

July 3, 1951

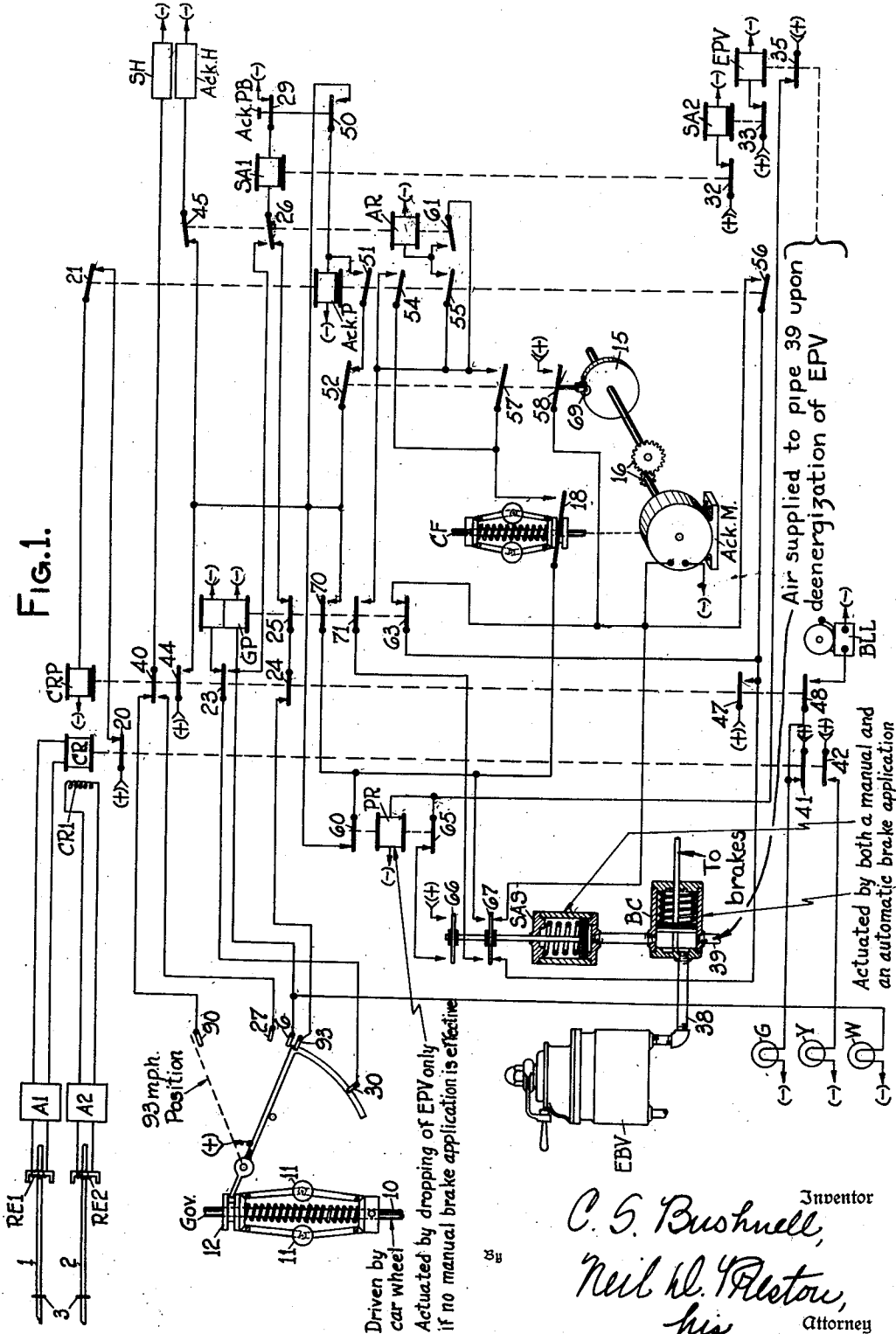
C. S. BUSHNELL
SPEED CONTROL WITH PENALTY MEANS IN CONTINUOUS
INDUCTIVE TRAIN CONTROL SYSTEMS

2,559,397

Filed Oct. 11, 1945

2 Sheets-Sheet 1

Fig. 1.



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2 Sheets-Sheet 2

FIG. 2.

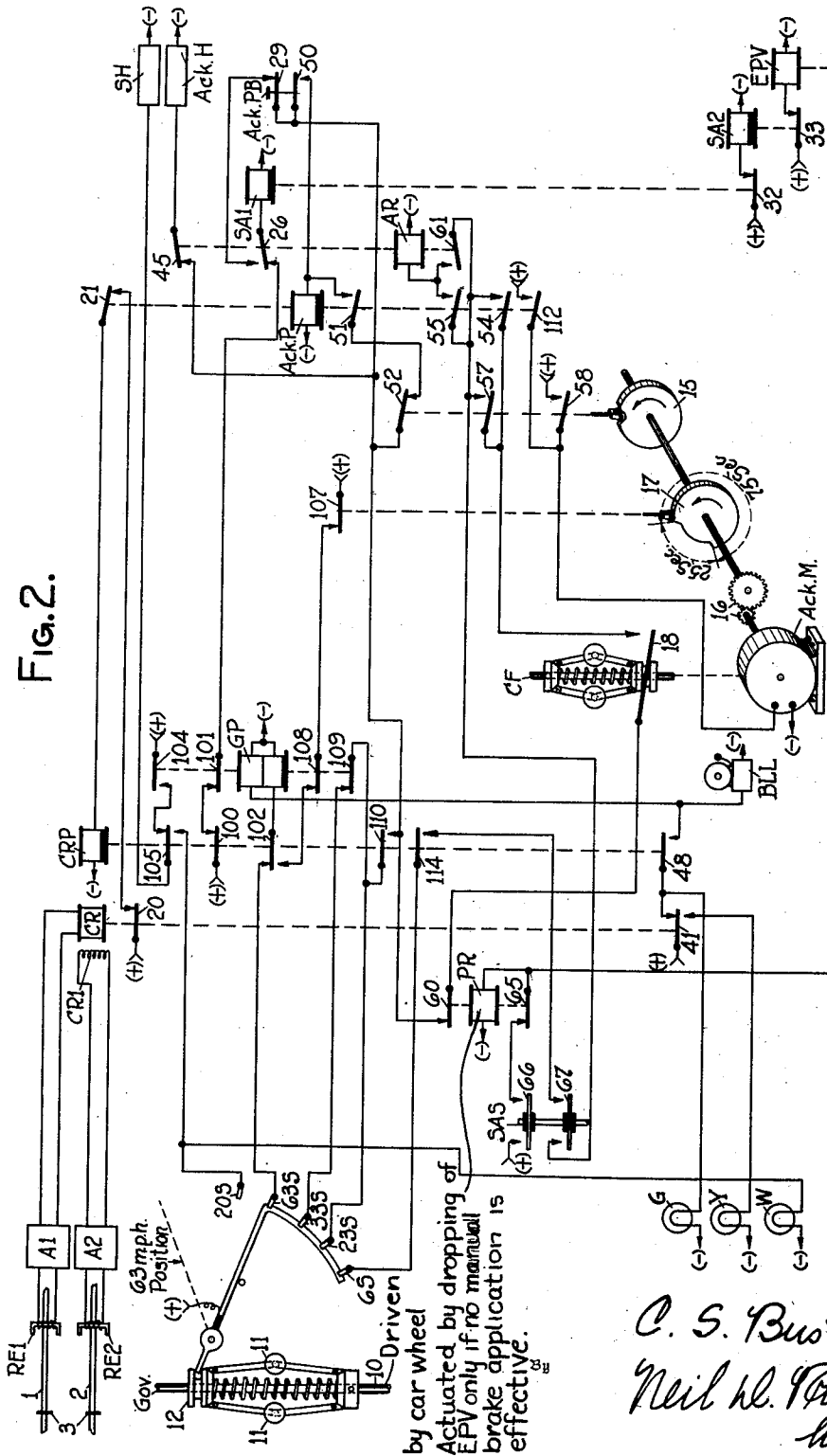
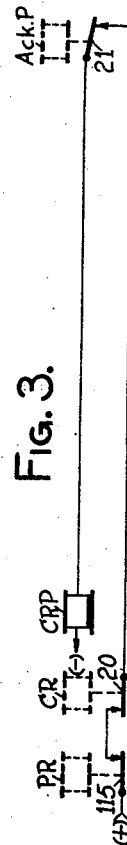


FIG. 3.



