supplied with track circuit current and with local current of normal relative polarity, voltages are induced in the track coil and the local coil. The resulting currents in windings 26 and 25 of relay G are displaced in phase and are in such relation that the contact fingers of relay G are swung toward the right in which case certain normal contacts are closed. When the train is on a stretch of track which is supplied with track circuit current and with local current of reverse relative polarity, the relation of the resulting currents in windings 25 and 26 causes the contact fingers of relay G to be swung to the left in which case certain reverse contacts are closed. When the train occupies a stretch of track from which the supply of either track circuit current or local current or both is discontinued, the re-

sulting interruption of the current in one or both of the windings of relay G causes the contact fingers to assume an intermediate position in which case certain back contacts are closed.

The operation of the apparatus thus far explained is as follows: As shown in Fig. 2 the apparatus is in the condition corresponding to the normal or unoccupied condition of the stretch of track shown in the drawing. Under such conditions the rails of section O—P are supplied with track circuit current from transformer UP. Relay R^P is energized and local current of normal relative polarity is therefore supplied to the rails of section O—P throughout the length of the section from transformer UP. If now train V (see Fig. 1) enters the section O—P at point O, relay G is energized as explained hereinbefore, through the medium of the track coil and the local coil, in such a direction that the normal contacts on this relay are closed.

I will now assume that section P—Q is occupied by a train. Under these conditions, relay R^P is de-energized. The supply of track circuit current to section O—P by transformer TP is unaffected by this condition but the rails of section O—P are now supplied with local current of reverse relative polarity between impedances 4 and 5 and with no local current between impedances 5 and 6. If vehicle V now enters section O—P, the currents supplied to windings 25 and 26 are in such direction and of such phase relation that the reverse contacts on relay G are closed. This condition persists until the train V passes the impedance 5 in section O—P. Beyond this impedance the interruption of the local current in the track rails causes an interruption of the current in winding 25 of relay G, which in turn causes relay G to become de-energized thus closing the back contacts of this relay. After the train enters section P—Q, the absence of track circuit current causes winding 26 of relay G to become de-energized and the relay therefore remains open as the train proceeds through section P—Q.

To simplify the description, I have shown and described one specific arrangement of trackway circuits and apparatus, but it is understood that this particular composition is not essential to my invention and that any means for similarly controlling a train carried relay by energy received from the trackway could be substituted for the apparatus shown without affecting my invention.

The relay G controls, through the medium of certain apparatus which I will describe in detail hereinafter, a magnet valve M which in turn controls suitable governing mechanism such as the brakes on the train. The magnet valve M is a pin valve of the usual and well known type and comprises a

valve member 28 controlled by a winding 33. This valve comprises a valve body 34 containing a valve chamber 29 and a second chamber 30 constantly connected with atmosphere by means of a port 32. The valve member 28 is normally biased by means of a spring 31 into a position wherein chamber 29 communicates with chamber 30. When winding 33 is energized, however, valve member 28 is moved against the bias exerted by spring 31 into a position in which chamber 29 is disconnected from chamber 30. A brake pipe *p* is connected with chamber 29 and is normally supplied with fluid pressure. Automatic brake application mechanism, forming no part of my present invention and omitted from the drawing for the sake of simplicity is responsive to the pressure in this pipe *p* to apply the brakes in the usual manner when the pressure in pipe *p* is reduced. It is therefore clear that de-energization of magnet valve M results in venting pipe *p* to atmosphere through chambers 29 and 30 and port 32 and applying the brakes.

The reference character A designates a source of constant potential such as a turbine-driven generator. A second generator here designated by the reference character B is connected with a moving part of the train in such a manner that the electro-motive force produced by this generator is proportional to the speed of the train. The two generators are so designed that the electro-motive force produced by generator B when the train is moving at maximum speed is less than the constant potential delivered by generator A. The two generators A and B are connected in series opposition so that the voltage across their terminals, that is, the voltage between wires 110 and 111 is at all times inversely proportional to the speed of the train. These generators are provided with a circuit which passes from generator A through wires 110 and 140, electro-responsive device K, wire 141, indicator L, wires 142 and 111, generator B, wires 92 and 143 and back to generator A. This circuit, it will be noted, includes the indicator L and the device K in series. The indicator L informs the engineer of the train speed. This indicator may be a voltmeter calibrated to read directly in miles per hour or may be of any other suitable form. The electro-responsive device K controls certain contacts in response to the voltage between wires 110 and 111 and hence in response to the train speed. As here shown this device comprises a solenoid 58 connected in series with indicator L and containing a magnetizable plunger 59. A contact finger 60, pivotally mounted at point 60^a is controlled by this plunger and the parts are so disposed that when the train speed is below a low speed such as 15 miles per hour, the solenoid which

is then supplied with a high voltage draws the plunger upward against the force of gravity into a position wherein contact finger 60 engages three contact strips 61, 62 and 63. If the train speed increases, the voltage applied to solenoid 58, as explained hereinbefore, is reduced by an amount proportional to the train speed and the plunger therefore is allowed to move downward. It will thus be clear that for any train speed there will be one, and only one position of finger 60. The various parts are so proportioned that at speeds between 15 miles per hour and an intermediate speed such as 45 miles per hour, finger 60 engages only strips 62 and 63, at speeds between the intermediate speed and a high speed such as 60 miles per hour, the finger 60 engages only strip 63, and at speeds above the high speed, as 60 miles per hour, finger 60 moves out of engagement with all the strips 61, 62 and 63. It should be noted that if the circuit for solenoid 58 becomes open the device will open all its contacts, thus applying the brakes as will be seen hereinafter.

