Dec. 30, 1952 J. F. KEY 2,623,990

TRAIN CONTROL

Filed June 7, 1947 2 SHEETS—SHEET 1

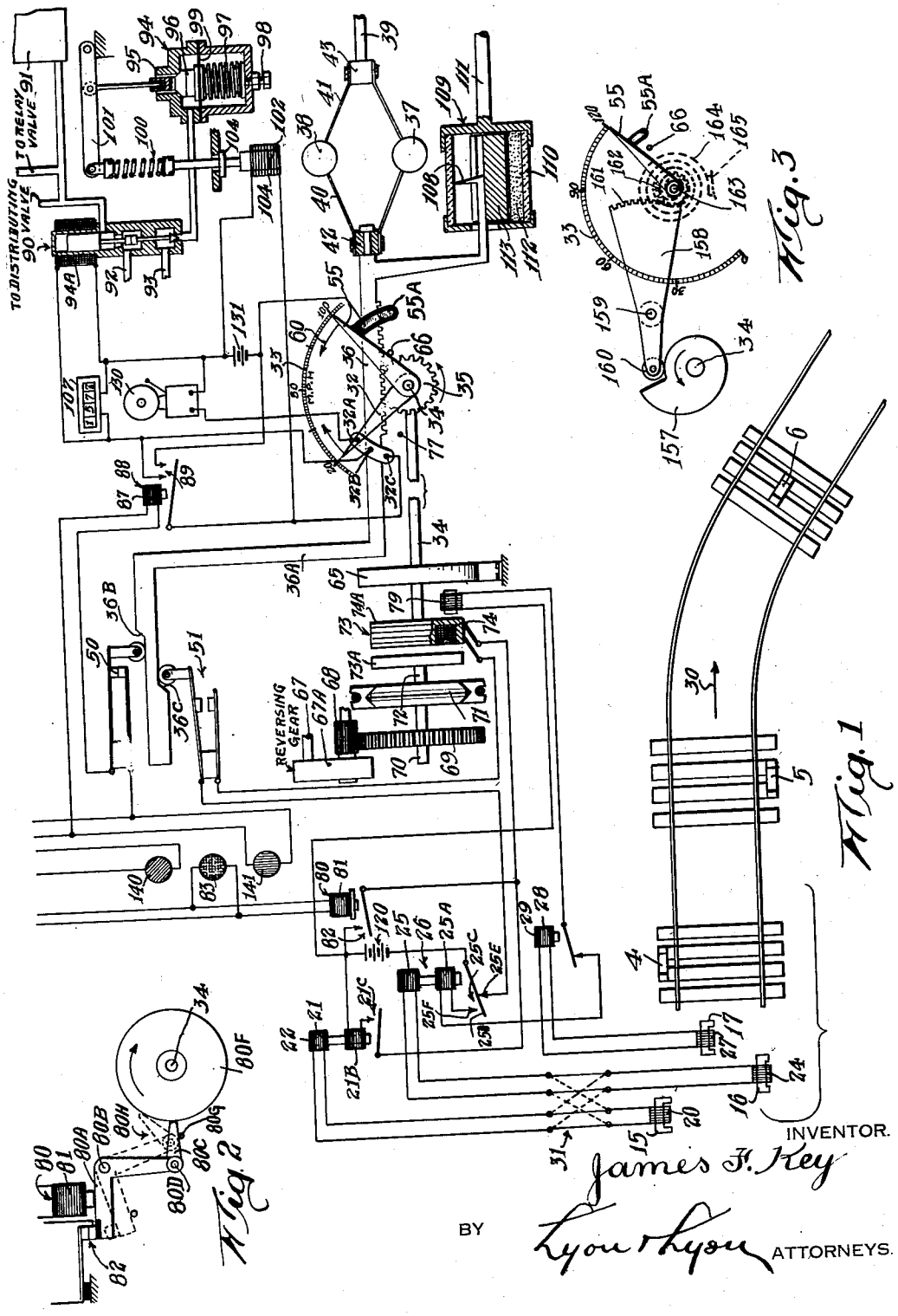


Fig. 1

Fig. 2

Fig. 3

Dec. 30, 1952 J. F. KEY 2,623,990

TRAIN CONTROL

Filed June 7, 1947 2 SHEETS—SHEET 2

Fig. 4

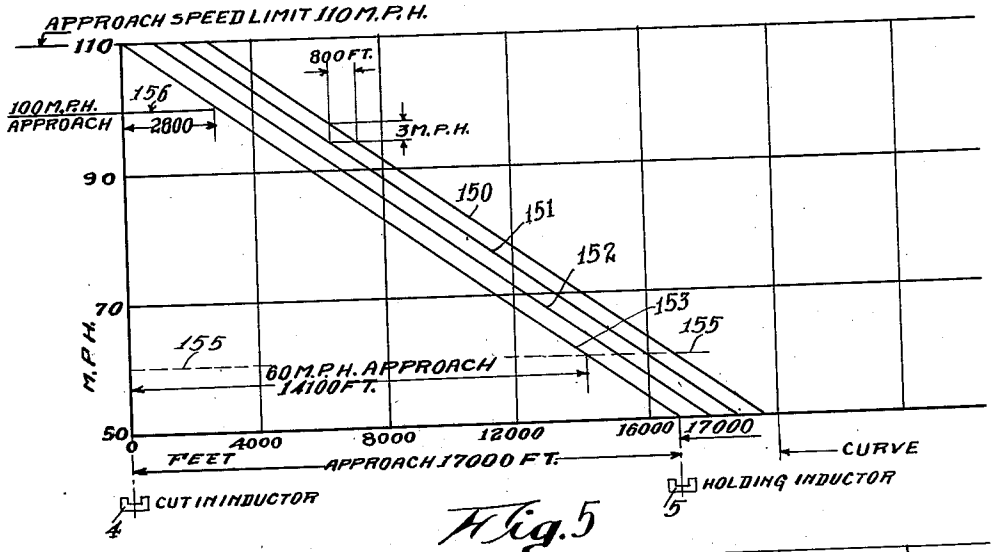
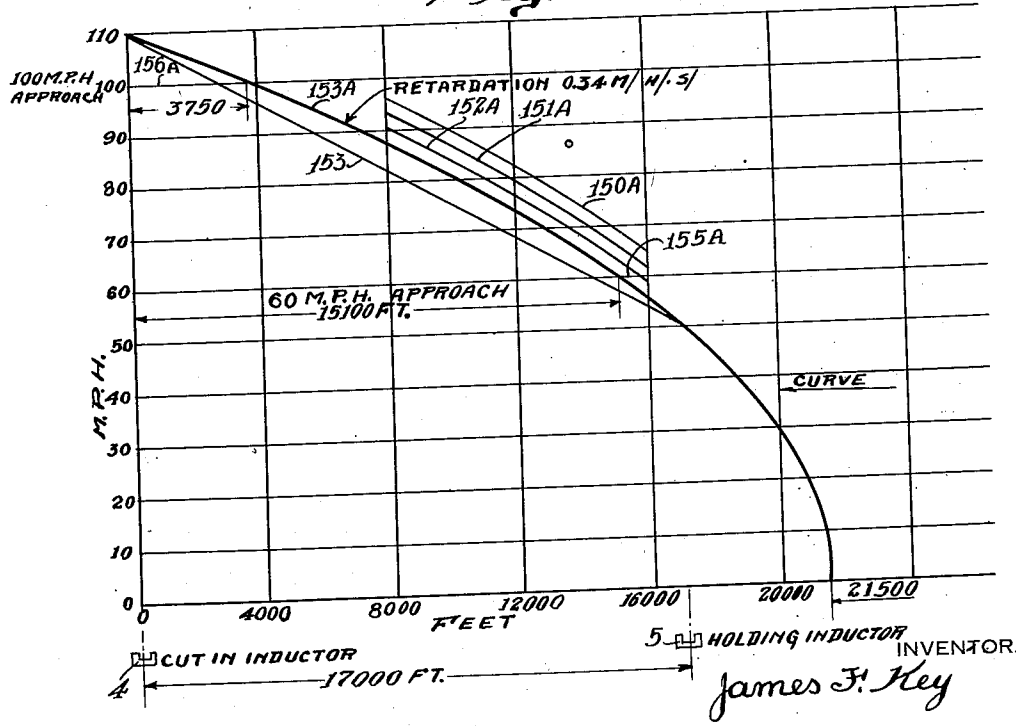


Fig. 5



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Patented Dec. 30, 1952 2,623,990

UNITED STATES PATENT OFFICE

2,623,990

TRAIN CONTROL

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Application June 7, 1947, Serial No. 753,242

2 Claims. (Cl. 246—182)

1

The present invention relates to a control system particularly useful in the operation of trains.

An object of the present invention is to provide an improved train control system having novel means incorporated therein whereby the deceleration of the train may be controlled in accordance with a predetermined plan to avoid excessive speeds on curved portions and approaches thereto of the train track.

Still another object of the present invention is to provide an improved train control system responsive to both speed of the train and also to the distance traveled by the train for either producing an indication of excessive speed or for automatically applying the brakes on the train.

Still another object of the present invention is to provide an improved train control system useful to prevent a train from going around a curved portion of track at excessive speeds.

Yet another object of the present invention is to provide an improved train control system incorporating means whereby trains may pass around curved tracks at the maximum prescribed speed for that particular stretch of track without exceeding such prescribed speed.

Still a further object of the present invention is to provide an improved train control system incorporating means whereby a train traveling at an excessive speed in entering an approach zone may be decelerated in a prescribed manner so that when the train enters the curved portion of the associated track the train travels at the particular speed prescribed for that particular curve; a subsidiary object being that each train, whether it is a passenger or a freight train, has adjustable means whereby the prescribed speed may be altered.