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UNITED STATES PATENT OFFICE

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SPEED CONTROL WITH PENALTY MEANS IN
CONTINUOUS INDUCTIVE TRAIN CON-
TROL SYSTEMSCharles S. Bushnell, Rochester, N. Y., assignor to
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4 Claims. (Cl. 246—63)

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This invention relates to automatic train control systems and more particularly to a train control system of the speed control type.

In accordance with the present invention it is proposed to require the engineer to reduce the speed of the train when he enters a restricted zone and to require him to acknowledge that he is aware of being in such restricted zone by performing repeated acknowledging acts and the proposed system is an improvement over the system disclosed in the Christofferson Patent No. 1,755,772, dated April 22, 1930, which also requires intermittent or recurrent acknowledgment but does not impose a speed restriction nor afford a suppressive braking reward.

One of the objects of the present invention resides in the imposition of a speed reduction on entering a restricted zone by the employment of simple equipment and without the use of complicated speed cams and other gradual step-by-step speed reducing mechanism.

As another object of the present invention it is proposed to provide means to produce a continuing audible signal so long as the train moves at excessive speed.

Another object of the present invention resides in the provision of means for producing an audible signal each time the engineer is to perform an acknowledging act.

Another object of the present invention resides in the provision of means to impose a penalty if the speed reduction is brought about by an automatic brake application. This penalty, among other things, resides in the requirement that the engineer bring the train substantially to a full stop.

Another object of the present invention resides in the provision of means whereby if the engineer himself makes a manual brake application upon entering a restricted speed zone he may avoid the penalty in that the brakes may be manually released when the speed has been reduced to an intermediate value but if the brakes are thus released intermittent or recurrent acknowledgment at repeated time intervals must still be continued until the train has been brought substantially to a stop or has entered unrestricted territory.

Another object of the present invention resides in the provision of means requiring the engineer to intermittently manifest that he is aware of operating in a restricted zone, by making suitable acknowledgment of this fact.

Another object of the present invention resides in the provision of a governor repeater relay which is controlled on the open circuit principle

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but which relay is checked against accidental deenergization thereof without the imposition of a restriction in the movement of the train.

Other objects, purposes and characteristic features of the present invention will in part be understood from the description hereinafter and will in part be obvious from the accompanying drawing.

In describing the invention in detail, reference is made to the accompanying drawings in which:

Fig. 1 illustrates schematically a brake control system for use in a continuous train control system as one embodiment of the present invention;

Fig. 2 illustrates schematically a brake control system for use in a continuous train control system as another embodiment of the present invention; and

Fig. 3 illustrates a modified form of control that can be applied to the system according to Fig. 2 where additional penalty means is required in practice.

STRUCTURE—FIG. 1

Although the features of the present invention may be employed in a train control system of the intermittent inductive type the system is preferably employed in, and has been shown in connection with, an automatic train control system of the continuous inductive type. The main control relay CR which manifests traffic conditions in advance of the train or vehicle is preferably a relay of the polyphase type such as disclosed in the patent to Wenholz, No. 1,692,361, dated November 20, 1928. It should, however, be understood that this control relay may be a simple neutral relay which is held up in response to the train control current flowing in the track rails ahead of the train such for instance as disclosed in the patent to Smith, No. 2,201,116, dated May 14, 1940. If a polyphase alternating current relay CR, such as shown, is employed it is preferably controlled inductively from the trackway through the medium of two amplifiers A1 and A2 which amplifiers have their input wires connected to receivers RE1 and RE2 which are inductively coupled with the track rails 1 and 2, respectively, as shown. These track rails 1 and 2 of the railway track are preferably divided into block sections by insulating joints 3 and have alternating current applied thereto at the exit end of each block in accordance with traffic conditions in the next block in advance, all as fully explained in the Wenholz patent above referred to.

It may be pointed out that one advantage of a

polyphase relay CR used as shown is that the system will not easily respond to false or foreign currents, in that current must flow in one direction in one of the rails and in the opposite direction in the other rail and in that these currents must be in phase with each other, or substantially so, in order to control the relay CR to its energized position. In this connection it may be pointed out that if a polyphase alternating current relay of the usual construction is employed, suitable current phase displacement must be provided for on the car to cause the current flowing in one of the windings CR to be displaced substantially 90° with respect to the current flowing in the other winding CR1. One manner in which this may be accomplished has been shown in said Wenholz patent.

On the railway vehicle is preferably provided a suitable speed indicating device Gov preferably of the centrifugal type, which centrifuge is preferably connected to the end of the usual horizontal railway vehicle axle but has for convenience been shown connected to a vertical shaft 10 in the drawings. In practicing this invention a centrifugal governor such as illustrated in the prior application of Taylor, Ser. No. 523,462, filed February 22, 1944, which has resulted in Patent No. 2,457,748, dated December 28, 1948, is preferably employed. This shaft 10 operates a fly-ball centrifuge including fly balls 11 which as the speed increases cause downward sliding movement of the movable collar 12 on the shaft 10. Although in practice this centrifugal speed responsive device Gov operates speed contacts of a different construction than those illustrated, the particular conventional showing of these speed contacts in the drawings has been resorted to to render it more readily apparent at what speed the circuits controlled thereby are opened or closed by the speed responsive device. For instance, it is readily seen that with the centrifuge or governor Gov in its zero position, as illustrated, the two speed contacts 30 and 93 are closed, whereas the contacts 6, 27 and 90 are open. It is also readily seen from the arrangement and size of the contacts that contact 6 is closed when the speed is increased to substantially 6 M. P. H., that the contact 27 is closed when the speed is increased to substantially 27 M. P. H., and that the contact 90 is closed when the speed is increased to substantially 90 M. P. H. A slight increase in the speed of the train above 27 M. P. H. will open the contact 30 and a slight increase in the speed of the train above 90 M. P. H. will open the contact 93. As pointed out hereinafter if in clear territory the 93 M. P. H. speed limit is exceeded an automatic brake application is imposed without the imposition of a penalty. In restricted territory, however, if the 30 M. P. H. speed limit is exceeded without a manual brake application in effect before the device EPV is deenergized an automatic brake application will ensue with the imposition of a penalty, but if a manual brake application is made before the device EPV is deenergized no such penalty is imposed.

The car carried apparatus is also provided with a control repeater relay CRP, a governor repeater relay GP, an electrically operated speed horn SH, an electrically operated acknowledging horn AckH, an acknowledging repeater relay AckP, an acknowledging repeater relay AR, two slow acting brake control relays SA1 and SA2, and an electro-pneumatic valve EPV.