In addition to the apparatus already described, the train is provided with a slow acting relay H, an auxiliary relay J and three timing devices here designated by the reference characters C, D and E.

Referring particularly to device C, the reference character 65 designates a rotatable shaft supported by means not shown in the drawing and provided with two contact cams 66 and 67 rigidly attached to the shaft 65. Under normal conditions the shaft 65 is biased, by means of a spring 179 into the position shown in the drawing in which a projection 66^a on cam 66 engages a fixed stop 68 thus preventing further motion. Shaft 65 is arranged to be moved longitudinally by a centrifugal device 79. This device comprises a longitudinally fixed, rotatable shaft 76 co-axial with shaft 65 and adapted to be rotated by a motor device 64. Rigidly attached to shaft 76 is a collar 75^a. A second collar 78, rotatable on shaft 65, is adapted to at times engage a collar 65^a on shaft 65. Two weights 75 are attached by means of linkwork to collars 78 and 75^a. Under normal conditions shaft 65 is biased to its left hand position by a spring 77, but when motor device 64 is energized, shaft 76 is rotated, and weights 75 are caused by centrifugal force to move away from shaft 76 thus causing collar 78 to engage projection 65^a and thereby move shaft 65 longitudinally to the right until the end of shaft 65 engages the end of shaft 76, thereby preventing further longitudinal movement. Simultaneously friction between collar 78 and projection 65^a on shaft 65 will cause shaft 65 to rotate against the bias exerted by spring 179 into a position wherein the projection 67^a on cam 67 engages a second fixed stop 72.

The motor device 64 is so designed that its speed increases in accordance with increases in the magnitude of the voltage applied thereto and the length of time required for

5 the device C to complete its stroke therefore varies with the voltage applied to motor device 64. A contact finger 73 is adapted to engage cam 67 at all times and a similar
10 contact finger 71 is adapted to engage the projection on cam 67 only when device C is in its normal condition, that is, when motor device 64 is de-energized and the parts are in the position shown in the drawing. When
15 motor device 64 rotates shaft 65, the projection on cam 67 moves out of engagement with contact finger 71 and contact 67—71 is broken. A contact finger 74 engages cam
20 66 at all times and a second contact finger 70 is adapted to at all times engage the projection 66^a on this cam. When device C is in the normal position, contact finger 70 does not engage cam 66 but if motor device
25 64 is energized, the longitudinal movement of shaft 65 due to the operation of centrifugal device 79 moves cam 66 into engagement with contact finger 70. As the motor device continues to operate, cam 66 is rotated in a counter-clockwise direction as
30 viewed in Fig. 1 and after a definite time interval depending upon the proportion of the parts and the magnitude of the voltage applied to motor device 64, contact 70—66 is again broken by the movement of projection 66^a out of engagement with finger 70.

35 The timing device D is similar to timing device C except that the cam 67 is omitted, and a contact 80 similar in all respects to contact 71 for cam 67 of timing device C, is added for co-operation with cam 66 of
40 timing device D. Clockwise motion of cam 66 is limited, in this device, by engagement of a pin 68^a on cam 66 with stop 68. Timing device E is similar to device C except that contact finger 71 is omitted, and a contact
45 finger 81 is provided which engages cam 67 of device E as long as device E is energized. In addition to finger 80 provided to co-operate with cam 66 as in device D, an auxiliary contact finger 82 is arranged to engage
50 finger 70 when this finger is in contact with the projection on cam 66 of device E. The purposes and functions of these various contacts will be apparent as the description proceeds.

55 Although in the particular embodiment of my invention herein illustrated the timing devices C, D and E are electrical devices, it should be understood that any other equivalent forms of apparatus could be substituted
60 for these devices without affecting the operation.

65 The reference character F designates a manually operable switch comprising two contacts 83—84 and 85—86. As shown in the drawing this switch is in its normal posi-

tion and under this condition both these contacts are open. When switch F is reversed, however, contacts 83—84 and 85—86 are both closed.