Yet another object of the present invention is to provide an improved train control system useful in safely operating trains around curves with certain portions of the system being useful also in controlling the train in a block system, especially the type of block system with automatic cap signals which indicate the condition of the various blocks.

Still another object of the present invention is to provide an improved train control system incorporating means useful for conjoint operation in both block systems and also on curves; and, in those instances where the block includes a portion of the curve, the most restrictive signal has the greatest priority either in indicating such most restrictive condition or effecting automatically suitable controls on the train.

Still a further object of the present invention

2

is to provide an improved control system including a visible dial and movable hands associated therewith especially useful for the safe operation of trains around curves, the system being effective to assure a predetermined deceleration in the approach to a curve and to assure constant speed around the curve; and, a subsidiary feature being that such system may be incorporated in block signals to produce prescribed deceleration when the train passes through the block against a restrictive signal.

Still another object of the present invention is to provide an improved safety control system which remains inoperative and to which the operator of a train need pay no attention so long as he operates the train safely but which is effective to produce either an alarm or to automatically apply brakes in the event he operates the train unsafely.

Still a further object of the present invention is to provide an improved self-erasing recorder characterized by its simplicity, ruggedness and the fact that it requires substantially no attention, timing clock or paper and is effective at any one particular time to indicate previous events in enlarged scale.

Still a further object of the present invention is to provide an improved train control system operable upon excessive speeds in either an approach to a curve or in a block system, the system being capable to operate in a novel manner the brakes of the train with different degrees of braking force, depending upon the degree of excess speed.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. This invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings in which:

Figure 1 is a diagrammatic representation including structural features of apparatus embodying the present invention.

Figure 2 shows a modified structure for producing a delayed action in the operation of relay 81 whereby the associated train travels approximately 200 feet after relay coil 81 is deenergized and before switch 82 opens, in which case the delayed action of the relay coil 81 is substantially independent of the speed at which the train travels.

Figure 3 shows modified apparatus for coupling the shaft 34 to the pointer 55.

Figure 4 is a graphical representation useful in describing certain features of the present invention in the apparatus shown in Figure 1.

Figure 5 is a graphical representation similar to the representation shown in Figure 4 useful in describing other features of the present invention when the apparatus shown in Figure 1 is modified in accordance with the disclosures of Figure 3.

In accordance with the present invention I provide a system and apparatus initially energized by one or more inductors in the approach zone to a curve which is useful in decelerating the train to the prescribed speed for that particular curve and to automatically indicate that prescribed speed when the train either approaches or travels around the curve. This apparatus is useful for safe passage around a curve and is adapted to also assure safety in block systems in accordance with the present invention.

Referring to Figure 1, there is indicated in the lower left portion thereof a section of a track and as indicated therein the section includes an approach zone and a contiguous curve, there being a so-called "cut in" inductor 4 mounted on the left side of the track at the beginning of the approach zone, a so-called "holding inductor" 5 mounted on the right side of the track at the junction of the approach zone with the curved length of track and a so-called "cut out" inductor 6 mounted midway between the two rails of the track and at the end of the curved portion of the track. These three inductors may be of conventional structure and may, for example, be of the type shown on page 435 of the "Scientific American" for May, 1929. Also, each one of these inductors may simply comprise a soft iron magnetic member arranged to cooperate with a permanent magnet structure carried by the locomotive passing over the inductor to change the amount of flux threading a coil mounted on such permanent magnet structure.

In Figure 1 there are three such inductors 4, 5 and 6 and correspondingly there are three cooperating receiver inductors 15, 16 and 17 on the train or locomotive. The coil 20 on the receiver inductor 15 has its opposite terminals connected respectively to opposite terminals of the actuating winding 21 of relay 22; the winding 24 on receiver inductor 16 has its opposite terminals connected respectively to opposite terminals of the actuating winding 25 of relay 26; and the winding 27 has its opposite terminals connected respectively to opposite terminals of the actuating winding 28 of relay 29.

In the event that the locomotive carrying the receiver inductors 15, 16 and 17 is driven with its back end forward in the same direction along the track indicated by the arrow 30, the reversing switch 31, represented in diagrammatic form, may be actuated to connect winding 24 with winding 21 and to simultaneously connect winding 20 to winding 25 as indicated by the dotted lines. This particular configuration of inductors on the track and locomotive with the reversing means 31 indicated by the dotted lines allow the train to be moved around the track in the direction indicated by the arrow 30 either with the forward end of the locomotive forward or with the rear end of the locomotive forward, as will be more readily apparent from the folowing description.

The speed of the locomotive is indicated by the pointer 32 cooperating with its scale 33. The pointer 32 is mounted for rotation about shaft

34 and has affixed thereto gear wheel 35 arranged to cooperate with and to be actuated by the rack member 36 whose longitudinal position is determined by the pair of centrifugally urged fly ball members 37, 38. The fly balls 37, 38 are revolved upon rotation of the axle 39 which is connected in conventional manner to indicate the speed of a locomotive axle. The members 37, 38 are attached by spring elements 40 and 41, respectively, to collars 42 and 43 respectively on rack member 36 and shaft 39. The collar 42 cooperates with the rack member 36 to move it longitudinally but to allow rotational movement of the collar 42, while on the other hand, collar 43 is preferably rigidly affixed to the shaft 39.