This electro-pneumatic valve EPV if deenergized causes an automatic brake application unless the brakes have already been manually applied. The apparatus also includes pneumatically controlled apparatus including a suppression air switch SAS and a penalty relay PR, the latter of which may be either pneumatically or electrically operated but which has been illustrated as being electrically operated. The car carried apparatus also includes an acknowledging motor AckM provided with an acknowledging cam 15 this cam being operated by the motor AckM through reduction gearing 16. This reduction gearing is preferably such that the cam 15 operates through a complete revolution in substantially 1.5 minutes. In order to assure against accidental failure of operation of the acknowledging motor AckM, as due to the accidental breaking of a circuit for this motor at a time when this motor should be operating, a second centrifuge CF comprising a similar fly-ball governor which closes its contacts 18 when the speed of the motor AckM exceeds a predetermined value, has been provided. The car carried apparatus also includes cab signal lights G, Y and W preferably colored green, yellow and white respectively and also includes another audible signal BL1 which has been conventionally shown as an electric bell of the self-interrupted or doorbell type and is sounded momentarily to inform the engineman that speed may be resumed.

The car carried apparatus has been illustrated in its clear traffic condition, namely, with the control relay CR energized, and with the car or vehicle on which such apparatus is mounted standing still on the track rails 1 and 2, that is, with the centrifuge Gov assuming its zero speed position. Under this clear zero-speed condition the control repeater relay CRP is energized through a circuit which may be traced from the terminal (+) of a suitable source of current through front contact 20 of the relay CR, and back contact 21 of the relay AckP, winding of the relay CPR to the other terminal (—) of this source. The governor repeater relay GP is energized under this zero speed clear traffic condition through a circuit which may be traced from the terminal (+) of a suitable source of current, the speed contact 30, front contact 23 of the relay CRP, through upper winding of the relay GP to the other terminal (—) of this source. A normally energized slow drop away relay SA1 is energized under the conditions assumed through a circuit which may be traced from the terminal (+) of a suitable source of current through speed contacts 93 of the centrifuge Gov, through front contact 24 of the relay CRP, front contact 25 of the relay GP, back contact 26 of the relay AR, the winding of the relay SA1, and through the normally closed contact 29 of the acknowledging push button AckPB to terminal (—). With the relay SA1 in its energized condition a slow drop away relay SA2 is energized through a circuit readily traced in the drawing and including the front contact 32 of the relay SA1. And similarly, with relay SA2 energized the electro-pneumatic control valve EPV is energized through a circuit readily traced in the drawing and including the front contact 33 of the relay SA2. This electro-pneumatic valve EPV may be of a construction such as shown in my Patent No. 1,818,941, dated August 11, 1931. Also, with this electro-pneumatic valve EPV in its energized condition the

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penalty relay PR is energized through a circuit readily traced in the drawing and including a front contact 35 of the electro-pneumatic valve EPV. In practice pneumatic operation may be employed in place of this latter circuit. The engineer's brake valve EBV and a railway brake cylinder BC have been shown conventionally. It should be understood that air pressure enters brake cylinder BC via pipe 38 when the brakes are applied manually and via pipe 39 when they are automatically applied. The device SAS of course responds to this air pressure.

OPERATION—FIG. 1

Let us assume that the vehicle equipped with the apparatus illustrated in the drawing has started from rest and has its speed gradually increased, resulting in functions as presently explained. Let us assume that traffic conditions in advance are favorable as a result of which there is a flow of current in the track rails 1 and 2. This current is picked up inductively, is amplified and holds the main control relay CR energized. As the speed of the vehicle increases to 6 M. P. H. the speed governor contact 6 is closed and thereby energizes a second circuit for the governor repeating relay GP which may be readily traced and includes this governor contact 6. This speed governor contact 6 also closes a circuit for the governor indicating lamp W to thereby cause illumination of this indicating lamp. The purpose of this indicating lamp W is to advise the engineer that the governor is in good working condition and has responded to the movement of the vehicle. As the speed is further increased to 27 M. P. H. the speed contact 27 is closed but this does not result in the closure of a circuit for obvious reasons. As the speed is increased to 30 M. P. H. the speed governor contacts 30 are opened and this causes the interruption of one of the circuits for the governor repeating relay GP but this relay GP does not drop because it is maintained energized by the other circuit including the contact 6 of the speed governor Gov. As the speed is further increased to say 90 M. P. H. the speed governor contact 90 is closed and completes a circuit for the speed horn SH, which circuit may be traced from the terminal (+) of a suitable source of current through speed contact 90, front contact 40 of the relay CRP, winding of the speed horn SH to the other terminal (—) of this same source of current. This sounding of the speed horn SH advises the engineer that he is approaching the maximum speed limit and should not increase his speed but rather reduce it. Also, since the sounding of this speed horn is very annoying the engineer will probably reduce his speed to a value so that his speed horn is no longer sounded.

Let us assume, for example, that the engineer does not act in response to the warning given by the speed horn SH and allows his speed to increase to 93 M. P. H. When this speed is reached the contacts 93 of the speed governor Gov are opened thereby interrupting the energizing circuit heretofore traced for the brake control relay SA1. This relay SA1 has a drop-away time of substantially 3 seconds and will after such 3 seconds result in the opening of its contacts 32 to thereby cause deenergization of the second brake control relay SA2. This second brake control relay SA2 is also slow dropping and requires substantially 3 seconds to assume its deenergized position and if the speed of the

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train has not been reduced in the meantime to again pick up these relays, both of these relays SA1 and SA2 being rather quick picking up pick up almost immediately, the contact 33 of the relay SA2 will be opened and result in dropping of the electro-pneumatic brake control valve EPV, this valve EPV being rather quick acting. Dropping of the valve EPV will of course cause an automatic brake application and will also, by the opening of its front contact 35, or its pneumatic equivalent not shown, cause dropping of the penalty relay PR. All that the engineer is called upon to do is to reduce the speed of his train to a value below 93 M. P. H. as a result of which the speed contact 93 will be reclosed resulting in the picking up of the devices SA1, SA2 and EPV in succession in that order. The picking up of the electro-pneumatic valve EPV will allow the engineer to remove the brake application by manipulating his engineer's brake valve in a particular manner, such for instance as operating it from its normal running position to its lap position and back to its running or release position. If this is done the brakes are released and no penalty is imposed. The speed horn is, however, sounded in the meantime and this may be considered to be a penalty.

Let us now assume that the train is moving at a speed between 6 and 30 miles per hour and that while proceeding at this speed it enters a restricted zone. Under this condition there is no energy in the track rails 1 and 2 either because such energy has been shunted away, as by another train in advance in the same block, or because such energy has been removed from the track rails at the exit end of the block because the next block in advance is occupied. This entrance of the train into a restricted zone will of course cause deenergization of the main control relay CR. Dropping of this relay CR by the opening of its contact 41 will cause the clear green lamp G to be extinguished and by the closing of its back contact 42 will cause the caution lamp Y to be lighted. Also, the dropping of this main control relay CR, as by the opening of its front contact 20, causes deenergization of the control repeater relay CRP for obvious reasons. Dropping of the control repeater relay CRP will not sound the speed horn SH unless the speed is in excess of 27 M. P. H. It will, however, by the closing of its back contact 44 close an energizing circuit for the acknowledging horn AckH which may be traced from the terminal (+) of a suitable source, back contact 44 of relay CRP, back contact 45 of relay AR, the winding of the acknowledging horn AckH to the other terminal (—) of this same source. The completion of this circuit causes the acknowledging horn to sound thereby advising the engineer that he has entered restricted territory if he is not already aware of this fact due to the lighting of the caution lamp Y and the extinguishment of the clear lamp G.

