May 10, 1932. H. S. FOLKER 1,857,186

TRAIN CONTROL SYSTEM

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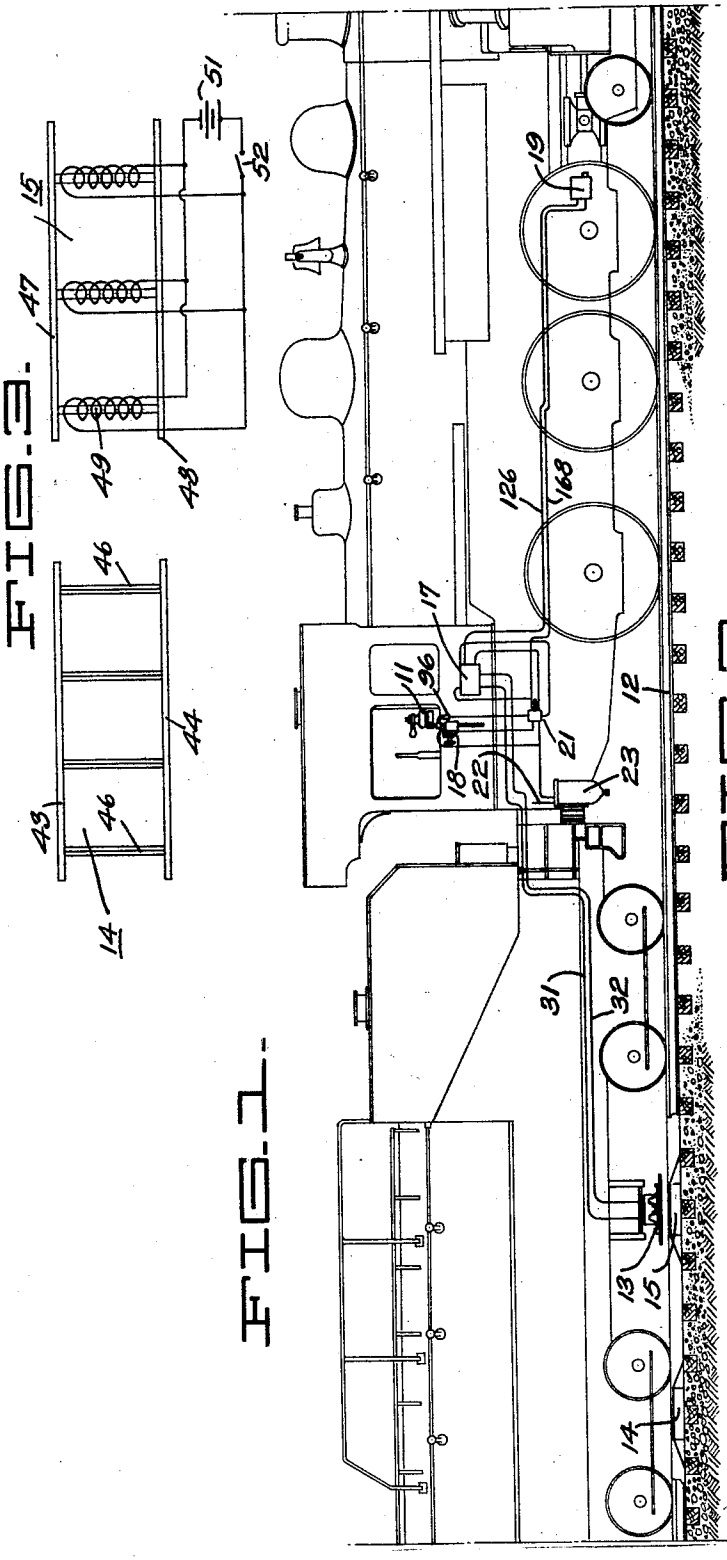


FIG. 3.

FIG. 1.

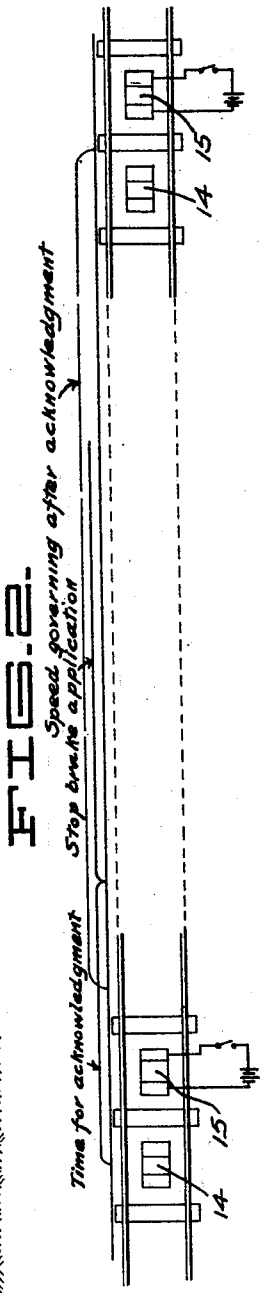


FIG. 2.

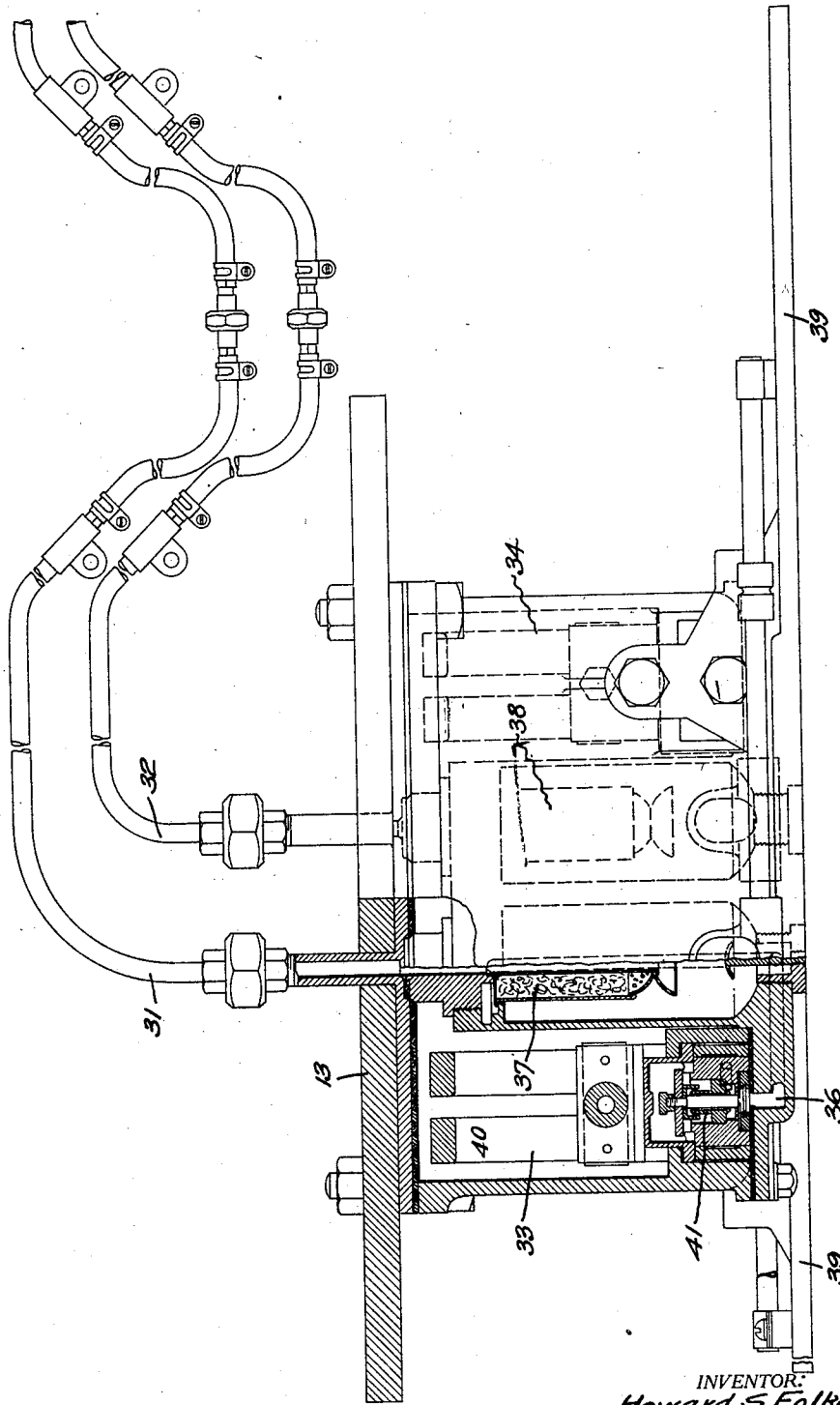
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FIG. 4.



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FIG. 5.