Under normal conditions, that is, when 70 main relay G is energized in the normal direction, and switch F is in normal position, relays H and J and timing devices C, D and E are de-energized. Under these circumstances a circuit is provided which passes 75 from one terminal of generator A, through wires 110 and 87, contact 60—63 of device K, wire 88, normal contact 89 of relay G, wire 90, winding 33 of magnet M, and wires 91 and 92 back to generator A. It is plain 80 that this circuit is closed only when relay G is energized in the normal direction and the speed of the train is below 60 miles per hour. If now the main relay G becomes energized in the reverse direction, the opening 85 of normal contact 89 will de-energize magnet M and result in an automatic brake application. If, however, just previous to such reversal, as just before the train enters the section next in the rear of an occupied section, the engineer reverses switch F, a circuit is closed which passes from generator 90 A, through wires 110 and 100, contact 74—66—80 of timing device E, wire 99, contact 74—66—80 of timing device D, wire 97, 95 motor device 64 of timing device C, wire 96, contact 83—84 of switch F, wire 95, normal contact 94 of main relay G, and wires 93 and 92, back to generator A. Timing device C is therefore energized and immediately closes contact 70—66 thereon. After a definite time interval, for example 10 seconds, this contact is again opened, as explained hereinbefore. Since motor device 64 is energized from a source of constant 105 potential the time interval required for its operation is fixed and having been once adjusted is not variable. The closing of contact 70—66—74 of timing device C completes a pick-up circuit for slow-acting relay H and current flows from generator 110 A, through wires 110 and 100, contact 74—66—80 of timing device E, wire 99, contact 74—66—80 of timing device D, wire 98, contact 74—66—70 of timing device C, wire 101, 115 normal contact 29 of relay G, wire 102, winding of relay H and wires 93 and 92 back to generator A. It will be clear that this circuit is closed only during the time interval of 10 seconds during which contact 70—66 of timing device C is closed. If before the expiration of this time interval, relay G becomes energized in the reverse direction the timing device D becomes energized over a circuit which passes from generator B, through wires 111 and 104, motor 125 device 64 of timing device D, wire 105, reverse contact 106 of relay G, wire 107, front contact 108 of slow acting relay H, and wires 109 and 92 back to generator B. Of 130

course the pick-up circuit traced above for relay H is opened by the reversal of relay G, but relay H, being slow acting, remains closed for a short interval of time. The circuit just traced for timing device D being closed, this device becomes energized. Since motor device 64 of this timing device is energized from generator B, the voltage of which is proportional to the train speed, it follows that the time interval required for timing device D to complete its stroke is inversely proportional to the speed of the train. As soon as this device commences to operate, a stick circuit is closed for relay H which passes from generator A through wires 110 and 100, contact 74—66—80 of timing device E, wire 99, contact 74—66—70 of timing device D, wire 112, reverse contact 28 of relay G, wire 113, front contact 114 of relay H, wires 115 and 103, winding of relay H and wires 93 and 92 back to generator A. At the expiration of the time interval required for device D to operate, the opening of contact 70—66 will de-energize relay H unless the train speed has been reduced to 45 miles per hour or less in which case relay H will be maintained in its energized condition over a circuit which passes from generator A, through wires 110 and 87, contact 60—62 of device K, wire 116, front contact 117 of relay H, wire 118, reverse contact 28 of relay G, wire 113, front contact 114 of relay H, wire 115, winding of relay H, and wire 92, back to generator A. As soon as timing device D becomes energized, that is, as soon as relay G becomes energized in the reverse direction, the engineer can restore switch F to its normal position, thus interrupting the circuit for timing device C which returns to its normal condition. As soon as this is accomplished, a circuit is established for magnet valve M over which current flows from generator A, through wires 110 and 100, contact 74—66—80 of timing device E, wire 99, contact 74—66—70 of timing device D, wires 112 and 119, contact 73—67—71 of timing device C, wire 90, winding 33 of magnet valve M, and wires 91 and 92 back to generator A. Since this circuit includes contact 66—70 of device D, it is obvious that the circuit will be interrupted, subsequent to the energization of device D, at the expiration of a time interval inversely proportional to the train speed. If the train speed is reduced to below 45 miles per hour prior to such interruption a brake application is prevented, magnet M then being energized by current which flows from generator A, through wires 110 and 87, contact 60—62 of device K, wire 116, front contact 117 of relay H, wires 118, 112 and 119, contact 73—67—71 of timing device C, wire 90, winding 33 of magnet valve M, and wires 91 and 92 back to generator A. The train

is then allowed to proceed at speeds below 45 miles per hour as long as relay G is energized in the reverse direction.

If main relay G is now de-energized, as by the train passing impedance 5 in the section next in rear of an occupied section, the opening of reverse contact 106 thereon opens the circuit for timing device D which thereupon returns to its normal condition. Simultaneously the opening of reverse contact 28 opens the circuit for relay H. This relay does not open its front contacts, however till the expiration of a definite time interval because of its slow acting characteristics. For a short time interval, therefore, a circuit is closed which passes from generator B, through wires 111 and 120, motor device 64 of timing device E, wire 121, front contact 122 of relay H, wire 123, back contact 94 of relay G, and wires 93 and 92 back to generator B. The circuit just traced is provided with a branch which passes from wire 121, through contact 73—67—81 of timing device E, back to wire 123. It will be plain therefore that as soon as the device E is energized by the circuit just traced, contact 73—67—81 is closed and, thereafter relay H is removed from the control of device E. This device then completes its stroke, the time required for this operation being inversely proportional to the speed of the train. The device is then maintained in its final position by the current through the branch just traced till relay G is energized.