Dropping of the control repeater relay CRP also causes closure of its back contact 40 to thereby cause the speed horn SH to sound if the speed of the train is in excess of 27 M. P. H. Also, dropping of this control repeater relay CRP causes closure of its back contacts 47 and 48. The closure of back contact 47 starts the acknowledging motor AckM into operation through the medium of a circuit including the contact 67 of suppression air switch SAS in its lower position and front contact 63 of relay GP in multiple. The closure of back contact 48,

however, produces no result because the front contact 41 of the relay CR is open. Furthermore, this dropping of the relay CRP results in the opening of its front contacts 23 and 24 of which the opening of front contact 23 produces no result in that the relay GP is held energized through another circuit but the opening of front contact 24 causes deenergization of the brake control relay SA1. The closure of back contact 23 of this relay CRP prepares a new circuit for this brake control relay SA1 which circuit is, however, open at the front contact 26 of the relay AR.

Let us assume that in response to the sounding of acknowledging horn AckH, and remembering that the speed of the train is between 6 and 30 M. P. H., the engineer depresses the acknowledging push button AckPB, resulting in the closure of its contact 50. This results in the closure of a pick-up circuit for the acknowledging relay AckP which may be traced from the terminal (+) of a suitable source of current, back contact 44 of relay CRP, back contact 50 of the acknowledging push button AckPB, winding of the relay AckP to the other terminal (—) of this source. It should be remembered that the brake control relays SA1 and SA2 are extremely slow dropping and that they presumably have not yet assumed their deenergized positions. The picking up of the relay AckP results in closure of a stick circuit including its stick contact 51, the back contact 52 controlled by the acknowledging cam 15, it being assumed that this acknowledging cam 15 has not yet operated far enough to open this contact 52. This circuit also includes back contact 44 of the relay CRP. The engineer may of course immediately release his acknowledging push button AckPB and thereby reclose the contact 29 of this push button to reclose the common part of the circuits for relay SA1.

With the relay AckP now picked up and stuck up and with its front contacts 54 and 55 closed an energizing circuit for the relay AR is closed as soon as the motor AckM has reached a speed where its governor contact 18 is closed. The relay AR is now picked up through the following pick-up circuit: beginning at the terminal (+) of a suitable source of current, back contact 44 of the relay CRP, contact 60 of the penalty relay PR, speed controlled contact 18 of the centrifuge CF, front contacts 54 and 55 of relay AckP in series, winding of the relay AR to the other terminal (—) of this relay. With this relay AR once picked up it is stuck up through a circuit independent of front contacts 54 and 55 of relay AckP and including its stick contact 61 and also including cam operated contact 57, governor contact 18, penalty relay contact 60, and control repeater relay contact 44. This relay AR by the closure of its front contact 26 establishes a new circuit for the brake control relay SA1 so that an automatic brake application will be prevented. This is on the assumption that the relay AR is picked up before the six-second delay imposed by the relays SA1 and SA2 has been consumed. We may therefore assume that the automatic brake application has been prevented by the picking up of the relay SA1 through a circuit including the 30 M. P. H. speed contact 30, the front contact 26 of the relay AR and the back contact 23 of the relay CRP before the electro-pneumatic valve EPV assumed a deenergized position. This is on the assumption

that the speed of the train does not exceed 30 M. P. H.

It will be seen that the acknowledging motor AckM is kept operating through a circuit including the back contact 47 of relay CRP in series with the front contact 63 of the relay GP and the contact 67 of the air switch SAS in multiple. At the expiration of a time period of substantially 1.5 minutes the cam 15 will have completed its revolution resulting in the opening of its contacts 57 and 58 and the reclosure of its contact 52. The opening of the contact 58 produces no result in that there are other closed energizing circuits for motor AckM. The opening of contact 57 will cause deenergization of the auxiliary relay AR because contacts 54 and 55 are now open to thereby cause a second deenergization of the brake control relay SA1. The picking up of this relay AR for reasons above given by the opening of its back contact 45 resulted in silencing of the acknowledging horn AckH and obviously the dropping of the relay AR again causes this horn to be sounded. The engineer is therefore apprised that he must perform an acknowledging act to avoid an automatic brake application. If the engineer now depresses his acknowledging push button AckPB he may pick up the acknowledging repeater relay AckP in the same manner as he did heretofore as a result of which the automatic brake application may be avoided for another period of substantially 1.5 minutes, the time required for the cam 15 to make one revolution. It is thus seen that by recurrent acknowledgment, manifesting alertness, the engineman may keep the train moving at speeds under 30 M. P. H. in restricted territory.

Let us now assume that a train moves at a speed in excess of 30 M. P. H. but less than 90 M. P. H. when it enters a restricted zone causing the deenergization of the control relay CR. This will result in the deenergization of the brake control relay SA1 by the opening of front contact 24 of the relay CRP for like reasons as heretofore pointed out. In this case, however, the automatic brake application cannot be avoided because even though the auxiliary relay AR could be picked up in response to acknowledgment by the engineer resulting in the picking up of the acknowledging relay AckP this will not cause energization of the brake control relay SA1 because even though its energizing circuit is closed at front contact 26 of relay AR and at back contact 23 of relay CRP it is still open at the speed governor contact 30. It is readily seen that the dropping of relay CRP will cause sounding of the acknowledging horn AckH the same as heretofore and although the act of acknowledgment will not prevent a brake application the engineer will in practice acknowledge recurrently to prevent the sounding of the horn AckH. The speed horn SH is also sounded.

If the engineer wants to avoid the penalty of being required to reduce his speed to 6 M. P. H., which is the equivalent of bringing it to a stop, in that the brakes cannot be released until the train is at stop, the engineer must himself apply the brakes, within the six seconds above mentioned, to avoid dropping of the penalty relay PR. If the penalty relay PR becomes deenergized its front contact 60, which is included in the pick-up circuit of relay AR heretofore traced, will be open and the engineer will thereafter be unable to pick up the relay AR by depression of the push button

AckPB. At least not until the train has been brought substantially to a stop to close back contact 70 of relay GP in multiple therewith.

Let us therefore assume that the engineer himself applies the brakes by operating the engineer's brake valve EBV. This results not only in a pneumatic brake application but also results in pneumatic actuation of the suppression air switch SAS. It will be pointed out that this suppression air switch SAS is actuated each time a manual or automatic brake application is made. This may be accomplished, as shown, by connecting the air switch SAS directly to the brake cylinder BC of the vehicle which cylinder has air pressure applied thereto during both a manual and an automatic brake application. If the engineer makes a manual brake application immediately he will cause the actuation of the suppression air switch SAS before the electro-pneumatic valve EPV assumes its actuated position, this being true because a six-second delay is imposed by the sequential deenergization of the brake control relays SA1 and SA2. The net result is that actuation of the suppression air switch SAS causes a stick circuit including the stick contact 65 of relay PR and the air switch contact 66 for the penalty relay PR to be closed before its pick-up circuit is broken at front contact 35 of the valve EPV.

The engineer now having applied the brakes will operate his acknowledging push button AckPB to thereby close the pick-up circuit for the acknowledging relay AckP heretofore traced. The picking up of the relay AckP results in the closure of the pick-up circuit for the relay AR heretofore traced so that this relay AR is again stuck up and is maintained stuck up through its stick circuit heretofore traced for a period of 1.5 minutes. If more time is required to bring the speed down to 30 M. P. H. the acknowledging horn will again be sounded and the engineer may perform another acknowledging act resulting in reenergization of the auxiliary relay AR. In other words, the engineer will attempt to maintain the relay AR in its energized position so that the moment the speed is reduced to a value of 30 M. P. H. or less and the speed contact 30 is closed, the energizing circuit for the brake control relay SA1 is reclosed. This circuit may be traced from the terminal (+) of a suitable source of current, speed contact 30 of governor GP, back contact 23 of relay CRP, front contact 26 of relay AR, winding of the relay SA1, contact 29 of the acknowledging push button AckPB, to the terminal (—) of the same source of current. The picking up of the relay SA1 will of course result in the picking up of the relay SA2 and the electro-pneumatic valve EPV.