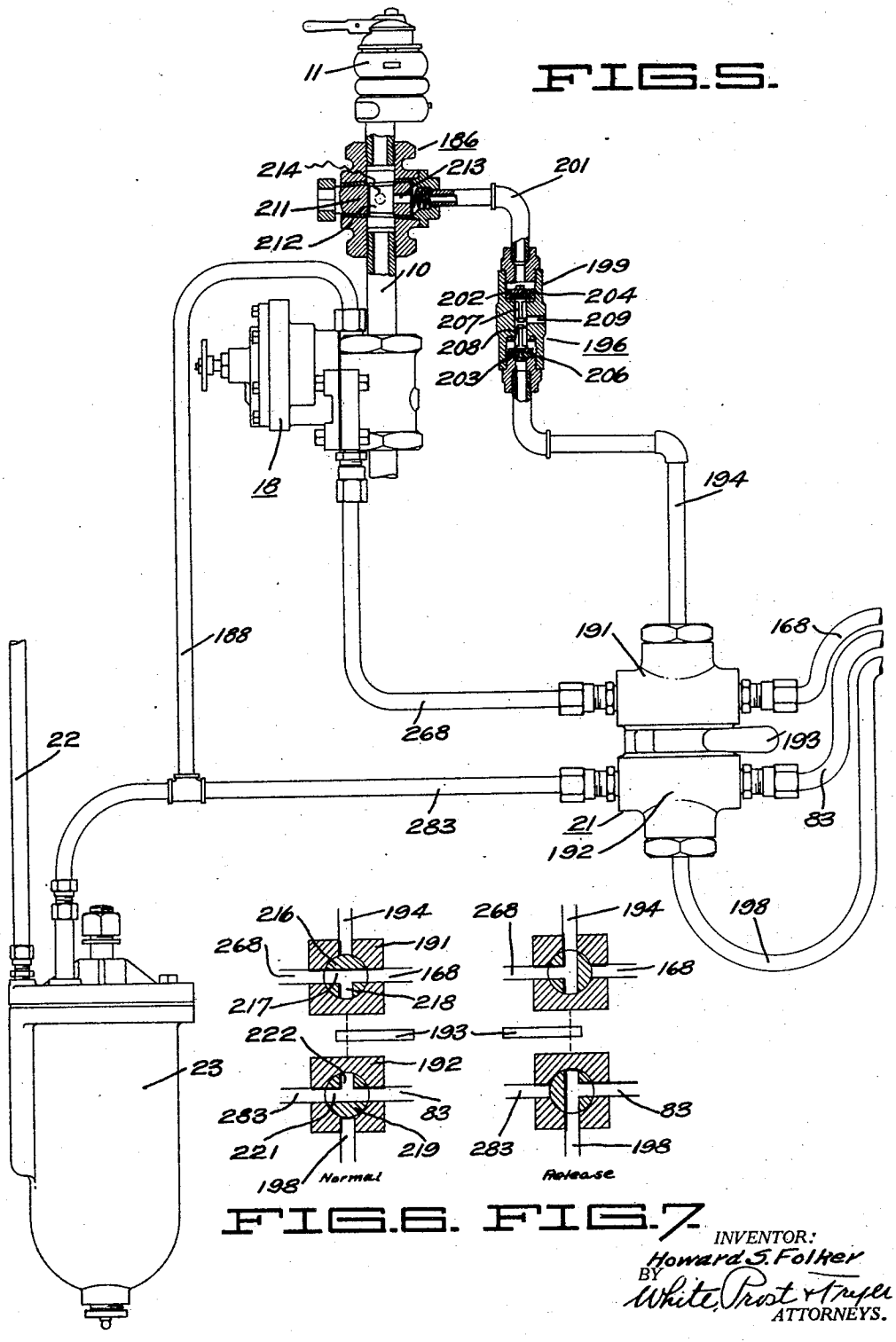


FIG. 6. FIG. 7.

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TRAIN CONTROL SYSTEM

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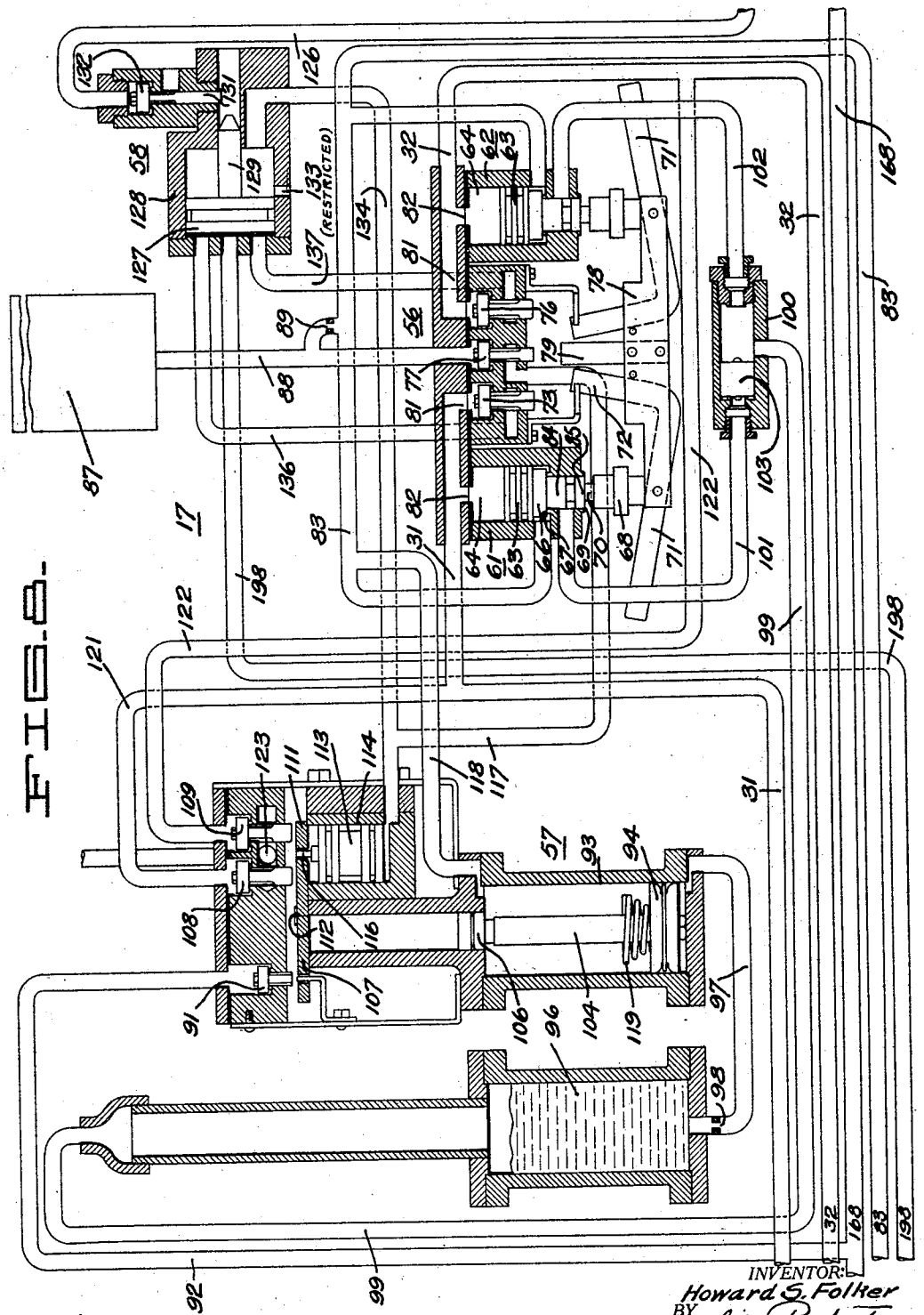


FIG. 8.

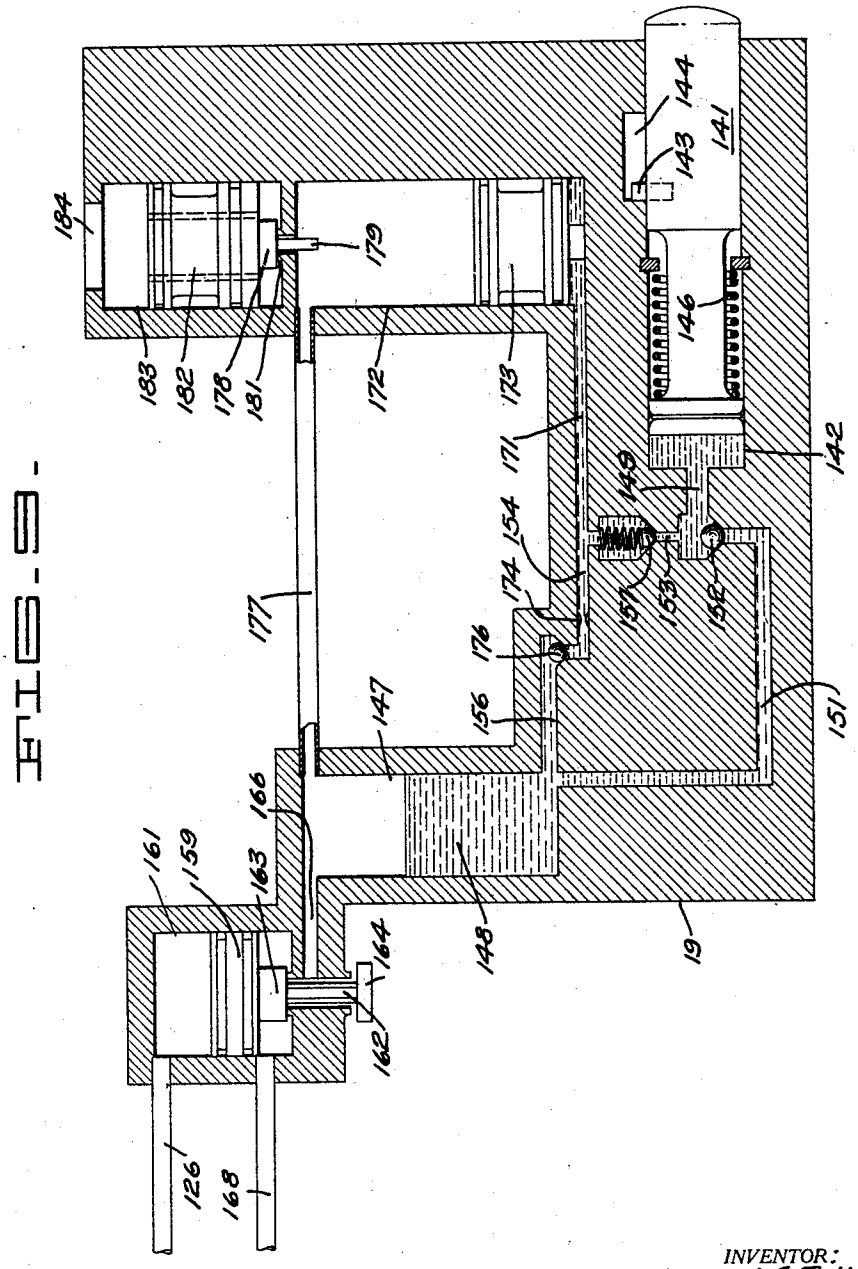
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FIG. 9.



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Patented May 10, 1932 1,857,186

UNITED STATES PATENT OFFICE

HOWARD S. FOLKER, OF MILL VALLEY, CALIFORNIA, ASSIGNOR TO NATIONAL SAFETY APPLIANCE COMPANY, OF RENO, NEVADA, A CORPORATION OF NEVADA

TRAIN CONTROL SYSTEM

Application filed October 17, 1927. Serial No. 226,637.

This invention relates generally to systems for automatically controlling movements of trains or other vehicles.

It is a primary object of this invention to devise a system which will automatically control the movements of a train in such a manner as to provide utmost safety.

It is a further object of this invention to devise an automatic train control system which will automatically place the train under speed governing condition while the train is passing thru a given track section, and which will cause automatic stopping of the train if the engineer or other human operator ignores a caution or stop signal upon entering such track section and fails to perform an acknowledgment operation.

It is a further object of this invention to devise means in an automatic train control system whereby within a limited time period following a characteristic track impulse the operator may perform an acknowledgment operation and thereby prevent an automatic brake application, the acknowledging means being so cooperatively related with a train speed governor that the acknowledging operation will immediately place the train under speed governing condition.