The speedometer elements 37, 38 besides acting as such, serves also as a governor as will be more evident as this description continues.

The rack 36 has an extension 36A with cam surfaces 36B and 36C arranged to actuate switches 50 and 51, respectively.

The pointer 32 is freely rotatable on the shaft 34 in accordance with movement of the rack 36 but the other dial pointer 55 is rigidly coupled to shaft 34 and moves in response to rotary motion imparted thereto in a manner described later. The dial pointers 32 and 55 each carry mutually cooperating switch contacts. The insulated contact member 55A carried on pointer 55 is arranged to contact, in turn, the contacts 32A, and 32B and 32C on pointer 32, in that order. It is noted that in the movement of the pointer 55 in the direction indicated by the arrow 60, initially contact 55A engages contact 32A and then contact 32B and then contact 32C.

The pointer 32 is referred to herein as the speed indicating pointer while the pointer 55 is referred to as the speed limiting pointer. It is evident that the position of pointer or hand 32 is dependent solely upon the speed of the train on which it is mounted; and, it will be evident that the position of the hand 55 is dependent solely on the distance traveled by the train measured from the position of the cut in inductor 4 mounted at a predetermined position on the track.

The pointer 55 is driven by shaft 34 which is normally biased by the torsion spring 65 to a position wherein the pointer 55 normally is at its extreme right position againts the stop member 66, the inner end of the torsion spring 65 being attached to the shaft 34 and the other end of the spring 65 being maintained stationary. This shaft 34 may be driven from the locomotive axle to which it is coupled in turn, through the axle 67, reversing gear 67A, pinion 68, gear 69, shaft 70, slip friction clutch 71, shaft 72 and electromagnet clutch 73. Thus, when the winding 74 of the electromagnet clutch 73 is energized to magnetically couple the soft iron disk 73A on shaft 72, shafts 67 and 34 both rotate in such direction to into produce movement of the pointer 55 in the direction indicated by the arrow 60. Such movement of pointer 55 may be continued until the pointer 55 engages the stop member 77, in which case there is sliding motion between the complementary parts of the friction clutch 71 and shaft 34 remains stationary while the shaft 67 continues to rotate.

The shaft 34 and pointer 55 may be maintained in any one of a plurality of positions to which it is rotated by the shaft 67 upon energization of the braking coil 79, in which case, the magnetic attraction between the coil

79 and the adjacent magnetic housing 74A of the clutch 73 will block return movement of the shaft 34 which would otherwise be produced by the stressed torsion spring 65.

The cam members 36B and 36C on extension 36A of rack member 36 are arranged to produce, respectively, opening of the switch 50 when the train speed is greater than 15 miles per hour and to close the switch 51 when the train speed is greater than 30 miles per hour.

Relay 22 comprises the actuating winding 21, the holding winding 21B and normally open switch 21C which is closed upon energization of either one of windings 21 or 21B.

Relay 26 comprises the actuating winding 25, the holding winding 25A and the single pole double throw switch 25C having its contact 25D and 25E normally in engagement and the contact 25D out of engagement with the contact 25F.

Relay 80 has an actuating winding 81 and a normally open switch 82 which is closed upon energizing winding 81, the terminals of which are connected to corresponding terminals of the yellow aspect light bulb 83 forming a portion of the cab signalling arrangement in a block system. The yellow aspect lamp bulb 83 forms one of the three elements of a green, yellow and red block condition indicating system of conventional nature used in present day locomotives; for example, in the cab signalling system shown on page 270 of the April 1927 edition of the "Scientific American." It is noted that certain features of the present invention do not depend for their existence on such green, yellow and red block condition indicating lamps in the cab, but the present invention may be practiced independent of the same. However, certain portions of the apparatus embodying the present invention, as described herein, may be used conjointly with both the curve indicating system and also the block condition indicating system.

When such existing green, yellow and red block condition indicating system is utilized in conjunction with certain phases of the present invention, the terminals of the yellow lamp may be connected to the terminals of the actuating coil 81 as explained previously and the terminals of the red indicating lamp may be connected through switch 50 to corresponding terminals of the actuating coil 87 of relay 88 having the normally open switch 89.

The braking system on the train is of conventional nature; and, the essential operating parts thereof portraying the system, in relationship to the parts arranged to practice the present invention, are shown in Figure 1.

In Figure 1 the solenoid operated valve 90 serves to connect the main reservoir 91 to the brake valve through conduit 92. The return conduit from the brake valve comprising the brake pipe 93 is connected to the diaphragm valve 94. Upon energization of the winding 94A of the solenoid actuated valve 90, the connection between the main reservoir 91 and brake valve is at least partially closed, while simultaneously the brake pipe 93 is placed in communication with the diaphragm actuated valve 94. Of course, when there is a reduction in pressure in the brake pipe 93, the air brakes of the train are automatically applied.