The speed of the train will of course continue to be reduced and as it reaches 27 M. P. H. the sounding of the speed horn SH will cease, advising the engineer that he may now release the brakes. The engineer may now release the brakes as by moving his brake handle from either the service or lap position to either the running or the release position. The engineer is now required to keep his speed a little below 30 M. P. H. except as conditions of traffic within vision ahead of the engineer may require further speed reduction. The engineer must, however, continue to recurrently or repeatedly perform an acknowledging act every predetermined period of time, assumed to be 1.5 minutes, in order to maintain his train operating without the imposition of an automatic brake application.

It may be pointed out that the normally closed

contact 29 of the acknowledging push button AckPB has been provided to prevent the engineer misusing this push button, as by permanently tying it into its active position. In other words, each acknowledging act permits the engineer to depress this push button AckPB only for a short time of less than 6 seconds in that it takes about 6 seconds for the relays SA1 and SA2 to assume their deenergized position after having been deenergized.

Let us now assume that the train was either moving at a speed in excess of 30 M. P. H. when it entered restricted territory and that the engineer himself applied the brakes and kept them applied until the speed was reduced below 30 M. P. H. or that the train was moving at less than 30 M. P. H. when it entered such restricted territory. Let us also assume that the engineer continued to make recurrent acknowledgment of the fact that he is moving in restricted territory by depressing the acknowledging push button AckPB recurrently once every 1.5 minutes and that the train speed was eventually reduced to 6 M. P. H. It should be understood that the train may be kept running indefinitely at any speed from zero to 30 M. P. H. provided the engineer recurrently operates the acknowledging device AckPB as required. Let us however assume that the engineer desires to stop his train and to do this applies the brakes. With the speed of the train reduced below 6 M. P. H., the governor repeating relay GP becomes deenergized because both of its windings are deenergized, the upper winding being deenergized because the relay CRP is deenergized and the lower winding being deenergized because the speed governor contact 6 is open. Since the engineer has applied the brakes and since the front contact 63 of the relay GP is open as is also the normally closed bottom contact 67 of the suppressing air switch SAS the motor AckM is deprived of some of its energizing circuits. The acknowledging motor AckM now, in fact, depends for its energizing current on either the front contact 58 operated by cam 15 or the front contact 56 of the relay AckP as a result of which the acknowledging motor AckM will be brought to a stop the next time the cam 15 reaches its normal position (roller 69 is in the notch of the cam 15) because the relay AckP now assumes its deenergized position. Furthermore the auxiliary relay AR is now stuck up independently of contact 57 operated by cam 15 and contact 18 operated by centrifuge CF. This is true because dropping of the governor repeater relay GP caused closure of its back contacts 70 and 71 to thereby close a special stick circuit for the auxiliary relay AR which may be traced from the terminal (+), back contact 44 of relay CRP, back contact 70 of relay GP, upper contact 67 of the suppression air switch SAS, back contact 71 of relay GP, and stick contact 61 of the relay AR, through the winding of this relay to the other terminal (—). The relay AR is therefore maintained energized and holds its back contact 45 open to prevent sounding of the acknowledging horn AckH. It also maintains its front contact 26 closed to thereby maintain the device EPV in its energized condition.

The next time that the acknowledging cam 15 reaches its normal position, with the roller 69 in the notch of the cam 15 the opening of contacts 58 with the lower contact 67 of air switch SAS open and the contact 63 of the relay GP and the contacts 56 of the relay AckP open, causes deenergization of the acknowledging motor

AckM to thereby cause it to discontinue its operation. It is thus seen that recurrent acknowledgment is not required when the train is moving below 6 M. P. H. in restricted territory with the brakes applied.

Should traffic conditions in advance now become favorable resulting in the picking up of the main control relay CR the closing of its front contact 41 will relight the clear lamp G and the opening of its back contact 42 will extinguish the yellow lamp Y. Also, closing of its front contact 41 will sound the bell BLL through a circuit including this contact 41 and the back contact 48 of the relay CRP. This bell will, however, be sounding for a short time only, to manifest that full speed may be resumed, because the picking up of the relay CR will be followed after a short time by the picking up of its repeater relay CRP, which is slow acting, to thereby open its back contact 48 included in a circuit of the bell BLL.

The picking up of the control repeater relay CRP will by the closure of its front contact 23 result in the picking up of the relay GP which by the opening of its back contacts 70 and 71 will result in the dropping of the auxiliary relay AR. With the auxiliary relay AR deenergized the original circuit for the brake control relay SA1 is closed. This circuit includes the contacts 24, 25 and 26 of the relays CRP, GP and AR respectively. The picking up of relay SA1 will of course result in the picking up of the relay SA2 and the electro-pneumatic valve EPV so that the engineer may release the brakes by suitably manipulating his engineer's brake valve handle. The engineer's bringing of the train to a full stop under the conditions just assumed cannot be considered a penalty because it is presumed that the engineer for safety reasons brought his train to a stop voluntarily. Had the engineer failed to make a manual application of the brakes when he originally entered restricted territory at a speed in excess of 30 M. P. H. the brakes would have been maintained applied automatically until the train was brought to a full stop (below 6 M. P. H.), and in this case it could have been considered a penalty because there is a possibility that the train might have advanced much nearer to the obstruction in advance if the engineer had taken appropriate action by he himself making a manual brake application.

Thus far nothing has been said about the need for the circuit including the contact 67 of the suppression air switch SAS when it is in its normal lower position. This contact is used to permit the train to proceed at less than 6 M. P. H. with the brakes released under recurrent acknowledgment enforcement in restricted territory. Under this condition the back contact 47 of the relay CRP is closed and since front contact 63 of the relay GP is now open as is also true of the front contact 56 of the relay AckP, the motor AckM would come to a stop as soon as the normal position of cam 15 is reached were it not for the normally closed contact 67 of the suppression air switch SAS. In other words, under the condition assumed, acknowledgment is enforced and the brakes are permitted to be in a released condition by reason of the circuit for the acknowledging motor AckM beginning at the terminal (+) and extending through back contact 47 of the relay CRP, normally closed contact 67 of the suppression switch SAS, and field and armature winding of the motor AckM in multiple, to the other terminal (—) of the same source. By this construction the train is permitted to proceed in

restricted territory at less than 6 M. P. H. with the brakes released but with the requirement of recurrent acknowledgment at 1.5 minute time intervals. Similarly, the upper contact 67 of the air switch SAS in combination with the back contact 71 serves to provide a stick circuit for the auxiliary relay AR when the speed of the train is below six miles per hour and the brakes are applied. In other words, lower contact 67 and contact 63 in multiple therewith and both open, and also upper contact 67 and contact 71 in series therewith and both closed manifest that the train will actually be brought to a full stop. This construction is resorted to because it is impossible to build a centrifuge speed contact that manifests zero speed. A centrifuge contact will upon a reduction of speed either produce a contacting function before zero speed is reached or else will not produce a contacting function at all. In other words, the series and multiple contact arrangement just mentioned has been resorted to as a means for manifesting zero speed in that a train will stop within a few feet if the speed is once as low as 6 M. P. H. and the brakes are actually applied. If desired the back contact 71 of the relay GP may be omitted in which event the requirement of recurrent acknowledgment cannot be dispensed with, even at zero speed, unless the engineman has made a manual brake application.