It is a further object of this invention to simplify systems for automatically placing a train under governing condition while the train is passing across a given track section, the system utilizing a single track impulse for initiating the governing condition, and utilizing two impulses for restoring the normal running condition.

It is a further object of this invention to devise an automatic train control system which will respond to a single track impulse to either cause an automatic stop brake application or cause the train to enter a condition of speed governing, irrespective of the direction of movement of the train, and which will respond to two track impulses for restoring the system to its normal condition.

It is a further object of this invention to utilize two oppositely selective track devices for controlling an automatic train control system, one of said devices being permanently conditioned and the other conditioned in accordance with track signals.

It is a further object of this invention to devise a speed control system which will penalize an operator for failing to acknowledge a stop or caution signal, or for failing to limit the train speed thereafter.

It is a further object of this invention to devise a novel form of speed governor which utilizes a motion transmitting means associated with a moving part of the train and controlled in such a manner that no motion is transmitted to the governor unless it is desired to limit the train speed.

Further objects of this invention will appear from the following description in which I have set forth the preferred embodiment of my invention. It is to be understood that the appended claims are to be accorded a range of equivalents consistent with the state of the prior art.

Referring to the drawings:

Fig. 1 is a side elevational view of a locomotive and tender, illustrating diagrammatically the positioning of the various mechanisms constituting the system of my invention.

Fig. 2 is a plan view showing diagrammatically a track section with track devices applied thereto for supplying track impulses.

Fig. 3 is a plan view illustrating diagrammatically the construction of the track devices for supplying polarized track impulses.

Fig. 4 is a detail illustrating the construction of one suitable form of control mechanism.

Fig. 5 is a detail view illustrating certain mechanisms forming a part of my system, together with their associated piping.

Figs. 6 and 7 are diagrammatic views illustrating two positions of the restoring mechanism.

Fig. 8 is a view showing diagrammatically the acknowledgment mechanism and other mechanisms together with their associated piping.

Fig. 9 is a view showing diagrammatically the construction of the governing mechanism.

Figures 4, 5, 8 and 9 are intended to be used in conjunction to disclose a complete system.

The specific system which I have disclosed in the drawings is designed to be used in conjunction with the ordinary standard pneumatic braking equipment of an electrical or steam train. As is well known in the art pneumatic braking systems generally utilize a pipe hereinafter termed the "brake pipe", which when vented to the atmosphere causes a brake application. By means of the apparatus which I utilize in combination with such braking equipment, venting of the brake pipe is effected automatically in response to track impulses in order to control the train movements.

Referring to Fig. 1, the various mechanical parts of my apparatus have been shown as applied to the locomotive and tender of a train, so as to cooperate with the usual pneumatic braking equipment. Arranged in the locomotive cab I have shown the usual engineer's valve 11 by means of which the engineer manually controls the train brakes. The other mechanical parts which I utilize in that embodiment of the invention to be presently described, may be distributed at convenient portions of the locomotive and tender. For example, mounted below the tender so as to move in proximity to the track 12, there is a control mechanism 13 adapted to be actuated by track impulses. The impulses in this instance are supplied by a pair of magnetic devices 14 and 15 which are arranged upon the track 12, in a manner to be presently described. The control mechanism 13 is cooperatively associated with a secondary responsive mechanism 17 which is preferably located so as to be convenient to the operator, as in the locomotive cab as shown. The mechanism 17 may effect direct venting of the brake pipe, but preferably effects such venting thru the use of an automatic stop valve 18. Arranged so as to be actuated by a moving part of the train there is a speed responsive device or governor 19 which is cooperatively associated with the remainder of the system to limit the speed of the train under certain conditions. After a stop application of the train brakes has occurred, a restoring operation must be effected and for this purpose I have shown a penalty restoring device 21. The system has communication with the main pressure reservoir of the train braking equipment thru the main resevoir pipe 22, the air from which may be first passed thru a suitable air filter 23.

The system may be entirely electrical, or part electric and part pneumatic, altho in the preferred form of the invention the system is entirely pneumatic with the exception that magnetic impulses are employed.

One of the principal characteristics of this invention is that the controlling mechanism 13 is formed so as to provide two oppositely conditioned controlling devices. The use of oppositely conditioned controlling devices makes possible automatic actuation of the system by only two track impulses which are also oppositely selective or conditioned in the sense that one impulse will only effect actuation of a similarly conditioned controlling device. In the case of magnetic impulses which I prefer to use in my system, the opposite conditioning of the impulses is secured by utilizing magnetic devices capable of having opposite polarity. Thus referring to Fig. 1, one of the magnetic track devices, say device 14, is effective to provide a magnetic impulse when the train passes a caution or stop signal. Because of the polarity of the magnetic impulse and because the controlling devices are oppositely conditioned, only one controlling device will be actuated when the train passes over the track device 14, the particular device actuated depending upon the direction of movement of the train. When the train passes a clear track signal, two magnetic track devices are provided which are oppositely conditioned to provide magnetic impulses of different polarities, thereby causing substantially simultaneous actuation of both controlling devices. It is obvious that in place of utilizing magnetic impulses oppositely selective by virtue of their polarity, I may also utilize oppositely conditioned mechanical impulses for effecting similar results, or the impulses may be inductive or may utilize positive electrical current flow.

In Fig. 4 the details of one particular controlling mechanism are shown, which is capable of effecting pneumatic control of the secondary devices in response to magnetic track impulses. One characteristic of this mechanism is that it effects control by varying pneumatic pressures in two separate control pipes 31 and 32. As will be presently explained these pipes have restricted communication with a source of air under pressure, and are adapted to effect automatic control of the secondary devices by venting the same to the atmosphere. The two controlling devices 33 and 34 incorporated in the mechanism 13, are adapted to separately control venting of the control pipes 31 and 32 respectively. The details of this control mechanism are substantially identical to the magnetically controlled valve described in United States Patent No. 1,548,593 issued to Howard S. Folker. The only change necessary in modifying the construction shown in said patent, is to separately connect the valves to the control pipes 31 and 32 instead of having these valves jointly vent a single control pipe. Thus the magnetically controlled valve 33 has been shown as communicating with passageway 36 which connects with control pipe 31 thru a suitable air filter 37. Valve 34 is provided with a like passageway which communicates with control pipe 32 thru a suitable air filter 38. Both control valves are oppositely polarized as by means of magnets 40 and are

associated with a pair of inductor planes 39 in a manner similar to the construction described in the above patent, so that in passing over a polarized track device, the movable valve member 41 of one or the other of the devices 33, 34, will be actuated to vent either control pipe 31 or 32.

Apparatus capable of providing oppositely conditioned impulses for actuating the control devices, has been illustrated diagrammatically in Fig. 3. One track device is preferably permanently polarized and may consist for example of a pair of spaced equalizing bars 43 and 44 in magnetic relationship with the poles of one or more permanent magnet bars 46. Generally the equalizing bars 43 and 44 are arranged in a horizontal plane between the track rails in such a position that the inductor planes 39 will pass directly over the same. Another track device is preferably provided in close proximity with the permanently polarized device and may consist for example of the equalizing bars 47 and 48 magnetically associated with the poles of electromagnets 49. The windings of the electromagnets are adapted to be energized from some suitable remotely controlled circuit, indicated for example by the battery 51 and switch 52. When the circuit of battery 51 is closed, the track device 15 is polarized oppositely to that of track device 14. Therefore in passing over two such track devices, either one or both of the controlling devices of the control mechanism 13 will be actuated, depending upon whether or not the track device 15 is energized.

Secondary responsive mechanism

Detail construction of the secondary responsive mechanism is shown in Fig. 8. It consists principally of selective acknowledgment mechanism 56, timing and resetting mechanism 57, and governor mechanism 58. The chief function of the acknowledgment mechanism 56 is to initiate operation of the timing mechanism 57, so that after predetermined lapse of time following the reception of a single track impulse, the train brake pipe is vented to cause a brake application. Means are also provided so that the operator may acknowledge the reception of a single track impulse, thereby preventing an automatic brake application and causing the train to thereafter proceed under control of the speed governor. The mechanism is also designed so that two track impulses will not automatically affect movement of the train except when two impulses are received while the train is under governing condition, in which event the governor is automatically rendered inoperative to vent the brake pipe and the governing condition is removed.

The particular form of pneumatic acknowledging mechanism which I have shown utilizes a pair of devices 61 and 62 which may be substantially identical in construction and which are adapted to automatically respond to the venting of control pipes 31 and 32 respectively. A detailed description of one of these devices will suffice for both. The construction shown utilizes a pneumatic piston 63 or other pressure responsive member, disposed within a cylinder 64. Movable with the pneumatic piston 63, there is a valve member 66 adapted to cooperate with the relatively stationary valve seat 67, and another oppositely disposed movable valve member 68 adapted to cooperate with a stationary seat 69. Pivotally secured to stem 70, depending from cylinder 64, there is an acknowledgment lever 71 which in practice extends from the mechanism so as to be visible to the engineer or other operator or is suitably connected to indicating means. The inner end of acknowledgment lever 71 is formed, as by means of the upturned end portion 72, so that in raised position it may engage and open a pneumatic valve 73. The distance between the end portion 72 and valve 73 is such however that when piston 63 has dropped down to the lower limit of its movement, manual movement of acknowledgment lever 71 cannot open valve 73. In order to properly distinguish the functions of devices 61 and 62, the valve corresponding to valve 73 for device 62, has been designated 76. Another valve 77 is also provided which is adapted to be opened by the joint action of devices 61 and 62. This is accomplished as by means of a bar 78 having its ends pivotally secured to the pistons 63, and having a projecting member 79 of insufficient length to open valve 77 when only one of pistons 63 is lifted to the limit of its upward movement, but which will cause opening of valve 77 when both pistons 63 are lifted substantially simultaneously. Both pistons 63 are biased to their lower positions, as by gravity.