As soon as timing device E is energized a preliminary valve magnet circuit is closed which passes from generator A through wires 110 and 100, contact 74—66—82 of timing device E, wire 124, back contact 125 of relay J, wires 126 and 90, winding 33 of valve magnet M, and wires 91 and 92 back to generator A. After a time interval the duration of which is a function of the train speed, timing device E will open contact 66—82 and the circuit just described will be opened, thus de-energizing magnet M and applying the brakes. This occurrence may be prevented if, prior to the expiration of this time interval, the engineer reverses switch F. Relay J is then energized by current which flows from generator A, through wires 110 and 100, contact 74—66—70 of timing device E, wires 127 and 128, contact 86—85 of switch F, wire 129, winding of relay J, and wires 130 and 92, back to generator A. The switch F may then be restored to its normal position and relay J will be retained in its energized condition by a stick circuit which will pass from generator A, through wires 110 and 100, contact 74—66—70 of timing device E, wires 127 and 128, front contact 131 of relay J, wires 132 and 129, winding of relay J, and wires 130 and 92, back to generator

A. It is therefore clear that relay J will be maintained in its energized condition till the expiration of the time interval required for the operation of timing device E. The energization of relay J closes a temporary circuit for magnet valve M which may be traced from generator A, through wire 110, front contact 125 of relay J, wires 126 and 90, winding 33 of magnet valve M, and wires 91 and 92 back to generator A.

If the train speed is below 15 miles per hour relay H is energized by current which flows from generator A, through wires 110 and 87, contact 60—61 of device K, wire 103, winding of relay H and wires 93 and 92 back to generator A. The energization of relay H completes a final valve magnet circuit which passes from generator A, through wires 110 and 87, contact 60—62 of device K, wire 116, front contact 117 of relay H, wires 118, 112 and 119, contact 73—67—71 of timing device C, wire 90, winding 33 of valve magnet M, and wires 91 and 92 back to generator A. Under these conditions the train is allowed to proceed at any speed below 15 miles per hour. If the train speed exceeds 15 miles per hour device K opens contact 60—61 thereon, thereby de-energizing relay H which in turn de-energizes valve magnet M and causes an automatic brake application.

Under certain circumstances a dangerous condition might arise from the failure of one of the generators A or B. For example, if a train is proceeding through an occupied section, and generator B should become short-circuited, the entire voltage of generator A would be applied to device K and this device would indicate a low speed. The train could then proceed at any speed without incurring an automatic brake application. This is undesirable and to prevent its occurrence I preferably construct the solenoid of device K as shown in Fig. 3. A member 133 is biased into the position shown in the drawing by a spring 134. In this position a projection 133^a on member 133 connects wire 110 with generator A. When the plunger 59 is gradually drawn upward against member 133, as by a decrease in the train speed under normal operating conditions, the spring 134 prevents member 133 from being displaced and hence no change is made in the circuit controlled by projection 133^a. If however, the entire voltage of generator A is suddenly applied to winding 33, plunger 59 will be drawn sharply upward, and the considerable momentum of this plunger will then move member 133 upward against the bias of the spring 134 and open contact 135—133^a—136. As a result, energy will be disconnected from the apparatus, valve magnet M will be de-energized, and the brakes will be applied. A trigger device 137 urged against plunger

59 by a spring 138 will engage the lower end of the plunger and maintain it in its upper position, thus holding member 133 in such position that wire 110 is disconnected from generator A.

In describing the operation of the apparatus as a whole, I will first assume that the section to the right of point Q in Fig. 2 is occupied by a train. As has been explained hereinbefore, section O—P is supplied with track circuit current and with local current of normal relative polarity. Section P—Q is supplied with track circuit current throughout its length and with local current of reverse relative polarity between impedances 4 and 5, but with no local current from impedance 5 to impedance 6. Track circuit current is shunted away from that portion of the section to the right of Q which lies between the train occupying that section and point Q. If now a train equipped with the apparatus illustrated in Fig. 1 enters section O—P at point O, main relay G is energized in the normal direction. The train is therefore allowed to proceed at high speed. If the speed of the train exceeds 60 miles per hour, however, the opening of contact 60—63 of device K de-energizes the valve magnet M and applies the brakes. If the train is proceeding at a speed less than 60 miles per hour and the supply of either track circuit current or local current is discontinued, the consequent de-energization of relay G causes normal contact 89 to open the circuit for magnet M and the brakes are applied.

As the train enters section P—Q, the reversal of the local current causes relay G to become energized in the reverse direction. Assuming that the engineer fails to make acknowledgement of this change by proper manipulation of switch F, the opening of normal contact 89 of relay G de-energizes magnet M and applies the brakes. If however just prior to the entrance of the train into section P—Q, the engineer operates switch F, timing device C is energized. This closes the pickup circuit for relay H. It will be clear that if an interval of more than 10 seconds elapses subsequent to the reversal of switch F and prior to the reversal of relay G, relay H will again be de-energized and the brakes will be applied when relay G does reverse. But if relay G reverses within this time limit of 10 seconds, an actuating circuit is closed for timing device D. The operation of this device closes a stick circuit for relay H. This circuit is closed, however, only for a limited length of time, the duration of which is dependent upon the speed of the train. If, before the expiration of this time interval, the speed of the train is reduced below 45 miles per hour another stick circuit is closed for relay H including contact 60—62 of device K. As soon as re-