This reduction in air pressure is accomplished by actuating the diaphragm valve 94. Of course, the normal pressure in the brake pipe 93 is regulated by conventional means such as a so-called feed valve which is not shown in the drawings but which is included in a serial path comprising in turn conduit 92, the feed valve, the brake valve, and the brake pipe 93.

The diaphragm actuated valve 94 for releasing the pressure in the brake pipe 93 comprises two cooperating valve members 95, 96 normally biased in conduit closing position by the adjustable compression spring 97 having one of its ends seated against the adjusting screw 98 and its other end seated against the movable diaphragm 99. Also, supplementing the action of the compression spring 97 is a tension spring 100 normally biasing the valve member 96 in such direction to tend to move it to conduit opening position against the action of the other spring 97. This tension spring 100 has one of its ends connected to the fulcrumed supporting member 101 having an intermediate point thereon affixed to the inner cooperating valve member 96 while the other end of the tension spring 100 is affixed to the core member 102 arranged to cooperate with the stationary support or stop 104. The movable magnetic core 102 cooperates with the solenoid winding 105 to effectively alter the tension in the tension spring 100.

Upon energizing the solenoid winding 94A, the valve member 90 serves to place the brake pipe 93 in communication with the diaphragm valve 94 in which case the diaphragm valve 94 opens to allow the escape of air until the pressure in the brake pipe 93 has been reduced below its normal operating pressure in an amount of approximately 7 pounds per square inch. In the event that the solenoid winding 105 is energized, the reduction in pressure from normal brake pipe pressure is in the order of 15 pounds per square inch.

The reduction in pressure in the amount of 7 pounds per square inch corresponds to what I refer to herein as a service application, and the reduction in brake pipe pressure in the amount of 15 pounds per square inch corresponds to what I term herein as an increased service application, the first mentioned application existing when the solenoid winding 105 remains de-energized while the increased service application corresponds to the condition when the solenoid winding 105 is energized.

As a matter of convenience and record, an electrically operated counter 107 has its terminals connected to corresponding terminals of the solenoid winding 94A to register the number of times the solenoid actuated valve 90 is operated.

The rack member 36 may serve to produce corresponding movement of a stylus member 108 in the recorder 109 embodying certain features of the present invention. This recorder 109 embodying the present invention comprises essentially a transparent drum member which is attached to and driven by a rotatable shaft 111, the movable stylus member 108 being arranged to engage the upper portion of the inner surface of the drum member 110 which rotates about its horizontal longitudinal axis. Talcum powder 112 covers a portion of the inner bottom surface of the drum member 110. If desired, a baffle member 113 may be placed within the drum member to assure confinement of the talcum powder 112 in the position shown in Figure 1 in the event of an accident to the train. Preferably, the shaft member 111 is coupled to the driving axle of the train through gearing such that the drum 110 makes approximately one revolution per 6 miles of train travel.

When and as the drum member 110 rotates, a thin film of talcum remains on the upper inner

surface thereof after it passes through the talcum to provide a fresh surface for inscribing thereon movements of the stylus member 108 which may comprise simply a metal pointer.

An important feature of this type of recorder is that it is self-erasing; that is, when and as the drum member 110 is rotated, any markings made on its inner surface by the stylus 108 are filled by the talcum powder at the bottom of the drum. Another feature of this type of recorder is that no paper or other similar expendable material is required, and relatively large scale variations may be recorded in the speed of the train. The recorder gives a record of the speed variations in the last three or four miles at, for example, a scale in which one inch represents one mile of train travel. Thus, in the event of an accident, a record is available of the speed at which the train traveled in its last three or four miles of travel.

While I prefer to use talcum powder in the recording arrangement, it is within the province of the present invention to use other material such as Vaseline, inks, greases or other materials which do not evaporate readily. In those instances where inks and greases are used, I may have a roller or pad at the bottom interior surface of the drum to apply such materials uniformly to the inner surface of the drum for subsequent marking.

In operation of a control system, the train as it travels in the direction indicated by the arrow, first carries the receiver 20 in proximity to the cutin inductor 4 located adjacent to and outside the rail, and then carries the receiver 16 in proximity to the holding inductor 5 located adjacent the rail, and then subsequently carries the receiver 17 in proximity to the cutout inductor 6 located midway between the tracks, it being understood of course, that the cutin inductor 4 is located at the beginning of an approach zone to a curve, the inductor 5 is positioned at the beginning of the curved section of the track and at the end of the approach zone and the cutout inductor 6 is located at the end of the curved portion of the track.

The distance between the cutin inductor 4 and holding inductor 5 measured along the track depends largely upon the degree of curvature of the curved section between the holding inductor 5 and the cutout inductor 6 and also the prescribed speed for traveling around the curved portion. For example, the distance between the cutin inductor 4 and holding inductor 5 may be approximately 21,000 feet for a speed reduction from 110 miles per hour to 50 miles per hour. This corresponds to a deceleration of 0.34 mile per hour per second. This is approximately one-half the maximum possible deceleration using maximum service applications.