The pneumatic connections to the acknowledgment mechanism are as follows: First with respect to the device 61, valve 73 has its intake port 81 communicating with the control pipe 31, and this control pipe also has communication with the upper end of cylinder 64 of device 61, through port 82. With respect to the device 62, valve 76 likewise has an intake port 81 in communication with control pipe 32, and this pipe also has communication with the upper end of cylinder 64 of this device thru a like port 82. The lower ends of both cylinders 64 for the two devices 61 and 62 are connected to a source of pneumatic pressure as by means of pipe 83. For example pipe 83 may communicate with the main pressure tank of the train braking equipment. Pistons 63 preferably have different upper and lower pressure areas so that when the pneumatic pressure above and below these pistons is substantially equal, a force component tends to move them down-

wardly. Thus referring specifically to device 61, if the pressure in control pipe 31 is substantially the same as the pressure supplied by pipe 83, then because of the smaller area presented by the lower side of the piston, the piston is forced down upon its valve seat 67. However, if the associated control pipe is vented to the atmosphere thus causing the pneumatic pressure above the associated piston to suddenly fall, then the air pressure supplied by pipe 83 will cause that piston to immediately rise to the upper limit of its movement. When in such upper limit, valve member 68 seats upon valve seat 69 thus preventing escape of air from pipe 83 to the atmosphere. Both pistons 63 have a relatively leaky fit within their respective cylinders 64 whereby restricted flow of air may occur around the pistons. For providing a relatively small effective pressure area upon the lower side of each piston 63, the valve stem 70 of each piston preferably has spaced collars 84 and 85 which have a leaky fit with their associated guide walls.

It may be explained at this point that, by reason of the leaky fits of pistons 63 within their cylinders, control pipes 31 and 32 always have restricted communication with the air supply pipe 83, and when the control valve connected with either control pipe is opened by a track impulse, air flows from the air supply pipe 83 thru the control pipe and thus maintains a residual pressure which prevents restoration of the control valve. At the same time, the differences in pressure cause the piston 63 to remain at the upper limit of its movement so long as the control valve is open. However, as will presently appear, the control pipes may be more freely vented either by the opening of valve 108 or 109, connected with the respective control pipes by pipes 121 and 122, or by the opening of valve 73 or 76 which admits the residual pressure thru pipe 136 or 137 to cylinder 128 thereby moving piston 127 to the right and opening the exhaust port 133. This freer venting of the control pipe reduces the residual pressure to such a value that the control valve closes. But, so long as the vent thru valve 108, 109, 73 or 76 remains open, the resulting low pressure in the control pipe 31 or 32 causes the associated piston 63 to remain at the upper limit of its movement, and the piston does not return to normal position until the pressures are equalized by the building up of pressure in the control pipe after the control valve is closed.

The intake side of valve 77 is also associated with a source of pneumatic pressure, which may simply comprise a capacity air reservoir 87 shown connected to the intake of valve 77 by means of pipe 88. Pressure is stored up in reservoir 87 by air flow thru the restricted orifice 89, which communicates between pipe 88 and pipe 83. The remainder of the pneumatic connections between the acknowledgment mechanism and the other devices of this system will be presently described.

The timing and resetting mechanism 57 is adapted to be initiated into operation upon automatic actuation of one of the devices 61 and 62. Its function is to cause automatic venting of the brake pipe within a certain time period following an automatic actuation of either device 61 or 62. Therefore the timing mechanism includes a valve 91 which when opened, indirectly effects venting of the main brake pipe by control of stop valve 18. This stop valve 18 is connected to the intake of valve 91 as by means of pipes 92 and 168, cock 191 and pipe 268. Stop valve 18 is of some suitable type such as shown for example in Patent No. 1,529,058 issued to Howard S. Folker, and functions to vent the main brake pipe of the train braking equipment upon venting of the pipe 92. Pipe 92 has restricted communication with a source of pneumatic pressure thru the stop valve, as explained in said Letters Patent 1,529,058, so that when pipe 92 is again closed pressure within it builds up to automatically restore valve 18 to non-venting condition. Actuation of valve 91 is caused by suitable timing means which is automatically set into operation upon actuation of one of the devices of acknowledgment mechanism 56. One suitable form of timing means may consist of a cylinder 93 within which is disposed the movable member or piston 94. A liquid reservoir 96 communicates with the lower end of cylinder 93 thru pipe 97. Flow of liquid from reservoir 96 to cylinder 93 is restricted as by means of orifice 98. The liquid in reservoir 96 is adapted to be forced into cylinder 93 to raise piston 94, by means of pneumatic pressure applied thru pipe 99, which pipe is connected to the selecting mechanism 56 thru a two-way check valve 100. Check valve 100 is connected to device 61 thru pipe 101, which communicates between valve seats 67 and 69 of that device. Another pipe 102 similarly connects between check valve 100 and device 62. A movable piston type valve member 103 within the valve 100 is adapted to either establish communication between pipe 101 and 99, or pipe 102 and pipe 99, depending upon which of the pipes 101 or 102 has the greater pneumatic pressure. If the piston of device 61 is moved upwardly after automatic venting of control pipe 31, then pipe 101 has communication with air under pressure from pipe 83, which may pass around valve seat 67 and collar 84. If the piston of device 62 is then in normal position, the pressure in pipe 102 will be atmospheric and valve member 103 will be moved to establish communication between pipes 101 and 99. Air from pipe 101 flowing thru pipe 99, will like-

wise press down upon the liquid in reservoir 96 and cause gradual upward movement of the piston 94, the speed of movement of this piston depending upon the size of the orifice 98.

Near the upper limit of movement of piston 94, valve 91 is positively actuated to vent pipe 92. For this purpose a rod 104 has been shown as secured to piston 94, and carries a piston 106 which is adapted to strike and lift the member 107. This member 107 may simply rest upon a fixed support and may be guided so that when lifted by rod 104 it engages the depending stem of valve 91 to open the same.

Cooperatively associated with the member 107 in a novel manner, are the resetting valves 108 and 109. Bar 107 preferably has member 111 connected to the same as by means of the hinge 112 whereby member 111 may be lifted upwardly independently of member 107 to actuate and open valves 108 and 109, but is caused to move in unison with bar 107 when this bar is lifted upwardly by rod 104. Thus during the limit of the movement of rod 104, all three valves 91, 108, and 109 are opened, but by independent movement of member 111, valves 108 and 109 may be opened independently of valve 91.

To effect certain resetting operations, means are provided for moving member 111 independently of member 107. For example I have shown a pneumatic piston 113 operating within a suitable cylinder 114 and adapted to be actuated by pneumatic pressure to lift the member 111. A pin 116 may project loosely into an aperture provided in member 111 in order to guide the same and maintain the same in position to open the valves 108 and 109. The lower end of cylinder 114 is connected to the outlet of valve 77 by means of pipe 117. Piston 94 is biased toward lower or normal position as by means of pneumatic pressure applied to its upper pressure area thru pipe 118, which connects between the upper end of cylinder 93 and the pipe 83, which pipe in turn connects to a source of air under pressure as previously explained. A compression spring 119 may also be utilized to effect rapid initial return movement of piston 94 after pressure in reservoir 96 has been relieved, thus permitting quick closing of valves 91, 108 and 109.

As the effective pressure area upon the upper side of piston 94 is substantially equal to its total area less the area of piston 106 (on the upper side of which the pressure is atmospheric) and is therefore substantially less than the area upon the lower side of piston 94, substantially equal pressures in reservoir 96 and pipe 118, will cause a differential force tending to raise piston 94 to its upper position even against the opposition of spring 119.

The valves 108 and 109 serve to effect restoration of an actuated control valve as will be presently explained, and also of devices 61 and 62 which are automatically actuated in response to opening of one of the control valves. Thus the intake of valve 108 is shown as connected to control pipe 31 as by means of pipe 121, while the intake of valve 109 is likewise connected to control pipe 32 by means of pipe 122. The outlets of both valves 108 and 109 discharge to the atmosphere thru the port 123.

The governor cut-in mechanism 58 is associated with the governor by means of pneumatic pipe 126 and is adapted to cut in the governor by venting this pipe. Such venting is caused automatically when the operator acknowledges actuation of one of devices 61 or 62 by manually operating one of levers 71, within the period of operation of timing mechanism 57. To accomplish this function I have shown a pneumatic piston 127 operating within cylinder 128. Piston 127 carries a cam rod 129 adapted to engage and lift the stem 131 of valve 132. An intermediate portion of cylinder 128 is provided with an atmospheric exhaust port 133 the capacity of which is restricted for a purpose that will presently appear, and one end of the cylinder, say the right hand end is connected to the outlet side of valve 77 thru pipe 134 and pipe 117. The other cylinder end is in communication with the outlet of both valves 73 and 76, by means of pipes 136 and 137. Pressure in pipes 134 and 117 is normally atmospheric because pipe 134 is in communication thru cylinder 128 with exhaust port 133 and pipe 117 also has a small vent to atmosphere around the lower end of the stem of valve 77, this valve stem having a leaky fit in the guiding hole in the body of acknowledging mechanism 56. Under this condition as pneumatic pressure is applied to either pipe 136 or 137, as by opening of valve 73 or 76, piston 127 is moved to the right to engage and open valve 132, thus causing venting of pipe 126 and cutting in of the governor, as will be presently explained. Compression of air in pipes 134 and 117 by movement of piston 127 to the right beyond exhaust port 133 is prevented by the vent around the stem of valve 77. In order to render the governor inoperative, pressure applied to pipe 134 causes piston 127 to be moved to the left to permit valve 132 to close. Piston 127 is free to be moved to the left because pipe 136 or 137 was vented thru exhaust port 133 when the piston passed the port in its movement to the right, and these pipes are also vented around the lower ends of the stems of valves 73 and 76, which have leaky fits, like the stem of valve 77.

Speed governor

In the past it has been common to govern the speed of a train by means of a suitable mechanical device continuously connected to some moving part of a train and serving to vent the brake pipe of the pneumatic train

braking equipment when the speed exceeds a predetermined value. Because of the continuous operation of such governors they are subject to wear and require frequent servicing, and may even become inoperative to control the train speed. In my invention motion is transmitted to the speed responsive means only when the governor is being utilized for governing the train speed. Another novel feature of my governor is that I utilize the pumping of a liquid for effecting venting of the brake pipe when the train speed reaches a given value. This governor has been shown diagrammatically in Fig. 9 and preferably comprises a pump plunger 141 operating within a cylinder 142. Movement of plunger 141 is preferably limited as by means of lug 143 operating within slot 144 and means such as a compression spring 146 is provided for normally biasing the plunger in a direction to retract the same into the cylinder 142. Cylinder 142 is in communication with a reservoir 147 which contains oil 148 or some other suitable liquid, communication with this reservoir being established thru cylinder port 149 and passageway 151. Back flow of liquid from the cylinder into passageway 151 is prevented by a suitable check such as the ball check 152 and upon instroke of the plunger 141 liquid is forced to return to reservoir 147 thru another path established for example thru passages 153, 154, and 156. Interposed between port 149 and passageway 154 there is a pressure release valve such as for example the spring pressed ball check 157 which is adapted to be opened only when the pressure of liquid in port 149 and cylinder 142 exceeds a given predetermined value.