lay G has reversed, thus opening the high speed circuit for valve M, the engineer may restore switch F to normal thus allowing device C to return to its normal position and close a circuit for valve magnet M which includes contact 70—66 of device D. It is plain that this circuit is closed only during the variable time interval mentioned above at the expiration of which the magnet M will apply the brakes unless the speed is below 45 miles per hour. If the speed is below 45 miles per hour the medium speed valve circuit is closed, including contact 60—62 of device K and contact 67—71 of device C. The train is then allowed to proceed at any speed less than 45 miles per hour. If, under these conditions, the local circuit is energized in the normal direction, as by the train passing out of the section to the right of Q, the relay G will close its normal contact 89, thus closing the high speed valve circuit through contact 60—63 of device K and the train is then permitted to accelerate to 60 miles per hour. If, however, while running under a medium speed restriction, relay G is de-energized, as by an interruption of track circuit current or by the train passing impedance 5, relay H will be de-energized but, being slow acting, will hold its front contacts closed long enough to energize timing device E. This device is subsequently energized over its own contact 81—67—73. This closes the preliminary low speed valve circuit over contact 82—66—74 of timing device E and back contact 125 of relay J. The contact 82—66 of timing device E is closed immediately following the energization of this device but is subsequently opened at the expiration of a variable time interval the duration of which varies in accordance with the speed of the train. As soon as relay H opens its front contact 117, the intermediate valve circuit is opened and therefore as soon as contact 82—66 of device E is opened the brakes are applied by de-energization of magnet M. If, however, prior to the expiration of this interval, the engineman reverses switch F, relay J is energized and is subsequently held in this position by a circuit which includes its own front contact 131. The closing of front contact 125 of relay J completes a temporary low speed valve circuit for magnet M. If the train speed is reduced to below 15 miles per hour, a pick-up circuit is closed for relay H which includes contact 60—61 of device K. The switch F may now be restored to normal and the magnet M will be energized over a circuit which includes front contact 117 of relay H. The train will then be allowed to proceed at speeds below 15 miles per hour. If the speed of the train exceeds 15 miles per hour, relay H will be de-energized, which in turn

will de-energize magnet M and apply the brakes.

If, while the train is proceeding under this low speed limitation as in an occupied section, relay G should become energized in the reverse direction as by the train in advance moving out of the section, a stick circuit would be closed for relay H including reverse contact 28 of relay G and the train would thereafter be permitted to accelerate to 45 miles per hour. If while traveling under the low speed restriction, the main relay G should become energized in the normal direction, the high speed valve circuit would be closed at normal contact 89 of relay G and the train would be allowed to accelerate to 60 miles per hour.

Wherever in the foregoing description I have stated that the brakes are applied by de-energization of magnet M it is understood that they may be subsequently released only when magnet M is re-energized.

It is therefore clear that my invention provides means for continuously controlling the speed of a train in response to traffic conditions in advance with a simple arrangement of apparatus which may be made rugged and accurate. It further appears that the apparatus is so arranged that any failure will result in an immediate brake application which will stop the train.

Although I have herein shown and described only one form and arrangement of railway traffic controlling apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention what I claim is:

1. In combination on a vehicle, a generator adapted to supply a constant electro-motive force, a second generator adapted to supply an electro-motive force the magnitude of which increases in response to increases in the speed of the vehicle, a plurality of normally closed contacts, means responsive to the difference between the electro-motive forces of said generators for successively opening said contacts as the speed of the vehicle increases, and governing means for the vehicle controlled by said contacts.

2. In combination on a vehicle, means for producing an electro-motive force the magnitude of which decreases in response to increases in the speed of the vehicle, a solenoid responsive to the magnitude of said electro-motive force and provided with a reciprocable plunger, contacts controlled by said plunger, and governing means controlled by said contacts.

3. In combination on a vehicle, means for producing an electro-motive force the mag-

nitude of which decreases in response to increases in the speed of the vehicle, a plurality of normally closed contacts, means responsive to the magnitude of said electro-motive force for successively opening said contacts as the speed of the vehicle increases, and governing means for the vehicle controlled by said contacts.

4. In combination on a vehicle, means for producing an electro-motive force the magnitude of which decreases in response to increases in the speed of the vehicle, a plurality of normally closed contacts, means responsive to the magnitude of said electro-motive force for successively opening said contacts as the speed of the vehicle increases, means responsive to traffic conditions in advance, and governing means controlled by said contacts and by said last mentioned means.

5. In combination on a vehicle, a generator adapted to supply a constant electro-motive force, a second generator adapted to produce an electro-motive force the magnitude of which increases in response to increases in the speed of the vehicle, an electro-responsive device, an electro-responsive indicator, and an electrical circuit including said device and said indicator and said two generators in series opposition.

6. In combination on a vehicle, a generator adapted to supply a constant electro-motive force, a second generator adapted to produce an electro-motive force the magnitude of which varies in accordance with the speed of the vehicle, a device responsive to the difference of such electro-motive forces, a relay responsive to traffic conditions in advance, a magnet valve, and means controlled by said relay and said device for supplying energy to said magnet valve from said first generator.