In the example given it is assumed that the prescribed speed for traveling along a curved portion is 50 miles per hour and the apparatus described herein is capable of assuring maintenance of this constant speed in the curved portion without exceeding the prescribed value.

Immediately when the receiver 15 is in proximity to cutin inductor 4, the pointer 55 begins to rotate from its normal position against a stop 66 in the direction indicated by the arrow 60 provided the train speed is greater than 30 miles per hour. The pointer 55 continues to thus rotate until the receiver 16 is carried into proximity to the holding inductor 5, in which case movement of the pointer 55 is arrested. Thereafter, after the receiver 17 is carried into proximity to the inductor 6, the pointer 55 is released from its arrested position to allow it to return to its normal position against stop 66 under action of the stressed torque soring 55. The particular circuits and mechanical arrangements for achieving such movements of pointer 55 are described now.

Immediately when the receiver 15 is carried into proximity with the inductor, a surge of current flows through the winding 20 and actuating coil 21 thereby to cause the normally open switch 21C to close, in which case a holding current flows through the holding coil 21B in the following path to maintain the switch 21C closed: the path extends from one terminal of coil 21B through the switch 21C; through winding 74, through the switch 51, through the normally closed switch 25D, 25E, and through the battery 120 to the other terminal of winding 21B. It is noted that this circuit described immediately above remains open and the relay 22 remains de-energized in the event that the train is traveling a rate less than 30 miles per hour, in which case the switch 51 remains open. Assuming that the train speed is greater than 30 miles per hour under the conditions stated, the relay 22 remains energized after the receiver 15 has passed over the inductor 4 and also the electromagnetic clutch 73 is energized thereby to couple shaft 67 to shaft 34 to produce rotation of the pointer 55. The electromagnetic clutch 73 remains actuated in the time interval necessary for the train to travel between the cutin inductor 4 and the holding inductor 5.

When the train is in proximity to the holding inductor 5 a surge of current flows through the coil 24 and actuating winding 25 thereby to move the movable switch member 25D out of its normal engagement with the contact 25E and into engagement with the other contact member 25F, in which case the holding coil 25A becomes energized to maintain contacts 25D and 25F in engagement in the interval necessary for the train to travel from the holding inductor 5 to the cutout inductor 6, the current flow through the holding coil 25A in that the case being from its upper terminal through the normally closed switch 28A of relay 29, through the braking coil 79 through the battery 120 and through the switch 25D, 25F to the other terminal of the winding 25A. In such case, it is noted that switch 25D and 25E is opened to prevent the further flow of current through the coil of the electromagnetic clutch winding 74 thereby to prevent further rotative movement of the pointer 55. Thus, movement of pointer 55 is arrested by the magnetic interaction between winding 79 and metallic housing 74A. As a matter of fact, pointer 55 is locked in position by the magnetic interaction of coil 79 and its associated core provided by the magnetic housing 74A of the clutch 73. The pointer 55 is thus maintained at some predetermined position between the stop members 66 and 77 opposite a definite marking on the dial scale 33 which is calibrated in miles per hour. The pointer 55 remains in such position in the interval necessary for the train to travel from the holding inductor 5 to the cutout inductor 6.

When and as the train approaches the cutout inductor, a surge of current flows through the receiver coil 27 and actuating winding 28 or relay 29 to open its normally closed switch 28A and the circuit through the braking coil 79. In such case the shaft 34 and connected dial pointer 55 is free to return to its normal position adjacent its stop

66 under the influence of the prestressed spring 65.

It is important in the understanding of the present invention to realize that while the amount of movement of the pointer 55 is directly proportional to the distance traveled by the train, the pointer 55 itself indicates actual speeds which are purely fictitious in so far as the pointer 55 per se is concerned. Of importance is the interaction of the pointer 55 with the pointer 32 and the intelligence derived from observing their relative positions. While I have shown here in diagrammatic form electrical switching elements mounted on the dial pointers 32 and 55 themselves for the sake of convenience, it is of course understood that these corresponding electrical contact members may be carried or mounted on other members movable with the dial pointers.

In the safe operation of a train around a curve and in approach thereto, it is important that the dial pointer 55 should not move past the speed indicating pointer 32; otherwise, upon slight movement of pointer 55 past pointer 32, an alarm 130, such as a bell or whistle is sounded. Upon further continued movement of the dial pointer 55 past the pointer 32 a service application of the brakes results; and upon still further continued movement of the dial pointer 55 past the pointer 32 an increased service application of the brakes results. It is therefore important and desirable that the engineer of the train should control the speed of the train so that the dial pointer 55 is never to the left of the speed indicating pointer 32 and preferably the speed is controlled to maintain points 32 and 55 "matched," i. e. oriented in the same direction in superimposed relation.

The alarm 130 may be energized with current flowing from the battery 131 and through the cooperating switch contacts 55A, 32A.