When the governor is rendered operative to control the train speed, the plunger 141 is projected into abutting contact with some reciprocating part of the locomotive, as for example the locomotive cross head, so as to be reciprocated to pump the fluid thru the ball check 157. Outward movement of the plunger against the pressure of the spring 146 is secured by increasing the hydraulic pressure in reservoir 147, and this in turn is preferably accomplished by introducing pneumatic pressure into the reservoir. For example I have shown a pneumatic piston 159 operatively disposed in cylinder 161 and carrying a valve stem 162, which has attached thereto the opposed valve members 163 and 164. Communication between the valve seats of valve members 163 and 164, and the upper portion of reservoir 147, is established thru passageway 166. The upper portion of cylinder 161 is connected to pipe 126, which as previously explained is connected to the inlet of valve 132 of the governor cut-in mechanism. The lower end of cylinder 161 is connected to a pipe 168 which eventually communicates with the train stop valve 18, so that normally venting of pipe 168 effects an application of the train brakes. As has been explained in said Patent No. 1,529,058 when the stop valve 18 is in normal non-venting condition, its control pipe has restricted communication with the main pressure reservoir of the pneumatic braking system so that during normal condition of the system, pipe 168 will be subjected to the main reservoir pressure. Piston 159 has a comparatively leaky fit within its cylinder and due to the fact that valve 132 of the governor cut-in mechanism is normally closed, pressure in pipe 126 will build up to substantially the same value as the pressure in pipe 168. Due to the weight of piston 159, and as its lower exposed area is substantially smaller than its upper area, valve member 163 will normally be pressed against its seat to prevent communication between pipe 168 and the reservoir 147. Now assuming that pipe 126 is vented by some means as by opening of valve 132, pressure above piston 159 immediately drops and this piston is lifted by pressure in pipe 168, to cause pneumatic pressure to be applied to the liquid in reservoir 147, since when the piston 159 moves upwardly valve 164 is closed to prevent escape of air to the atmosphere. The hydrostatic pressure thus applied to the oil 148 is sufficient to overcome the pressure of spring 146 and therefore causes the plunger 141 to be projected into operative position to be reciprocated by the moving part of the train. Communicating with passage 154, thru passage 171, there is a cylinder 172 within which is disposed a weighted piston 173. When plunger 141 is reciprocated, liquid is pumped from reservoir 147 thru passage 151, and may be returned to the reservoir thru check valve 157, passage 154 and passage 156. However, return of liquid into the reservoir is restricted as by means of orifice 174, so that when the flow of liquid exceeds a certain value, the pressure of the fluid is sufficient to cause flow thru passage 171 into the cylinder 172 to lift the piston 173. Cylinder 172 is preferably of considerable volumetric capacity so that a lapse of time will occur from the time the engine exceeds its safe speed till the complete lifting of piston 173 occurs. Direct flow of liquid from reservoir 147 into cylinder 172 when initially projecting the plunger 141 is preferably prevented as by means of a ball check 176. The pneumatic pressures in reservoir 147 and cylinder 172 are preferably equalized as by means of an interconnecting pipe or passage 177.

Positioned near the upper end of cylinder 172, there is a valve member 178 carrying a depending valve stem 179 and adapted to rest upon the valve seat 181. When piston 173 has been lifted to the upper limit of its movement by flow of oil into cylinder

172, it is adapted to strike stem 179 to lift valve 178, which consequently vents air from the cylinder 172 past piston 182 which, as will be presently explained, has a leaky fit in cylinder 183, to atmosphere thru port 184. Since this cylinder is in communication with reservoir 147 thru pipe 177, and as reservoir 147 is at this time in communication with pipe 168, pipe 168 is likewise vented to cause an automatic actuation of the main stop valve 18, thus effecting a stop application of the train brakes. To continue such venting in order to necessitate a penalty restoring operation, valve member 178 is preferably adapted to remain in venting position as long as air is bleeded from the stop valve thru pipe 168. For this purpose I have shown valve member 178 carried by a piston 182 having a relatively leaky fit in a cylinder 183. The upper portion of cylinder 183 is in communication with the atmosphere thru port 184. Before opening of valve 178, the weight of piston 182 is sufficient to keep this valve closed against pneumatic pressure in cylinder 172, but after opening of valve member 178, pneumatic pressure on the under side of piston 182 is sufficient to keep the piston in raised position, altho its leaky fit permits adequate venting of pipe 168 to effect automatic operation of train stop valve 18. In order to restore the train governor to normal condition with the valve 178 in non-venting position, it is merely necessary to close valve 132 and thus interrupt venting of pipe 126, whereupon piston 159 will drop to close valve member 163 and thus interrupt venting of pipe 168.

The penalty restoring feature of the invention may be best understood by referring to Fig. 5. As shown in this figure the train stop valve 18 is connected with the brake pipe 10 of the train braking equipment, together with the engineer's brake valve 11. Interposed between the stop valve 18 and the engineer's brake valve 11 there is a double heading cock 186. Stop valve 18 has communication with the main reservoir of the braking system by means of pipes 22 and 188, between which may be interposed the usual air filter 23. Pipe 268 leads from stop valve 18 and serves to control operation of the same, this pipe also serving to connect the stop valve with the penalty restoring device 21. This device may be briefly described as comprising a pair of valves 191 and 192 which are adapted to be operated simultaneously by the handle 193. Each valve preferably has three connections to the remainder of the system, valve 191 for example being connected with pipe 268 and pipe 168 leading from the train governor, and a third pipe 194 leading to an interlocking valve 196. The pipe connections to the other valve 192 consist of a pipe 283 which connects with the main reservoir pipe 22, pipe 83 which as previously described communicates with the selecting mechanism 56, and a third pipe 198 as shown in Fig. 8 connecting to the left hand end of cylinder 128 of the governor cut-in mechanism 58. The interlock valve 196 is substantially the same as that shown and described in my patent application No. 166,646 filed February 8, 1927. It may be described briefly as comprising a valve body 199 having two intake connections, one of which is connected to pipe 194 and the other which is connected to the double heading cock 186 thru pipe 201. Positioned within the valve body are the valve members 202 and 203 which are movable in opposite directions to close upon their respective seats. Valve member 202 forms a piston within a cylinder 204, and valve member 203 is likewise loosely fitted within a cylinder 206. Fluted valve stems 207 and 208 are adapted to abut each other so that when valve member 202 is down upon its valve seat, valve member 203 cannot be closed, while conversely when valve member 203 is seated upon its seat it may lift valve member 202, providing the pressure in pipe 201 has been reduced. Interposed between the valve members there is an exhaust port 209 so that when valve member 203 is open, pipe 194 may be vented to the atmosphere. Double heading cock 186 utilizes the usual rotatable plug 211 which has not only the lateral passageway 212 but also a central port 213 which serves to establish communication betwen port 212 and pipe 201. The valve body of the double heading cock 186 also is provided with an exhaust port 214 which is adapted to register with port 212 when the double heading cock is turned to off position as during double heading operations. In such position of the double heading cock air pressure applied to pipe 194 is sufficient to force valve member 203 upwardly to lift valve member 202 from its seat thus permitting complete closing of valve member 203 and preventing venting of pipe 194. When the double heading cock is moved to normal open position so as to permit control of the braking equipment from the engineer's brake valve 11, then pipe 201 is in communication with the pressure within the brake pipe and valve 202 is held down upon its seat to prevent closing of valve 203 and consequently pipe 194 may be vented.

The penalty restoring valve 21 is preferably located outside the engineer's cab so that after a penalty brake application has occurred, it is necessary for the engineer to dismount and effect a manual restoring operation. The operation of this penalty restoring device may be explained more clearly by referring to the diagrammatic showing of Figs. 6 and 7. Thus the rotatable valve member 216 of valve 191 has a thru port 217 and a lateral port 218. Likewise the rotatable valve member 219 of valve 192 has a

thru port 221 and a lateral port 222. In the normal position of the lever 193, pipes 168 and 268 are in communication thru port 217 while communication to pipe 194 is interrupted. Likewise with respect to valve 192, pipes 83 and 283 are in communication thru port 221, while communication to pipe 198 is interrupted. After an automatic brake application has occurred, either by operation of the train governor or by failure of the engineer to acknowledge a caution or stop signal, the engineer must dismount from his cab and turn the handle 193 to release position shown in Fig. 7. In this position communication is established between pipes 268 and 194, while communication to pipe 168 is interrupted, and likewise with respect to valve 192, communication is established between pipes 83 and 198, while communication with pipe 283 is interrupted. As will be presently explained, when handle 193 is again turned to normal position, the system is restored to speed governed condition and the train may proceed. If it is desired to render the automatic apparatus for a particular locomotive inoperable as for example during double heading operations, the double heading cock 186 is turned to off position and the lever 193 is left in release position.

The complete operation of the system can best be understood by first summarizing the various functions which it will perform, and then tracing through the operation of the apparatus for these functions.

These functions are as follows:

1. In response to a single track impulse as when the train passes a caution or stop signal and the engineer fails to perform an acknowledgment operation within a given time period thereafter, the brakes will be automatically applied to stop the train.

2. When the train passes a caution or stop signal the engineer by performing an acknowledgment operation may prevent an automatic stop application and after such acknowledgment the train will proceed under speed governing condition.

3. The train will be automatically stopped if a given speed is exceeded while the system is under speed governing condition.

4. The system will respond to two track impulses, corresponding to a clear track signal, for automatically removing the train from speed governing condition.

5. If a stop application of the brakes results from failure of the engineer to perform an acknowledgment operation within a given time following reception of a single track impulse, or is caused by exceeding the governor speed, the engineer is penalized and must dismount from the cab to operate the penalty restoring device before the train may proceed.

6. If two track impulses are received while the system is in normal running condition, movement of the train is not affected and the control valves are automatically restored.