STRUCTURE—FIG. 2

In Fig. 2 of the drawings has been illustrated a modified form of the invention which employs all of the same electrical and pneumatic devices as employed in Fig. 1 but these electrical devices are interconnected differently and this system performs functions some of which are different. Referring to Fig. 2 all of the devices illustrated are of exactly the same construction as those shown in Fig. 1 except that the recurrent acknowledging motor and cam structure including the motor AckM, includes an additional cam 17. Also the cams 15 and 17 of Fig. 2 are, when operated, driven one revolution in substantially 100 seconds (1½ minutes) whereas the cam 15 of Fig. 1 is, at times, driven one revolution in 90 seconds (1½ minutes). This cam 17 is used to interrupt a stick circuit for the governor repeater relay GP a predetermined period of time after initiation of the motor. This interruption of the stick circuit occurs about 75 seconds after an acknowledging act has been performed by the engineer following the entrance of the train into restricted territory.

The main control relay CR and the repeater relay CRP are controlled in exactly the same way as they are in Fig. 1 and for this reason like relay contacts have been assigned like reference numbers. All of the devices illustrated in Fig. 2 have been assigned the same reference character as in Fig. 1 but contacts performing different functions have been assigned different reference characters. The brake applying relay SA1 is normally energized through a circuit including the front contact 100 of the relay CRP, the front contact 101 of the relay GP, and the back contact 26 of the relay AR. The repeater brake applying relay SA2 and the electro-pneumatic valve EPV are controlled in exactly the same way as in Fig. 1 and for which reason the contacts involved in their control circuits have been assigned like reference numbers. The governor repeater relay GP is normally energized through a circuit which may be traced from the terminal (+) of a suitable source of car carried current, governor con-

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tact 63S, which is closed for all speeds below 63 miles per hour, and front contact 102 of the relay CRP. All of the rest of the electro-responsive devices are normally deenergized. It is believed that the difference between the system shown in Fig. 2 and that shown in Fig. 1, particularly with respect to the difference in functioning of the systems, is best understood by considering the operation of the system under various traffic conditions. Other speed limits may obviously be used, and it may be pointed out that the speed limits chosen for Fig. 1 apply more particularly to passenger service whereas the speed limits imposed by the Fig. 2 structure more particularly apply to freight service.

OPERATION—FIG. 2

The operation of the system shown in Fig. 2 will be considered under three main headings, namely, "Traffic conditions clear," "Traffic conditions change from clear to restrictive," and "Traffic conditions change from restrictive to clear" together with suitable subheadings.

Traffic conditions clear

The governor Gov (Fig. 2) has been shown in its zero-speed position and it is readily seen that as the speed increases the speed contacts 6S, 23S, 33S and 63S are successively opened. The speed contact 6S is open for all speeds above 6 M. P. H., the contact 20S closes when the speed has been increased to 20 M. P. H. and remains closed for all speeds above 20 M. P. H., the contact 23S is open for all speeds above 23 M. P. H., the contact 33S is open for all speeds above 33 M. P. H., and the contact 53S is open at all speeds above 63 M. P. H. Obviously, other speed values may be employed, if desired.

Let us now assume that traffic conditions are clear and that the train speed is increased to a point slightly above 63 M. P. H. where the contact 63S opens. The opening of the contact 63S of the governor Gov results in deenergization of the governor repeater relay GP. This causes the back contact 104 of relay GP to close and sound the speed horn SH. It also causes the front contact 101 of the relay GP to open to in turn cause deenergization of the brake control relay SA1. This relay SA1 is, however, slow dropping and will not open its front contact 32 for about three seconds. The sounding of the speed horn SH informs the engineer that he has exceeded his maximum speed limit and that he must reduce his speed to avoid a brake application. The brake applying repeater relay SA2 is also very slow dropping and will not open its contact 33 until about three seconds after the relay has been deenergized. The engineer has thus available to him about six seconds between the dropping of the relay GP, due to running at over-speed in clear territory, and the dropping of the electro-pneumatic valve EPV in which time he may himself take appropriate action to avoid an automatic brake application.

Since all of the three speed contacts 6S, 23S and 33S are open the engineer cannot successfully perform an acknowledging act by the depression of his acknowledging push button AckPB. The engineer may, however, make a manual brake application before actual deenergization of the electro-pneumatic valve EPV takes place and in so doing may maintain the penalty relay PR energized through a stick circuit including a front contact 65 of this penalty relay PR and including the contact 66 of the sup-

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pression air switch SAS. If the engineer makes a manual brake application as just assumed his train speed will be reduced and since it is assumed that traffic conditions in advance are clear and the relay CR and CRP are in their energized position the reduction in the speed of the train below 63 M. P. H. will result in the reenergization of the governor repeater relay GP and all of the apparatus will be restored to its normal condition without the imposition of a penalty. The speed horn SH is thus sounded so long as the speed of the train is above 63 M. P. H. Had the engineer not made a manual brake application an automatic brake application would have occurred and this automatic brake application could have been manually released as soon as it had caused a speed reduction to below 63 M. P. H. Under this condition no penalty would have been inflicted upon the engineer in that the apparatus may be restored to its normal condition as soon as the speed of the train has been reduced below its maximum speed limit of 63 M. P. H. In another modification of the present invention, as shown partially in Fig. 3, however, a penalty would have been imposed upon the engineer had he himself not made a manual brake application during temporary over-speed condition of the train in clear territory.

Speeds below over-speed.—The system illustrated in Fig. 2, under clear traffic conditions in advance, permits the engineer to operate his train at any speed between zero and the maximum imposed speed of 63 M. P. H. without causing the operation of any of the apparatus illustrated in Fig. 2, that is, without sounding any speed horn or any acknowledging horn or changing any lights except that the indicating light W is energized for all speeds above 20 M. P. H. and is deenergized and extinguished for all speeds below 20 M. P. H.

Traffic conditions change from clear to restrictive

When speed is between 33 and 63 miles per hour.—Let us assume that a train equipped with the apparatus illustrated in Fig. 2 is moving at a speed between 33 and 63 miles per hour at the instant traffic conditions in advance become restrictive resulting in the deenergization of the main control relay CR and its repeater control relay CRP. Dropping of the relay CR by the opening of its front contact 20 will cause deenergization of the repeater control relay CRP and by the dropping of its contact 41 will extinguish the green light G and light the caution light Y. Dropping of the repeater control relay CRP will cause sounding of the speed horn SH by the closure of a circuit which may be traced from the terminal (+) of a suitable source of current through speed governor contact 20S, back contact 105 of the relay CRP and the speed horn SH to the other terminal (−) of the same source of current. Dropping of the contact 100 of the relay CRP results in deenergization of the brake control relay SA1 whereas dropping of the contact 102 of the relay CRP results in the normal energizing circuit for relay GP being broken and results in the establishment of a stick circuit for this relay including the cam operated contact 157 operated by the cam 17, stick contact 108 of the relay GP, and the back contact 102 of the relay CRP.

As heretofore pointed out six seconds will elapse between the time of deenergization of the relay SA1 and the time of deenergization of the electro-pneumatic valve EPV. Since the speed of the train is now above 33 M. P. H. all of the speed

governor contacts 6S, 23S and 33S are deprived of energy so that acknowledgment of restrictive traffic conditions by the engineer depressing his acknowledging push button AckPB is impossible. The engineer may, however, make a manual brake application and if he makes such manual brake application before the electro-pneumatic valve EPV is actually deenergized he will cause actuation of the suppression air switch SAS resulting in the closure of contacts 66 and 67 of which the contact 66 completes a stick circuit for the penalty relay PR so that this penalty relay will not assume its deenergized position in spite of deenergization of the electro-pneumatic valve EPV. Eventual deenergization of the electro-pneumatic valve EPV will produce no particular result in that the brakes of the train have already been applied manually.