The winding 94A of the valve 90 is energized with current from the source 131 which flows in the following path: From the lower terminal of source 131, through switch contact 55A, through switch contact 32B, through winding 94A, to the other terminal of source 131.

Solenoid winding 105 is energized with current from source 131 which flows in the following path: from the lower terminal of battery 131, through the switch contact 55A, through the switch contact 32C, through the winding 105, to the other terminal of source 131.

It is thus noted that when the contact 55A engages contact 32A, the alarm 130 is sounded, then upon further movement of contact 55A into engagement with contact 32B, a service application of brakes results from energizing winding 94A; and, upon further movement of contact 55A into engagement with contact 32C, the winding 105 is energized to thereby produce an increased service application of brakes.

When the winding 94A alone is energized, the pressure in the brake pipe 93 is reduced in an amount substantially to 7 pounds per square inch. When the windings 94A and 105 are simultaneously energized the reduction in brake pipe pressure is in the order of 15 pounds per square inch.

It is noted that when the engineer reduces the pressure in the brake pipe 93 in an amount greater than 7 pounds per square inch with his conventional hand operated brake valve for producing service applications, his manual control has priority over the automatic control which might otherwise be placed in operation upon engagement of switch contact 55A with switch contact 32B. The converse is true; that is, if the engineer reduces the pressure in the brake pipe 93 in an amount less than seven pounds per square inch, the automatic control effected by closure of switch contacts 55A and 32B will have priority over the engineer's manual control.

The distance on the track between the cutin inductor 4 and the holding inductor 5 may vary for different curved portions of a track along the full length of the main line of a railroad, depending upon the curvature grade, and condition of such curved portion between the holding inductor 5 and the cutout inductor 6. In general, the higher the prescribed speed for a curve, the shorter is the distance between the cutin inductor 4 and the holding inductor 5; and conversely, the lower the prescribed speed the greater is the distance between the cutin inductor 4 and the holding inductor 5.

An important feature of this invention is that the exact distance between cutin inductor 4 and holding inductor 5 may be used alike for fast-moving trains, such as streamlined trains, and slow-moving trains, such as freight trains.

In the case of fast-moving trains, the pointer 55 is normally positioned to read a higher value on the dial scale such as 110 miles per hour, while on a slow-moving train the initial setting of the dial pointer 55 is advanced to read, for example, 75 miles per hour. This adjustment in initial setting of the dial pointer 55 may be conveniently accomplished by adjustment of the position of the stop member 66. In the case of very long loaded freight trains, it may be also desirable to change the ratio of the gearing between shaft 67 and 70 in such manner so as to slow down the resulting movement of the pointer 55. In such case, the gear 68 is made smaller or the gear 69 is made larger.

The apparatus described above may, if desired, be used in conjunction with the normal automatic cab signal systems found in locomotives. In Figure 1, this automatic cab signaling system comprises the green light source or lamp bulb 140, the yellow light source 83, and the red light source 141. These light sources 140, 83 and 141 are energized in accordance with any one of many well-known circuits arranged to produce indication of the condition of either the block in which the locomotive is present or the condition in the succeeding block.

The terminals of the yellow lamp 83 are connected respectively to corresponding terminals of the actuating winding 81 of the relay 80 having normally open switch 82, closure of which causes a current to flow from the lower terminal of battery 120 through the normally closed switch 25D, 25E, through the clutch winding 74, and through the switch 51 when the train speed exceeds 30 miles per hour. Thus, closure of switch 82 produced by energization of the yellow lamp 83 has that identical effect produced when the receiver inductor 15 is brought into proximity with the cutin inductor 4. Upon closure of switch 82, the speed limiting pointer 55 begins to move in the direction indicated by the arrow 60, as previously explained; and, in the event that the pointer 55 moves beyond the pointer 32, either an audible signal will be produced or the brakes of the train will be automatically applied, also as set forth previously. Of course, in the interim, if the yellow light source 83 is de-energized while the pointer 55 is being driven by shaft 67, the pointer 55 is allowed to return to its normal position

against stop 66 under the influence of the stressed torsion spring 65.

The red lamp bulb 140 has its opposite terminals connected through switch 50 to corresponding terminals of the actuating winding 87 of the relay 88 having normally open switch 89. Closure of switch 89 in response to energization of winding 87 causes two circuits to close, i. e. a circuit through winding 94A and a circuit through winding 105 to fully energize the same thereby to cause a reduction in the brake pipe pressure in the amount of approximately 15 pounds per square inch as explained previously. Thus, upon energization of the red light there is an increased service application of brakes, as explained previously, in the event, of course, the train is traveling at a speed greater than 15 miles per hour to cause closure of the switch 50.

Preferably the switch contacts 55A, 32A, 32B and 32C on the pointers 55 and 32 respectively are so spaced with respect to one another that when the train speed indicated by the pointer 32 exceeds the train speed indicated by the pointer 55 in an amount of 3 miles per hour, an audible signal is produced by the alarm 130; and, when this indicated speed difference amounts to approximately 6 miles per hour, a service application of brakes results; and, when such indicated speed difference exceeds 10 miles per hour, the increased service application of brakes results.