7. In combination on a vehicle, means for producing an electro-motive force the magnitude of which decreases in response to increases in the speed of the vehicle, a device responsive to the magnitude of said electro-motive force, a timing device, manually operable means for controlling said timing device, and brake application apparatus controlled by said first device and said timing device.

8. In combination on a vehicle, means for producing an electro-motive force the magnitude of which decreases in response to increases in the speed of the vehicle, a device responsive to the magnitude of such electro-motive force, a relay, manually operable means for energizing said relay, means controlled by said device for subsequently maintaining said relay in its energized condition, and brake application apparatus controlled by said relay.

9. In combination on a vehicle, means for producing an electro-motive force the

magnitude of which decreases in response to increases in the speed of the vehicle, a device responsive to the magnitude of such electro-motive force, a normally open contact, means for at times closing said contact for a definite time interval, a relay, means including said contact for energizing said relay, means controlled by said device for subsequently maintaining said relay in its energized condition, and brake application apparatus controlled by said relay.

10. In combination on a vehicle, means for producing an electro-motive force the magnitude of which decreases in response to increases in the speed of the vehicle, a device responsive to the magnitude of such electro-motive force, a contact, means for closing said contact for a fixed time interval and subsequently opening said contact, a relay, means including said contact for energizing said relay, means controlled by said device for subsequently maintaining said relay in its energized condition, and brake application apparatus controlled by said relay.

11. In combination on a vehicle, means for producing an electro-motive force the magnitude of which decreases in response to increases in the speed of the vehicle, a device responsive to the magnitude of such electro-motive force, a contact, means for closing said contact for a fixed time interval and subsequently opening said contact, a manually operable switch for actuating said second means, a relay, means including said contact for energizing said relay, means controlled by said device for subsequently maintaining said relay in its energized condition, and brake application apparatus controlled by said relay.

12. In combination on a vehicle, a contact responsive to traffic conditions in advance, means for automatically applying the brakes when such contact is opened, and means including an electric motor for at times preventing such brake application for a period of time the duration of which is dependent upon the speed of the vehicle.

13. In combination on a vehicle, a contact responsive to traffic conditions in advance, means for automatically applying the brakes, when such contact is opened, means including an electric timing device for at times preventing such brake application for a period of time the duration of which is dependent upon the speed of the vehicle, and manually operable means for actuating said first means.

14. In combination on a vehicle, a contact, responsive to traffic conditions in advance, means for automatically applying the brakes when such contact is opened, means including an electric timing device for at times preventing such brake applica-

tion for a period of time the duration of which is dependent upon the speed of the vehicle, and means for permanently preventing said automatic brake application if the speed of the train is reduced below a predetermined speed prior to the expiration of said period of time.

15. In combination on a vehicle, means responsive to traffic conditions in advance for causing an automatic brake application, a manually controlled electric timing device, a second electric timing device, and means including said two timing devices for at times delaying such automatic brake application for a time interval the duration of which depends upon the speed of the vehicle and for subsequently preventing such brake application if the speed of the vehicle is reduced below a predetermined speed prior to the expiration of such time interval.

16. In combination on a vehicle, an electro-responsive device, means for causing an automatic brake application when such device is de-energized, a second electro-responsive device responsive to the speed of the vehicle, means controlled by said second electro-responsive device for supplying energy to said first electro-responsive device, means responsive to traffic conditions in advance for at times interrupting such supply, a manually controlled electric timing device, and means controlled by said timing device and operative after such interruption to supply said first electro-responsive device with energy for a period of time the duration of which is dependent upon the speed of the vehicle.

17. In combination on a vehicle, an electro-responsive device, means for causing an automatic brake application when such device is de-energized, a second electro-responsive device responsive to the speed of the vehicle, means controlled by said second electro-responsive device for supplying energy to said first electro-responsive device, means responsive to traffic conditions in advance for at times interrupting such supply, a manually controlled electric timing device, a relay controlled in part by said timing device, and a circuit for said first electro-responsive device controlled by said relay.

18. In combination on a vehicle, an electro-responsive device, means for causing an automatic brake application when such device is de-energized, a second electro-responsive device responsive to the speed of the vehicle, means controlled by said second electro-responsive device for supplying energy to said first electro-responsive device, means responsive to traffic conditions in advance for at times interrupting such supply, a manually controlled electric timing device, a relay controlled in part by said timing device, and a circuit for said first electro-

sponsive device controlled by said relay and said timing device.

19. In combination on a vehicle, a timing device, a manually operable switch for actuating said device, a relay, a second timing device controlled by said relay, means controlled by said first timing device for energizing said relay, means controlled by said second timing device for subsequently maintaining said relay in its energized condition, and governing means controlled by said relay.

20. In combination on a vehicle, a timing device, a manually operable switch for actuating said device, a relay, a second timing device controlled by said relay, means controlled by said first timing device for energizing said relay, means controlled by said second timing device for subsequently maintaining said relay in its energized condition, a device responsive to the speed of the vehicle, means including said speed responsive device but not said second timing device for maintaining said relay in its energized condition, and governing means controlled by said relay.