Tracing thru the first of these functions, when the train passes caution or stop signals, a single magnetic impulse from the track device 14 will actuate one of the control valves 33 or 34, depending upon the direction of movement of the train. Assuming that control valve 33 is actuated, control pipe 31 will be vented to the atmosphere and will thus cause a reduction of pressure above the piston 63 of device 61. As the lower side of this piston is subject to air under pressure from pipe 83, this piston is immediately moved upwardly to open valve member 66 and seat valve member 68. The upward movement of the corresponding acknowledgement lever 71 will be visible to the engineer and will indicate that one of the devices 61 or 62 has been automatically actuated and that therefore a caution or stop signal has been passed. When piston 63 moves upwardly to seat valve member 68, air from pipe 83 may flow thru pipe 101, and by operating check valve 100, may flow thru pipe 99 to the reservoir 96. The pressure thus applied to the oil in reservoir 96 causes this oil to flow into cylinder 93 and slowly raise the piston 94. After a predetermined lapse of time following reception of the track impulse, say from five to ten seconds, piston 94 has moved sufficiently far to lift bar 107 upwardly thus causing opening of valves 91, 108 and 109. Opening of valve 91 causes venting of pipe 92 to the atmosphere, and since the restoring device 21 is in normal position, venting of pipe 92 also effects venting of the associated pipes 168 and 268 and thus causes automatic operation of the stop valve 18 to vent the main brake pipe, as disclosed in the aforementioned Patent 1,529,058. Opening of valves 108 and 109 causes the actuated piston 63 to remain in raised position and thus keep piston 94 in raised position till the train is stopped and a manual restoring operation is effected by mechanism 21. Assuming that movement of the train is reversed, control valve 34 is actuated to vent control pipe 32 thus causing automatic lifting of the piston of device 62 and subjecting the oil in reservoir 96 to pneumatic pressure from pipe 102, ultimately effecting the same result as explained above.

With respect to the second function, acknowledgment by the engineer is effected by pulling down upon the acknowledgment lever 71 of that device 61 or 62 which is automatically actuated. Assuming that control pipe 31 has been vented and the left hand device 61 has been automatically actuated in response thereto, the engineer may after piston 63 and its lever 71 have moved upwardly pull downward upon the lever 71 thus causing opening of valve 73. The opening of valve 73 establishes communication between control pipe 31, and pipe 136 which connects

to the governor cut-in mechanism 58. When control pipe 31 is placed in communication with pipe 136 by opening of valve 73, piston 127 immediately moves over to the right to cut in the governor as will be presently explained, and pipe 136 is then vented to the atmosphere thru port 133. Venting of pipe 136 causes the residual pressure in control pipe 31 to drop to a point which will permit closing of control valve 33. When the engineer releases lever 71, valve 73 immediately closes to prevent further venting of control pipe 31 and therefore pressure immediately builds up in this pipe to substantially the same as the pressure in the air supply pipe 83. Pressures upon the upper and lower faces of piston 63 therefore becomes equalized and because of the smaller lower pressure area, piston 63 is forced downwardly to seat valve member 66 thus interrupting further supplying of air from pipe 83 to the reservoir 96. Due to the opening of valve member 68, the air from reservoir 96 is vented thru pipe 99 and pipe 101, so that air pressure applied to the upper side of piston 94 thru pipe 118, forces this piston to return to normal position. Thus movement of piston 94 sufficiently far to cause opening of valve 91, is prevented by operation of the acknowledgment lever 71.

The third function of the system that is, to stop the train if a certain speed is exceeded after operation of the acknowledgment lever 71 will be obvious from the previous description of the speed governor. As previously explained upon movement of the acknowledgment lever 71 piston 127 is moved to open valve 132 thus venting pipe 126 to the atmosphere. Venting of pipe 126 causes upward movement of piston 159 and opening of valve member 163, to subject the oil or other liquid in reservoir 147 to the pressure in pipe 168. The pressure applied to the oil in this manner is sufficient to force plunger 141 outwardly in position to abut and be reciprocated by a moving part of the train. Because of the time relay feature which is herent because of the capacity of cylinder 172 the engineer has a reasonable time in which to reduce the train speed. However if he fails to reduce the speed to a given value after he has made proper acknowledgment of a stop or caution signal, the plunger 141 pumps sufficient oil to cause lifting of weighted piston 173, and opening of valve member 178. Due to piston 182, valve member 178 will remain open and thus continue to vent the pipe 168, which thus vents pipe 268 and causes automatic operation of stop valve 18 to vent the main brake pipe, thus causing a stop application of the train brakes.

Relative to the fourth function, or automatic actuation of the system by two track impulses, assuming that both track devices 14 and 15 are oppositely conditioned so as to produce magnetic impulses of opposite polarity, as by exciting the magnets of track device 15, then if the train is moving at an appreciable speed under control of the governor both control valves 33 and 34 will be actuated substantially simultaneously to vent both control pipes 31 and 32. Venting of both control pipes causes both pistons 63 to move upwardly, thus causing the member 79 to open valve 77. Opening of this valve supplies air under pressure from reservoir 87 by way of pipe 88, to pipe 117 and thus to the lower end of cylinder 114, to raise piston 113, the escape of air thru pipe 134 being restricted at port 133 so that sufficient pressure to raise the piston is obtained. The pressure soon falls however, as the escape of air thru port 133 depletes reservoir 87 more rapidly than the air is supplied thru restriction 89 from air supply pipe 83. Member 111 is thus lifted to open both valves 108 and 109. Opening of valve 108 vents pipe 121 to the atmosphere, and since this pipe is connected to control pipe 31, causes venting of this control pipe and thus restoration of control valve 33. Opening of valve 109 likewise causes venting of pipe 122, which is connected to control pipe 32 and thus restores the control valve 34. Due to the hinge connection between members 107 and 111, raising of member 111 does not raise member 107, and therefore does not open the valve 91, Since pipe 117 is also in communication with pipe 134, and since comparatively low pressure exists in pipes 136 and 137, piston 127 of the governor cut in mechanism 58 is moved to the left to permit valve 132 to close. As previously explained upon closing of valve 132, pressure immediately builds up in pipe 126 and by equalizing the pressures upon piston 159 of the speed governor, permits this piston to drop to close valve member 163 and thus prevents further venting of pipe 168. The air in reservoir 147 is then vented to the atmosphere around valve member 164 thus permitting compression spring 146 to retract and retain the plunger 141 in an inoperative position. Thus by simultaneous upward movement of both of the pistons 63, and thru the use of the bar 78 which interlocks the two pistons, both of the control valves 33 and 34 are restored and the governor is automatically cut out. The pressure in reservoir 87 soon drops to such a value that piston 113 is permitted to drop down to normal position by its own weight to permit the closing of valves 108 and 109. Since the control valves 33 and 34 have been restored to closed position, pressure immediately builds up in control pipes 31 and 32 and likewise the pressures become equalized upon the upper and lower sides of pistons 63 thus permitting these pistons to drop down again to normal position. When the train passes a clear track signal and two track impulses are received which causes a restoring operation

as explained above, the reception of such restoring impulses is visually indicated to the engineer by the lifting up of both of the acknowledgment levers 71.

The fifth function will be taken in two steps: Assuming first that a stop application of the brakes has occurred because of failure of the engineer to make acknowledgment of reception of a single track impulse, then the engineer must dismount from his cab and may restore the system to speed governing condition by operating lever 193 of restoring device 21. It it is to be noted however that the control valve automatically actuated, say valve 33, has been automatically restored by opening of valve 108 when members 107 and 111 are moved upwardly by the piston 94. The engineer throws over lever 193 to the position shown in Fig. 7. If the double heading cock 186 is in normal or open position, then continuous venting of pipe 268 will occur thru pipe 194. Thus the brake application will continue and the engineer cannot prevent operation of the system by tying handle 193 in released position. At the same time communication is established between pipes 83 and 198. Referring to Fig. 8, pipe 198 connects with the cylinder 128 of the governor cut-in mechanism 58, and causes piston 127 to move to the right to expose port 133, whereby both pipes 83 and 198 are exhausted to the atmosphere. Exhausting of pipes 83 and 198 permits movement of piston 94 toward its lower or normal position thus closing valves 108 and 109 so that pressure can build up in pipes 31 and 32. When the penalty restoring device 21 is returned to normal position as shown in Fig. 6, pressure immediately builds up in pipes 168 and 268 to reseat the stop valve to non-venting condition and mechanism 56 is also returned to normal condition. At the same time communication is again established between the air supply pipe 83 and the main reservoir pipe 22. However after a manual restoring operation the train governor is automatically cut in and thereafter the train must proceed under governing condition until a clear track signal is passed and the system is completely restored to normal condition.

When it is desired to render the automatic system for particular locomotives inoperative during double heading operations, then the double heading cock 186 is closed and the handle 193 is turned to release position. Then the pipe 201 will be vented to the atmosphere and pipe 194 will be closed by application of valve member 203 thus permitting pressure to build up in pipe 268 and causing stop valve 18 to be placed in non-venting condition, so that the train may proceed with the train control apparatus effective on the leading locomotive only.

Assuming now that the engineer has properly acknowledged a caution or stop signal but that an automatic stop application has been caused by action of the train governor when the train speed exceeded a certain value, then the engineer must likewise dismount from his cab and throw the lever 193 to released position. Communication between pipe 168 and train stop valve 18 is thus interrupted so that no more air is exhausted from the train stop valve and thus pressure in pipe 168 and reservoir 147 will immediately drop to cause closing of valve member 178 and retraction of the plunger 141. Piston 159 of the train governor then immediately drops to close valve member 163. Now when lever 193 is returned to normal position, sufficient pressure again builds up in pipe 168 to lift piston 159, open valve member 163 and again subject the oil 148 to a relatively high pneumatic pressure. Thus plunger 141 is again projected so as to be reciprocated when the train proceeds, so that the governing condition will not be removed until the train passes a clear track signal and two restoring track impulses are received.

In explaining the sixth function, or the response effected by two track impulses when the system is in normal condition, it will be assumed that the train has passed a clear track signal and both control valves 33 and 34 have been actuated; as previously explained pistons 63 of devices 61 and 62 are lifted substantially simultaneously to open valve 77. Opening of this valve causes upward movement of piston 113 to open both resetting valves 108 and 109, whereby both control valves 33 and 34 are automatically restored. Pressure building up in control pipes 31 and 32 immediately causes both pistons 63 to return to normal position. While oil from reservoir 96 may start upward movement of piston 94, the restoring operation of the control valves and acknowledgment mechanism is completed before piston 94 can effect venting of valve 91, an automatic stop brake application cannot take place, and after pistons 63 have returned to normal position, piston 94 likewise returns to normal position.

In addition to the above functions, many other features are incorporated. The train governor for example must always remain cut in until the train passes a clear track signal, or until two track impulses are received. When the engineer fails to make proper acknowledgment, and he attempts to restore the system to normal condition, the governor is automatically cut in so that he must thereafter proceed under governing condition. Movement of acknowledgment levers 71 will have no effect except within a given time period following an actuation by a single track impulse, since the portions 72 are of insufficient length to strike valves 73 or 76 unless one or the other of the pistons is in raised position. Likewise acknowledgment after a

predetermined lapse of time is of no effect. Successive stop signals may be encountered and the system is such that each of such signals must be separately acknowledged.