As a result of this manual brake application the speed of the train will be reduced and if the speed is reduced to 33 M. P. H. the contacts 60, 109 and 110 of relays PR, GP and CRP being closed, the engineer may cause the electro-pneumatic valve EPV to be reenergized by performing an acknowledging act consisting of the depression of his acknowledging push button AckPB. Depression of the push button AckPB results in closure of the following circuit for speeds just below 33 M. P. H.: beginning at the terminal (+) of a suitable source of current speed governor contact 33S, front contact 109 of the relay GP, back contact 110 of the relay CRP, acknowledging push button contact 50, winding of the relay AckP, to the other terminal (-) of this same source of current. The completion of this circuit causes the relay AckP to be picked up and stuck up through a stick circuit including in addition to contacts 109 and 110 just mentioned the stick contact 51 of this relay AckP and the normally closed contact 52 controlled by the acknowledging cam 15. The picking up of the acknowledging relay AckP will cause energization and operation of the acknowledging motor AckM through a circuit including the front contact 112 of the relay AckP. As soon as this acknowledging motor AckM gets up to speed it closes the contact 18 of the centrifuge CF to thereby close an energizing circuit for the acknowledging repeater relay AR. This circuit may be traced from the same source through the speed governor contact 33S, through front contact 109 of the relay GP, back contact 110 of the relay CRP, front contact 60 of the relay PR, contact 18 of the centrifuge CF, front contacts 54 and 55 of the relay AckP, through the winding of the relay AR to the other terminal (-). With this relay AR once picked up the sounding of the acknowledging horn AckH ceases, due to opening of back contact 45 of this relay AR, and this relay is stuck up through a stick circuit including its stick contact 61 and including all of the contacts including in the pick-up circuit just traced exclusive of front contact 55 of relay AckP.

The operation of the recurrent acknowledging mechanism including the cams 15 and 17 will result in closure of the normally open contacts 57 and 58 operated by the cam 15 and will result in the opening of the normally closed contact 52 operated by this cam to thereby cause deenergization of the acknowledging relay AckP. The acknowledging repeater relay AR will, however, not be deenergized because its stick circuit including its stick contact 61 is still intact in that the now closed contact 57 operated by

cam 15 has been substituted for the front contact 54 of the acknowledging relay AckP. The opening of the normally closed contact 52 operated by the cam 15 is, however, broken to thereby cause deenergization of the acknowledging relay AckP. The brake control relay SA1 is now energized through a circuit which may be traced from the terminal (+) of a suitable source of current, governor contact 33S, front contact 109 of relay GP, back contact 110 of relay CRP, normally closed contact 29 of the acknowledging push button AckPB, and front contact 26 of the relay AR.

Although the engineer may now release the brakes, the electro-pneumatic valve EPV having been reenergized, he must not release these brakes unless he is convinced that the speed of the train will have been reduced to a speed below 23 M. P. H. before 75 seconds have elapsed since he started the recurrent acknowledging apparatus into operation by depressing his push button AckPB. This 75 second time limit is imposed by the cam 17 which through the medium of a roller opens the contact 107 at a time 75 seconds after initiation of operation of the cam 17. If the engineer feels sure that his train speed will have been reduced to 23 M. P. H. before this 75 second time interval has elapsed he may release his brakes and if he does and the speed contact 23S closes before the cam operated contact 107 opens and deenergizes relay GP a new stick circuit will be established for the acknowledging repeater relay AR and including speed contact 23S. This circuit may be traced as follows: beginning at the terminal (+) governor contact 23S, back contact 110 of the relay CRP, front contact 60 of the penalty relay PR, centrifuge contact 18, normally open contact 57 operated by the cam 15, and stick contact 61 of the relay AR through the winding of this relay AR and then to the other terminal (-) of this same source of current. As soon as the recurrent acknowledging cycle has been completed and the normally open contact 57 is again opened, resulting in the dropping of the relay AR, the engineer is apprised of this fact by the sounding of the acknowledging horn AckH and is required to make another acknowledging act. By depressing the push button AckPB the acknowledging relay AckP and its repeater relay AR are again picked up, in this sequence, to thereby reestablish the heretofore traced energizing circuit for the brake control relay SA1 through front contact 26 of relay AR. The present invention therefore provides a very unusual feature in the train control system illustrated in Fig. 2 in that it allows the engineer 75 seconds to reduce his speed to 23 M. P. H. after having made an acknowledging act after the speed has been reduced to 33 M. P. H. This feature actually permits the engineer to start releasing his brakes before the speed has been actually reduced to 23 M. P. H. in that a considerable amount of time is involved in completely recharging the brake pipe and by the provision of these features the engineer may actually start releasing the brakes before the prescribed speed limit of 23 M. P. H. has been reached.

When speed is between 23 and 33 miles per hour.—If the train is moving at a speed between 23 and 33 M. P. H. when traffic conditions change from clear to restrictive the engineer may perform an acknowledging act immediately in that the acknowledging circuit including the speed contact 33S was closed at the time a change of

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traffic conditions took place. If the engineer makes this acknowledging act and he removes motive power from his locomotive to a sufficient extent to bring the speed of the train below 23 M. P. H. before the 75 second interval imposed by the cam 17 and its associated cam contact 107 has elapsed, the engineer need not make a manual brake application. If the speed is reduced to 23 M. P. H. or less during the 75 second interval the engineer must still, however, make a recurrent acknowledging act every 100 seconds by reason of the fact that it requires 100 seconds to rotate the cam 15 one complete revolution and the fact that this cam 15 imposes a reacknowledgment for each revolution. When traffic conditions change from restrictive to clear the brakes may be released without the imposition of a penalty which is ordinarily imposed by the penalty relay PR. In the modification of Fig. 3 such penalty is, however, imposed.

When speed is between 6 and 23 miles per hour.—If the speed of the train is between 6 and 23 M. P. H. when traffic conditions change from clear to restrictive it is only necessary for the engineer to make a recurrent acknowledging act every 100 seconds in that this will avoid an automatic brake application, it being understood, however, that he should not allow the speed of the train to exceed 23 M. P. H. after the first 75 seconds following the first acknowledgment have elapsed.

When speed is below 6 miles per hour.—The 6 miles per hour speed contact is primarily provided to manifest that the train is practically at a stop. In this connection it should be understood that if the brakes of the train are applied when the train is operating at a speed of 6 miles per hour it is impossible to release the brakes before the train has come to a full stop. In other words, the 6 M. P. H. speed contact is provided to manifest that the train is substantially at a stop. This 6 miles per hour governor contact 6S may be used to remove the burden and responsibility of recurrent acknowledgment while the train is being held at stop in restrictive territory. It will be seen that if a manual brake application is in effect a stick circuit may be traced for the acknowledging repeater relay AR which stick circuit includes the speed governor contact 6S, the back contact 114 of the relay CRP, the contact 67 of the suppression air switch SAS, and the stick contact 61 of the relay AR and under this condition the brake control relay SAI is energized through a circuit including the speed contact 23S, the back contact 110 of the relay CRP, the normally closed contact 29 of the acknowledging push button AckPB, and front contact 26 of the relay AR. It is thus seen that recurrent acknowledgment is not required if the brakes have been manually applied and the train is standing still or is moving at a speed of less than 6 miles per hour even though restrictive traffic conditions in advance are then existent.