21. In combination on a vehicle, a timing device, a manually operable switch for actuating said device, a relay, a second timing device controlled by said relay, means controlled by said first timing device for energizing said relay, means controlled by said second timing device for subsequently maintaining said relay in its energized condition, a device responsive to the traffic conditions in advance, means including said speed responsive device but not said second timing device for maintaining said relay in its energized condition, and governing means controlled by said relay.

22. In combination on a vehicle, a timing device, a manually operable switch for actuating said device, a relay, means responsive to traffic conditions in advance of the vehicle, a second timing device controlled by said means and said relay, means controlled by said first timing device for energizing said relay, means controlled by said second timing device for subsequently maintaining said relay in its energized condition, a circuit for said relay controlled by said first mentioned means, and governing mechanism controlled by said relay.

23. In combination on a vehicle, a timing device, a manually operable switch for actuating said device, a relay, means responsive to traffic conditions in advance of the vehicle, a second timing device controlled by said means and said relay, means controlled by said first timing device for energizing said relay, means controlled by said second timing device for subsequently maintaining said relay in its energized condition for an interval of time, means controlled by said first means but not by said second tim-

ing device for at times maintaining said relay in its energized condition after the expiration of said interval of time, and governing mechanism controlled by said relay.

24. In combination on a vehicle, a timing device, a manually operable switch for actuating said device, a relay, means responsive to traffic conditions in advance of the vehicle, a second timing device controlled by said means and said relay, means controlled by said first timing device for energizing said relay, means controlled by said second timing device for subsequently maintaining said relay in its energized condition for an interval of time, a device responsive to the speed of the vehicle, means controlled by said first means and said last mentioned device for maintaining said relay in its energized condition after the expiration of said interval of time, and governing mechanism controlled by said relay.

25. In combination on a vehicle, a timing device, a manually operable switch for actuating said device, a relay, means responsive to traffic conditions in advance of the vehicle, a second timing device controlled by said means and said relay, means controlled by said first timing device for energizing said relay, means controlled by said second timing device for subsequently maintaining said relay in its energized condition for an interval of time, and means controlled by said first means for maintaining such relay in its energized condition after the expiration of said interval of time if the speed of the vehicle is below a predetermined value.

26. In combination on a vehicle, a timing device, a manually operable switch for actuating said device, a relay, means responsive to traffic conditions in advance of said vehicle, a second timing device controlled by said means and by said relay and comprising a normally closed contact adapted to be opened following the energization of such device after the expiration of a time interval the duration of which is dependent upon the speed of the vehicle, means for energizing said relay, means including said contact for subsequently maintaining said relay in its energized condition, means responsive to the speed of the vehicle for maintaining said relay in its energized condition after the opening of said contact, and governing mechanism controlled by said relay.

27. In combination on a vehicle, a timing device comprising a normally open contact adapted to be closed only for a fixed interval of time following the energization of said device, a manually operable switch for energizing said timing device, means controlled by traffic conditions in advance of said vehicle, a relay, a second timing device controlled by said means and by said relay, means including said contact for energizing

said relay, means controlled by said second timing device for subsequently maintaining said relay in its energized condition for a time interval the duration of which is dependent upon the speed of the vehicle, means controlled by said first means but not by said second timing device for maintaining said relay in its energized condition after the expiration of said last mentioned time interval, and governing means controlled by said relay.

28. In combination with an automatic fluid pressure breaking mechanism on a vehicle, a magnet valve adapted when de-energized to cause a brake application, a relay responsive to traffic conditions in advance of such vehicle, means responsive to the speed of said vehicle and comprising a first contact normally closed but arranged to be opened when the speed of the train exceeds a predetermined high speed and a second contact normally closed but arranged to be opened when the speed of the train exceeds a predetermined medium speed, a circuit for said magnet valve including said first contact and controlled by said relay, a manually operable switch, a timing device comprising a third contact normally open but arranged to be closed only for a fixed time interval following operation of said switch, a normally de-energized relay, a second timing device controlled by said relay and comprising a fourth contact normally open but arranged to be closed when said relay is energized for a period of time the duration of which is inversely proportional to the speed of the vehicle, a pick-up circuit for said relay controlled by said first means and including said third contact, a stick circuit for said relay including said fourth contact and said second contact, a second stick circuit controlled by said first mentioned means and including said second contact, and an auxiliary circuit for said magnet valve controlled by said relay and including said second contact.

29. In combination on a railway vehicle, a timing device comprising a contact normally open but adapted to be closed when said timing device is energized and a second contact normally open but adapted to be closed for an interval of time following the energization of such device, means for temporarily energizing said timing device, means including said first contact for subsequently continuing said energization, and governing means controlled by said second contact.

30. In combination on a railway vehicle, a relay responsive to traffic conditions in advance of said vehicle, a second relay controlled by said first relay, a timing device, means controlled by said first relay and said second relay for at times energizing said device, means controlled by said first relay

but not by said second relay for continuing said energization, and governing means controlled by said timing device.