In Fig. 2 I have indicated diagrammatically a section of railroad track over which motion of a train is automatically controlled. Assuming that the energizing circuit for the magnets of track device 15 is open, then the system will receive a single track impulse, and unless acknowledgment is effected within a given lapse of time, a stop brake application will occur as diagrammatically indicated. However if an acknowledgment is effected by the engineer, then the governor is immediately brought into use and the train thereafter proceeds under governing condition until two track impulses are imparted by the next track devices. The track devices are therefore preferably located in groups of two at the beginning and end of certain track sections. If both of the tracks devices 15 at the beginning and the end of certain track sections are energized then the train may proceed along such track sections under normal running conditions, but if either track device 15 is not energized, then the train will be automatically controlled.

I claim:

1. In a train control system, oppositely conditioned responsive means on a vehicle, selective means on the trackway permanently effective for actuating either of said responsive means that the heading of the vehicle may present in cooperative relation thereto, associated oppositely selective means on the trackway governed by traffic conditions in advance for actuating under clear traffic conditions that one of said responsive means not actuated by said permanent trackway means, and control means on the vehicle set into controlling condition by actuation of either one of said responsive means alone and restored to normal condition by substantially simultaneous actuation of both said responsive means.

2. In a train control system, permanently effective means on the trackway at all times tending selectively to actuate responsive means on passing vehicles, associated means on the trackway governed by traffic conditions in advance tending under clear traffic conditions to actuate said responsive means with opposite selectivity, responsive means on a vehicle conditioned so as to be actuated by one or other of said trackway means according to the heading of the vehicle, and control means on the vehicle set into controlling condition by actuation of either one of said responsive means alone and restored to normal condition by substantially simultaneous actuation of both said responsive means.

3. In a train control system, two responsive means on a vehicle adapted to be actuated by trackway means, automatic brake application means, means for actuating said brake application means upon operation of either one of said responsive means, and means for automatically restoring said responsive means to normal condition, said restoring means being actuated by joint operations of said responsive means.

4. In a train control system, dual devices adapted to be actuated by a track impulse, and means controlled by actuation of either one of said devices for effecting governing of the speed of the train, said latter means being restored to normal condition by practically simultaneous actuation of both said devices.

5. In a train control system, means having a dual control for effecting an automatic brake application in response to actuation of either one of said controls by a track impulse, means for delaying said application for an appreciable time period following said impulse, means manually operable during said time period for preventing an automatic application, and means for preventing a brake application, said last mentioned means being responsive to substantially simultaneous actuation of both of said controls by track impulses.

6. In a train control system, a train speed governor, primary means adapted to be controlled by either one of two characteristic track impulses, secondary means responsive to actuation of said primary means by either one of said track impulses to effect restrictive control of the train speed by the governor, and means for removing the train from the control of the governor, said means for removing being responsive to actuation of the primary means by two such track impulses.

7. In a train control system, a train speed governor, primary means including a pair of devices adapted to be actuated by track impulses, and secondary means responsive to actuation of either one of said devices to place the train under restrictive control of the governor, said secondary means also including means for removing the train from control of the governor upon actuation of both said devices by track impulses.

8. In a train control system, two responsive means on a vehicle adapted to be actuated by trackway means, means for governing the speed of the train, means for rendering said speed-governing means effective upon operation of one of said responsive means, means for automatically restoring said responsive means to normal condition, said restoring means being actuated by joint operations of said responsive means, and means for restoring said speed-governing means to ineffective condition upon operation of said automatic restoring means.

9. In a train control system, means for braking the train, means for governing the train speed, and means for effecting control of both said braking and governing means, said control means including a pair of de-

vices adapted to be actuated in response to track impulses, said control means being effective to cause an automatic brake application responsive to actuation of either one of said devices, said governing means operable after such actuation to restrictively control the train speed, forestalling means for preventing said automatic application, and means operative in response to actuation of both said devices by a plurality of substantially simultaneous track impulses to prevent an automatic brake application and operation of said governing means.

10. In a train control system, two responsive means on a vehicle adapted to be actuated by trackway means, automatic brake application means, means for actuating said brake application means after a time delay following operation of one of said responsive means, means for governing the speed of the train, means for rendering said speed governing means effective upon operation of one of said responsive means, means for automatically restoring said responsive means to normal condition, said restoring means being actuated by joint operations of said responsive means, manual acknowledging means effective within the period of said time delay for restoring said responsive means to normal condition whereby operation of said brake application means is prevented, and means for restoring said speed governing means to ineffective condition upon operation of said automatic restoring means.

11. In a train control system, means for effecting a brake application, means for governing the speed of the train, and means including a pair of devices for controlling said braking means, either one of said devices being operable by a single track impulse to render said braking means operative to brake the train, the particular device actuated depending upon the direction of movement of the train, separate means cooperatively associated with each device adapted to be acknowledged by an operator within a limited time following actuation by one impulse for preventing an automatic brake application, means for rendering the governing means operative to govern the train speed upon effecting a manual acknowledgment of an actuated device, and means operative upon substantially simultaneous actuation of both said devices by two impulses for automatically rendering the governing means ineffective to govern the train speed and for preventing an automatic brake application.

12. In a train control system, means for effecting an automatic brake application including as elements thereof a pair of pneumatic control pipes each operative to effect a brake application only upon the venting of either one but not both of said pipes, and means associated with each of said pipes adapted to vent the same in response to a characteristic track impulse.

13. In a train control system, means including dual devices for effecting automatic governing of the train speed in response to actuation of either one of said devices alone by a track impulse, and interlocking means for preventing restoring of said system to normal condition except by substantially simultaneous actuation of both said devices by two track impulses.

14. In a train control system, means for effecting automatic governing of the train speed, said means including a pair of pneumatic control pipes each operative to effect governing of the train speed upon venting of the same, and means for rendering the governing means ineffective to govern the train speed, said last mentioned means being responsive to substantially simultaneous venting of both said pipes.

15. In a train control system, means for effecting governing of the train speed, said means including a pair of pneumatic control pipes each operative to effect governing of the train speed upon venting of the same, a control valve associated with each pipe and adapted to automatically vent their respective pipes upon receiving a track impulse, and means for rendering the governing means ineffective to govern the train speed, said last mentioned means being responsive to actuation of both of said valves by two track impulses.

16. In a train control system, means for effecting governing of the train speed, said means including a pair of pneumatic control pipes each operative to effect governing of the train speed upon venting of the same, a magnetically operated control valve associated with each of said pipes, each adapted to be operated by a characteristic magnetic track impulse, and means operative upon actuation of both said valves by track impulses to render said governing means ineffective to govern the train speed.

17. In a train control system, means for effecting automatic governing of the train speed, said means including a pair of control pipes each operative to effect governing of the train speed upon venting of the same, said pipes having restricted communication to a source of pneumatic pressure, a separate control valve associated with each pipe, each valve being adapted to be opened by a characteristic track impulse and remain in venting condition until restored to normal condition and means entirely on the train for automatically effecting restoration of said valves to normal non-venting condition subsequent to actuation of the same.

18. In a train control system, on the trackway a permanent magnet and associated and in alinement therewith an electromagnet controlled by traffic conditions in advance and

when energized under clear traffic conditions having polarity opposite to that of said permanent magnet, and on a vehicle two controlling devices biased to an operated position and held in a normal position by the attractive force of magnets variable by the flux of said track magnets, said devices being so disposed in alinement with their magnets of opposite polarities that by the movement of the vehicle they will be passed over both of said track magnets and either one or the other will be released to operated position by the magnetic influence of said permanent track magnet and both will be released by the influence of both track magnets when the track electromagnet is energized, and control means on the vehicle set into controlling condition by release of either one of said devices and restored to normal condition by substantially simultaneous actuation of both said devices.

19. In a train control system, on the trackway a pair of track magnets in alinement, one being a permanent magnet and the other an electromagnet controlled by traffic conditions in advance and energized under clear traffic conditions with polarity opposite to that of said permanent magnet, and on a vehicle a pair of magnetically controlled valves biased to open position by fluid pressure and maintained in open position by flow of fluid under pressure, magnets for normally holding said valves closed, the magnet of one valve being of opposite polarity to that of the other valve, either of said valves being released by the flux of a track magnet to which its holding magnet presents unlike poles when said valves are carried by movement of the vehicle over a pair of track magnets, and control means on the vehicle set into controlling condition by release of either one of said valves and restored to normal condition by substantially simultaneous actuation of both said valves.

20. In a train control system, means for braking the train, means for effecting governing of the train speed, means for automatically controlling said braking and governing means by track impulses, said control means including a pair of control pipes either operable to effect a brake application upon venting of the same, a control valve associated with each pipe and adapted to be actuated by track impulses to vent said pipes, said valves being adapted to continue in venting condition until restored, means manually operable to forestall an automatic brake application whereby the train may proceed under speed governed condition after actuation of either valve, means for restoring an actuated valve to normal condition after being actuated by an impulse to control said system, and means operative to render said governing means ineffective to govern the train speed, said last mentioned means being responsive to actuation of both of said control valves following a train governing condition.

21. In a train control system, on a vehicle a pair of normally closed control valves, said valves when released held open by flow of air under pressure, and an intermediate controlling appliance comprising a pair of valve operating members, for each said member a chamber closed by the member, a connection from a source of compressed air to said chamber through a restricted passage, means for biasing said member to an operated position, a pneumatic connection from said chamber to one of said control valves whereby when said control valve is closed air retained under pressure maintains said member in normal position and upon opening of said control valve reduction of pressure in said chamber allows operation of said member by said biasing means, a reset device biased to a normal position, a restoring valve, a reservoir connected to said source by a restricted passage and to said reset device through said restoring valve, a restricted vent between said restoring valve and said reset device, valve operating mechanism actuated by said members for opening said restoring valve only upon operation of both said members whereby air is admitted from said reservoir to operate said reset device and reduction of pressure due to escape of air through said restricted vent allows said reset device to return to normal position after a brief time interval, a pair of reset valves openable by operation of said reset device for relieving pressure in said pneumatic connections thereby allowing said control valves to close, said reset valves closing upon return of said reset device to normal position thereby retaining air for movement of said members to normal position, and means for automatically controlling the movement of the train operable upon movement of one said member to operated position.