Traffic conditions change from restrictive to clear

If traffic conditions become favorable after the train has operated in restrictive territory either because it enters a track section where clear traffic conditions exist or because traffic conditions have cleared up in the track section in which the train is operating, the train control relays CR and CRP will be picked up in that order. The picking up of the relay CRP will by the opening of its back contact 110 or 114 or both cause de-energization of the acknowledging relay AR,

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which latter relay by the closure of its back contact 26 will reestablish the original energizing circuit for the brake applying relay SAI. The engineer is apprised of the picking up of relay CR by the extinguishment of his yellow light Y and the light of his green light G. If a manual brake application was in effect or if the brakes were automatically applied the engineer may now release the brakes and resume speed. Since the engineer may not at this instant be looking at his cab signal he is also audibly informed that traffic conditions have changed from restrictive to clear by the sounding of the clear bell BLL. This clear bell is sounded by reason of the fact that the relay CR closes its front contact 41 before its repeater relay CRP opens its back contact 48. The bell BLL is thus sounded through a circuit including these contacts 41 and 48 in series. The upper winding of the governor repeater relay GP is connected in multiple with the bell BLL, this circuit having been provided so that the relay GP picks up and opens its back contact 104 before the front contact 105 of relay CRP is closed, this in order to avoid a momentary sounding of the speed horn SH. A change of traffic conditions from restrictive to clear thus returns all of the automatically controlled apparatus to its original and normal condition and this enables the engineer to release the brakes and operate his train in any manner he desires so long as he does not increase the speed of the train above its maximum speed limit which in the particular embodiment of the invention illustrated in Fig. 2 is 63 M. P. H.

Automatic brake application results in penalty in restrictive territory

The penalty imposed by an automatic brake application in restrictive territory resides in the requirement that the engineer bring his train speed below 6 miles per hour. This reduction in train speed by a brake application is equivalent to bringing the train to a full stop, in that the brakes cannot be fully released, if recharging of the brake pipe is started after the train speed has been reduced to 6 miles per hour, until the train is brought to a complete stop. After the engineer has accepted his penalty by bringing his train to a full stop, assuming restrictive territory, he is required to perform an acknowledging act which results in the picking up of the electro-pneumatic valve EPV. The picking up of the electro-pneumatic valve EPV will close a pick-up circuit for the penalty relay PR and this penalty relay PR will then through the circuit including its front contact 60 allow the train to operate at a speed of 23 miles per hour.

As is readily ascertained from the circuits of Fig. 2 the penalty imposed by the penalty relay PR is cancelled, under both conditions of an overspeed during clear traffic conditions or under conditions of excessive speed during restrictive traffic conditions, as soon as clear traffic conditions in advance of the train again exist. Some railway signal men may desire to have the penalty of bringing the train to a full stop, which under certain conditions is imposed by the penalty relay PR, carried out for each automatic application of the brakes irrespective of whether or not traffic conditions change to clear. In order to illustrate how the system of Fig. 2 may be modified to impose this penalty under all automatic brake applications a modified form of the system shown in Fig. 2 has been illustrated in Fig. 3 of the drawings.

STRUCTURE—FIG. 3

The system of Fig. 3 is identical to the system illustrated in Fig. 2 with the exception that a front contact 115 has been added to the penalty relay PR and has been included in the energizing circuit for the repeater control relay CRP. It is readily seen that the inclusion of this front contact 115 in the energizing circuit of the repeater control relay CRP will require reenergization of this penalty relay PR after it has once been dropped and it is readily seen from the drawing that this penalty relay PR can only be picked up after a manual brake application has been made (contact 67 closed) and then only if the speed of the train has been reduced to less than 6 miles per hour (contact 6S closed) in that the acknowledging repeating relay AR can only be picked up at a speed of less than 6 miles per hour when the penalty relay PR assumes its deenergized condition.

One of the features of the air brake system employed in the system disclosed resides in the provision of means requiring the engineer to operate his engineer's brake valve EBV to the lap position and then to the release position in order to release the brakes. This is a dead-man protection, in that a peculiar and double manipulation is necessary such as a dead man is not apt to make. This feature is not part of applicant's invention but is a feature entering into the manipulation of the system and for this reason is briefly mentioned.

Having thus shown and described three specific embodiments of the present invention it should be understood that the particular embodiments illustrated are not necessarily the embodiments which are preferably employed in practicing the invention, especially insofar as the control of the penalty relay PR is concerned in that this penalty relay in practice is preferably a pneumatic relay which is controlled by pneumatic apparatus in a manner equivalent to that in which it is electrically controlled by the devices EPV and SAS, and it should be understood that the particular embodiments illustrated have been selected for the purpose of facilitating description of apparatus which is capable of performing the functions desired to be performed and which are accomplished rather than the specific apparatus preferably employed in practicing the invention, and that various changes, modifications and additions may be made to meet the various problems encountered in practicing the invention without departing from the spirit or scope of the invention, except as demanded by the scope of the following claims.

What I claim as new is:

1. An automatic train control system comprising, a vehicle carried control relay controlled in accordance with traffic conditions in advance and energized when traffic conditions in advance are favorable, a speed responsive contact closed only if the speed of the vehicle is below a predetermined value, a brake control device, an audible speed signal, an audible acknowledging signal, means for holding said brake control device inactive when said control relay assumes an energized condition, means for sounding said audible speed signal so long as said control relay assumes its deenergized position and said speed responsive contact is open, other means for holding said brake control device inactive when the speed of the vehicle has been reduced to a value where said speed responsive contact is closed effective only if the engineer himself maintained the brakes

applied so long as said speed responsive contact was open and said control relay assumed its deenergized condition, said other means also including means for intermittently sounding said acknowledging signal and an acknowledging device which must be intermittently manually operated once for each sounding of said acknowledging signal.

2. An automatic train control system comprising, a vehicle carried control relay controlled in accordance with traffic conditions in advance and energized when traffic conditions in advance are favorable, a speed responsive contact closed only if the speed of the vehicle is below a predetermined value, a brake control device, an audible speed signal, means for holding said brake control device inactive when said control relay assumes an energized condition, means for sounding said audible speed signal so long as said control relay assumes its deenergized position and said speed responsive contact is open, other means for holding said brake control device inactive when the speed of the vehicle has been reduced to a value where said speed responsive contact is closed effective only if the engineer himself maintained the brakes applied so long as said speed responsive contact was open and said control relay assumed its deenergized condition, said other means also including an acknowledging device which must be intermittently manually operated once for each predetermined period of time.

3. An automatic train control system comprising, a vehicle carried control relay controlled in accordance with traffic conditions in advance and energized when traffic conditions in advance are favorable, a speed contact closed only if the vehicle speed is below a predetermined value, a normally energized brake control device controlled by said relay and said speed contact, and acknowledging means for holding said brake control device inactive in spite of deenergization of said control relay effective only if the vehicle speed does not exceed said predetermined value but is in excess of a predetermined lower value and requiring the performance of successive substantially equally spaced acknowledging acts by the engineer, said acknowledging means also including means for rendering it effective at a speed below said predetermined value effective only if the brakes are in the released condition.

4. In a continuous train control system, vehicle carried apparatus comprising in combination, a normally energized control relay that is deenergized upon entrance of the vehicle into a restricted section, a governor driven in accordance with the speed of the vehicle having contacts closed at respective medium and low speeds, an audible acknowledging signal, manually operable acknowledging means, penalty means including an electro-pneumatic valve effective when actuated to automatically apply the brakes of the vehicle continuously until the vehicle is substantially brought to a stop, irrespective of any attempt subsequent to its actuation to release the brakes manually so long as the vehicle is in a restricted section, suppressed braking means including contacts actuated by said governor effective at said low speed to permit the vehicle to proceed at or below said low speed in a restricted section without brake application and without rendering said penalty means actuated, provided that said acknowledging means be intermittently actuated, circuit means including said medium speed contacts for energizing said acknowledging signal when the vehicle is in a restricted section

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upon reduction of the speed of the vehicle to said medium speed, and brake penalty control means including contacts actuated by said governor rendering said penalty means actuated when the vehicle enters a restricted section at a speed above said medium speed unless the brakes are manually applied continuously until said medium speed contacts are closed, said penalty brake control means being effective to forestall actuation of said penalty means without the brakes being applied only for a single predetermined time interval provided that said acknowledging means has been actuated and provided that the speed of the vehicle is at or below said medium speed but above said low speed when the vehicle is in a restricted section.

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