31. In combination on a railway vehicle, means responsive to traffic conditions in advance, a timing device controlled by said means, a relay, a manually operable switch, means controlled by said timing device and said switch for at times energizing said relay, means controlled only by said timing device for subsequently maintaining said relay in its energized condition for an interval of time the duration of which decreases in response to increases in the speed of the vehicle, and governing means controlled by said relay.

32. In combination on a railway vehicle, means responsive to traffic conditions in advance, a timing device controlled by said means, a relay, a manually operable switch, means controlled by said timing device and said switch for at times energizing said relay, means controlled only by said timing device for subsequently maintaining said relay in its energized condition for an interval of time the duration of which increases in response to decreases in the speed of the vehicle, and means effective upon the de-energization of said relay to cause a brake application unless the speed of the vehicle is below a predetermined speed.

33. In combination on a railway vehicle, means responsive to traffic conditions in advance, a timing device controlled by said means, a relay, a manually operable switch, means controlled by said timing device and said switch for at times energizing said relay, means controlled only by said timing device for subsequently maintaining said relay in its energized condition for an interval of time the duration of which decreases in response to increases in the speed of the vehicle, a device responsive to the speed of the vehicle, and governing means controlled by said relay and said speed responsive means.

34. In combination on a railway vehicle, means responsive to traffic conditions in advance, a timing device controlled by said means, a relay, a manually operable switch, means controlled by said timing device and said switch for at times energizing said relay, means controlled only by said timing device for subsequently maintaining said relay in its energized condition, for an interval of time the duration of which decreases in response to increases in the speed of the vehicle, and means effective upon the de-energization of said relay to cause a brake application unless the speed of the vehicle is below a given low speed.

35. In combination on a vehicle, means responsive to traffic conditions in advance, a timing device, means controlled by said first means for energizing said timing de-

vice, a relay controlled by said timing device, means controlled by said first means for causing a brake application, manually operable means for delaying said application for an interval of time following the energization of said timing device, a second relay, and means controlled by said second relay for at times preventing said brake application.

36. In combination on a vehicle, means responsive to traffic conditions in advance, a timing device, means controlled by said first means for energizing said timing device, a relay controlled by said timing device, means controlled by said first means for causing a brake application, manually operable means for delaying said application for an interval of time following the energization of said timing device, a second relay, and means controlled by said second relay for at times preventing said brake application if the speed of the vehicle is below a predetermined low speed.

37. In combination on a vehicle, means responsive to traffic conditions in advance of the vehicle, a timing device controlled by said means, a relay, manually operable means effective for a time interval following the energization of said timing device to energize said relay, means controlled by said relay for causing a brake application at the expiration of said time interval, a second relay, and means controlled by said second relay for preventing such brake application.

38. In combination on a vehicle, means responsive to traffic conditions in advance of the vehicle, a timing device controlled by said means, a relay, manually operable means effective for a time interval following the energization of said timing device to energize said relay, means controlled by said relay for causing a brake application at the expiration of said time interval, a second relay, and means controlled by said second relay for preventing such brake application if the speed of the vehicle is below a predetermined speed.

39. In combination on a vehicle, means responsive to traffic conditions in advance of the vehicle, a timing device controlled by said means, a relay, manually operable means effective for a time interval following the energization of said timing device to energize said relay, means controlled by said relay for causing a brake application at the expiration of said time interval, a device responsive to the speed of the vehicle, a second relay controlled by said last mentioned device, and means controlled by said second relay for preventing such brake application.

40. In combination on a railway vehicle, a device responsive to the speed of the vehicle and comprising a contact closed only when the speed of the vehicle is below a pre-

determined low speed, a relay, a circuit for said relay including said contact, a magnet valve for controlling the brakes on said vehicle, a manually controlled timing device
5 comprising a normally closed contact adapted at times to be opened, and a circuit for said magnet valve including said last mentioned contact and a front contact of said relay.

10 41. In combination with an automatic fluid pressure braking mechanism on a vehicle, a relay responsive to traffic conditions in advance of said vehicle, a manually operable switch, an electro-responsive timing device controlled by said relay and said switch,
15 and means controlled by said timing device, said switch and said relay for actuating said mechanism.

20 42. In combination with an automatic fluid pressure braking mechanism on a vehicle, means responsive to traffic conditions in advance of said vehicle, an electric timing device controlled by said means and comprising a rotating electric motor and a con-

tact mechanism, and means controlled by said contact mechanism for actuating said
25 braking mechanism.

43. In combination with an automatic fluid pressure brake application mechanism on a vehicle, a rotating electric motor responsive to traffic conditions in advance of
30 said vehicle, a cam operated by said motor, contact fingers cooperating with said cam, and means controlled by such contacts for actuating said mechanism.

35 44. In combination with an automatic fluid pressure brake application mechanism on a vehicle, a rotating electric motor responsive to traffic conditions in advance of said vehicle, a cam operated by said motor,
40 a contact finger constantly engaging said cam, a second contact finger for at times engaging said cam, and an electric circuit including said two fingers for controlling said
45 mechanism.

In testimony whereof I affix my signature.

HERBERT A. WALLACE.