22. In a train control system, on a vehicle a pair of normally closed control valves, said valves when released held open by flow of air under pressure, an automatic brake application mechanism, an intermediate controlling appliance comprising a pair of valve operating members each controlled by one of said control valves through a pneumatic connection supplied from a source of compressed air through a restricted passage, each said member adapted to be held in a normal position by pressure retained when said control valve is closed and to be moved to an operated position upon reduction of pressure due to opening of said control valve, a pneumatically operated reset device adapted in complete operation to relieve pressure in said pneumatic connections thereby allowing said control valves to close and then to retain pressure in said connections thereby caus-

ing return of said members to normal position, valve means for causing operation of said reset device only upon operation of both said members, a controlling valve operated by each said member, means for actuating said brake application mechanism after a time delay upon operation of one said controlling valve, means effecting coincidently with actuation of said mechanism for continuing said member in operated position thereby continuing said mechanism in brake applying condition, and for each said member a manually operable acknowledging valve operable to discontinue flow of air through the corresponding control valve thereby allowing said control valve to close and on return to normal position allowing pressure air retained by said closed control valve to return said member to normal position whereby actuation of said mechanism may be prevented by complete operation of said acknowledging valve within the period of said time delay, and separate manually operable means for restoring said continuing means to normal condition thereby restoring said member and said mechanism, said restoring means when operated causing a brake application until returned to normal condition.

23. In a train control system, on a vehicle a pair of normally closed control valves, said valves when released held open by flow of air under pressure, an automatic brake application mechanism, an intermediate controlling appliance comprising a pair of valve-operating members each controlled by one of said control valves through a pneumatic connection supplied from a source of compressed air through a restricted passage, each said member adapted to be held in a normal position by pressure retained when said control valve is closed and to be moved to an operated position upon reduction of pressure due to opening of said control valve, a pneumatically operated reset device adapted in complete operation to relieve pressure in said pneumatic connections thereby allowing said control valves to close and then to retain pressure in said connections thereby causing return of said members to normal position, valve means for causing operation of said reset device only upon operation of both said members, a controlling valve operated by each said member, means for actuating said brake application mechanism after a time delay upon operation of one said controlling valve, means effective coincidently with actuation of said mechanism for continuing said member in operated position thereby continuing said mechanism in brake applying condition, and for each said member a manually operable acknowledging valve operable to discontinue flow of air through the corresponding control valve thereby allowing said control valve to close and on return to normal position allowing pressure air retained by said closed control valve to return said member to normal position whereby actuation of said mechanism may be prevented by complete operation of said acknowledging valve within the period of said time delay, separate manually operable means for restoring said continuing means to normal condition thereby restoring said member and said mechanism, said restoring means when operated causing a brake application until returned to normal condition, speed-governing means adapted to be rendered effective to govern the speed of the train and maintained normally ineffective by pneumatic pressure control, a cut-in device including a valve for varying the pressure control of said speed governing means, said cut-in device operable by air pressure to a cut-in position for rendering said governing means effective and operable by oppositely effective air pressure to a cut-out position for rendering said governing means ineffective, means operable upon operation of one said valve operating member for effecting a pressure condition to operate said cut-in device to cut-in position, means operable upon operation of said manual restoring means for effecting said pressure condition, and means operable upon operation of both said members for effecting a pressure condition to operate said cut-in device to cut-out position.

24. A train governor intended to effect an application of the train braking equipment when the train speed exceeds a predetermined value, a hydraulic plunger adapted to be actuated by a moving part of the train, means for biasing the plunger toward disengaged position, said plunger being adapted to pump liquid thru a closed path, means responsive to the quantity of liquid pumped by said plunger to control said braking equipment, and controllable means for varying the hydraulic pressure in said path whereby said plunger may be operably engaged or disengaged from said moving part.

25. In automatic train control apparatus, on a vehicle a speed-responsive appliance comprising a pump operable by the running gear at speeds corresponding with the speeds of the vehicle, a reservoir communicating with the intake of said pump and containing a supply of liquid, a chamber, a movable member biased to a normal position forming part of the inclosure of said chamber, a duct from the discharge of said pump to said chamber and through a restricted passage to said reservoir whereby liquid is circulated from the reservoir back to the reservoir through said restricted passage by operation of the pump and above a predetermined speed of the pump accumulation of surplus liquid in said chamber causes operation of said movable member to an operated position,

and control means actuated by said movable member at operated position.

26. In an automatic train control apparatus, on a vehicle a speed responsive appliance comprising a piston pump, an operating rod for the piston of said pump, said rod adapted for cooperation with a part on the running gear of the vehicle by which thrusts may be imparted to the rod with a frequency proportionate to the speed of the vehicle, a reservoir communicating with the intake of said pump and containing a supply of liquid, a chamber, a movable member biased to a normal position forming part of the inclosure of said chamber, a duct from the discharge of said pump to said chamber and through a restricted passage to said reservoir whereby liquid is circulated from the reservoir back to the reservoir through said restricted passage by operation of the pump and above a predetermined frequency of reciprocation of said piston accumulation of surplus liquid in said chamber causes operation of said movable member to an operated position, a valve for at times connecting said reservoir with a source of compressed air thereby through said liquid applying pressure to said piston to force said rod outward into the path of said part on the running gear and to effect a return stroke of said piston and rod following each thrust imparted by said part, said valve at other times venting pressure from said reservoir, and control means actuated by said movable member at operated position.

27. In a train control system, means including a pipe adapted to be vented for effecting a brake application, mechanism for effecting venting of said pipe, means responsive to the train speed for actuating said mechanism, and a member movable to two positions for rendering said speed responsive means operative or inoperative, said member being moved to a position to render said speed responsive means operable by pressure in said pipe, and controllable means for normally retaining said member in said other position.

28. In a speed responsive appliance for use with automatic train control apparatus on a vehicle, a piston pump, an operating rod for the piston of said pump, said rod adapted for cooperation with a part on the running gear of the vehicle by which thrusts may be imparted to the rod with a frequency proportionate to the speed of the vehicle, means for applying pressure to said piston to force said rod outward into the path of said part on the running gear and to effect a return stroke of said piston and rod following each thrust imparted by said part, and biasing means for retaining said piston and rod in inward position in absence of said pressure.

29. In an automatic train control system utilizing an automatic train stop mechanism adapted to effect a brake application upon venting a mechanism control pipe, said pipe having restricted communication with a source of pneumatic pressure, a valve for effecting venting of said pipe, speed responsive means for actuating said valve, a member movable to either of two positions for rendering said speed responsive means effective or ineffective, and means for utilizing the pneumatic pressure within said mechanism control pipe for urging said member in a direction to render said speed responsive means effective to actuate said valve.

30. In automatic train control apparatus, on a vehicle a pneumatically operated brake application mechanism, a conduit connected with said mechanism and supplied from a source of compressed air through a restricted passage, said mechanism operable upon reduction of pressure in said conduit, a duct, a cut-off valve normally closing said conduit and venting said duct and operable to connect said conduit with said duct, a speed responsive appliance including a piston pump, an operating rod for the piston of said pump, said rod adapted for cooperation with a part on the running gear of the vehicle by which thrusts may be imparted to the rod with a frequency proportionate to the speed of the vehicle, a movable member biased to a normal position, restricted flow means for moving said member to an operated position when the reciprocation of said piston exceeds a predetermined frequency, a connection from said duct and means whereby upon operation of said cut-off valve pressure derived from said conduit acts upon said piston to force said rod outward into the path of said part on the running gear and to effect a return stroke of said piston and rod following each thrust imparted by said part, a normally closed governing valve openable by said movable member at operated position, said duct connecting said cut off valve with said governing valve, biasing means for holding said governing valve closed against pressure derived from said conduit when said cut off valve is operated, a venting chamber into which said governing valve opens, a movable holding member connected to said governing valve and forming part of the inclosure of said chamber, a restricted vent from said chamber whereby upon operation of both said cut-off and said governing valves reduction of pressure in said conduit causes operation of said brake application mechanism and a back pressure is maintained in said chamber, the area of said holding member such that said back pressure holds said governing valve open whereby continued venting of said conduit continues said brake application mechanism in operated condition, a manually operable restoring valve for closing off said conduit thereby allowing said governing valve to close, and controlling

means for operating said cut off valve under predetermined conditions.

31. In a train control system, two devices adapted to be actuated by track impulses, secondary mechanism responsive to actuation of said devices, said mechanism including two members corresponding respectively to said devices, said members being each movable in opposite directions, connections between said devices and said mechanism whereby upon actuation of a device by a track impulse a corresponding member of said mechanism is moved in one direction, means for automatically controlling movement of the same, said last mentioned means being responsive to movement of either one of said members after an actuation of its corresponding device, and means for discontinuing said controlling effect responsive to substantially simultaneous movement of both said members responsive to simultaneous actuation of both said devices by track impulses.

32. In a train control system, two devices adapted to be actuated by track impulses, secondary mechanism responsive to actuation of said devices, said mechanism including two members corresponding respectively to said devices, said members being each movable in opposite directions, connections between said devices and said mechanism whereby upon actuation of a device by a track impulse a corresponding member of said mechanism is moved in one direction, means for automatically controlling movement of the same, said last mentioned means being responsive to movement of either one of said members after an actuation of its corresponding device, and means for discontinuing said controlling effect responsive to substantially simultaneous movement of both members responsive to simultaneous actuation of both said devices by track impulses, and for effecting automatic restoration of said devices from actuated condition.

33. In a train control system, two devices adapted to be actuated by track impulses and to remain in actuated condition until restored, a secondary responsive mechanism connected to said devices, said secondary mechanism being capable of three responses corresponding respectively to actuation of one of said devices, to actuation of the other of said devices, or to substantially simultaneous actuation of both said devices, a member having a definite path of movement, means for setting said member into motion in one direction responsive to either of said first or second named responses of said mechanism, and means for automatically restoring said devices operating when said member has moved a predetermined distance.

34. In a train control system, two devices adapted to be actuated by track impulses and to remain in actuated condition until restored, a secondary responsive mechanism connected to said devices, said secondary mechanism being capable of three responses corresponding respectively to actuation of one of said devices, to actuation of the other of said devices, or to substantially simultaneous actuation of both said devices, a member having a definite path of movement, means for setting said member into movement in one direction responsive to either of said first or second named responses of said mechanism, means for automatically restoring said devices operating when said member has moved a predetermined distance, and additional means for effecting restoration of said devices operating automatically responsive to said third mentioned response of said mechanism.

35. In a train control system, two devices each adapted to be directly actuated by a characteristic track impulse and to remain in actuated condition until restored, a secondary mechanism actuated responsive to actuation of said devices, timing means comprising a member initiated into movement responsive to actuation of said mechanism upon actuation of one of said devices, and means for restoring said devices upon actuation of the same, said last named means being jointly controlled both by said mechanism and by movement of said member.

In testimony whereof, I have hereunto set my hand.

HOWARD S. FOLKER.