Preferably the train is decelerated at a rate in the order of .34 mile per hour per second, as indicated in the graphical representation shown in Figure 4, wherein the abscissa of the four straight inclined lines 150, 151, 152 and 153 are expressed in terms of feet and the corresponding ordinates are expressed in miles per hour. These four curves 150, 151, 152 and 153 are helpful in explaining the movement of the pointer 55 and its position with respect to the speed indicating pointer 32 under all possible practical speeds of a train entering the approach zone defined between the cutin inductor 4 and the holding inductor 5 and the prescribed speed variation of the train within such approach zone. For example, assuming a train enters the approach zone at a speed of 60 miles per hour as indicated by the horizontal line 155, the train may proceed at such speed of 60 miles per hour for a distance of 14,100 feet corresponding to the abscissa of the point of intersection of the horizontal line 155 with the line 153. At this point, the pointers 55 and 32 have the same angular position or are matched. In the event that the speed of the train is not reduced at this point, it will continue at such speed for a distance of approximately 800 feet, corresponding to the abscissa of the point of intersection of the horizontal line with the line 152, in which case an audible signal is produced by the alarm 130. In the event that the speed is not reduced from such valve of 60 miles per hour, the train will travel a further distance until the line 155 intersects the line 151, in which case there will be a service application of brakes. If the train continues further at the unabated speed of 60 miles per hour it will travel an additional distance corresponding to the intersection of line 155 with line 150, and in such case an additional service application of brakes results.

In operating a train incorporating the present system it is desirable that the speed of the train be manually controlled to maintain the dial pointers 55 and 32 matched.

In the example given above, the speed of the train is 60 miles per hour and an audible signal is first obtained after the train travels approximately 14,900 feet within the approach zone. In the event that the train approaches and travels through the approach zone at an increased speed of, for example, 100 miles per hour, represented by the horizontal line 156, an audible signal is first produced in a correspondingly shorter distance of 2,800 feet, as indicated in Figure 4.

From a study of the graphical representation in Figure 4, it is apparent that one may readily ascertain the distance in the approach zone at which the brakes should be applied in relationship to the particular speed of the train entering the zone.

Preferably relay 80 is of the slow "drop out" or "drop away" relay in which there may be incorporated a short circuited turn in the magnetic field of winding 81 to prevent the flux from collapsing too rapidly when winding 81 is deenergized thereby maintaining switch 82 closed for a prolonged period after winding 81 is deenergized. The reason for this type of relay is that in an automatic block system when passing over short sections of track where current may not be picked up for a distance of less than 175 feet such as staggered joints at the end of a track circuit or at a railroad crossing, the cab lights may flash from green to yellow and back to green without the whistles or bell sounding. No attention need be paid to these flashes.

This relay 80 may have a delayed drop out characteristic produced by the electrical means, which is conventional and which has been described above. In such case, however, the drop out time is definite and is not dependent upon the speed of the train. Preferably, the drop out relay 80 is made responsive to distance of train travel using the modified structure shown in Figure 2.

In Figure 2, the electrical connections to the relay 80 are identical with those shown in Figure 1. The movable armature 80A is fulcrumed at 80B on a fixed support and has a dog member 80C pivoted on its lower end at 80D adjacent the disk 80F affixed on shaft 34. Dog member 80C normally rests against stop member 80G when winding 81 is energized.

Upon deenergization of winding 81 in Figure 2, the free end of dog member 80C frictionally engages the outer rim of the rotatable disk 80F to maintain the switch 82 closed until the dog member 80C is moved up to the dotted line position 80H in which event switch 82 is allowed to open under the influence of gravity forces acting on armature 80A.

It is apparent that in a block signal the pointer 55 may be caused to move in response to a yellow cab signal and may be allowed to return to its initial normal position anywhere within the block by means of inductors such as the holding inductor 5 and cutout inductor 6. For example, in case, an inductor similar to the cutin inductor may be placed at the beginning of a block and the holding inductor 5 and cutout inductor 6 may be placed at predetermined spaced points within the block, the movement of pointer 55 being started by either a track inductor or in response to a yellow cab signal.

In the apparatus shown in Figure 4, the retardation rate varies somewhat when the train is decelerated such as to produce the variation represented by the line 153 in Figure 4. It is more desirable that the retardation rate be uniform at a rate of, for example, .34 mile per hour per second as represented by the parabolic curve

153A in Figure 5 which corresponds in other respects to the straight line 153 in Figure 4. Correspondingly, the lines 150A, 151A and 152A are sections of a parabolic curve which in other respects represent the same variations respectively as curves 150, 151 and 152 in Figure 4. To more clearly bring out the inner relationship in Figures 4 and 5, line 153 of Figure 4 is reproduced in a corresponding position in Figure 5. The variations represented by the curves 150A to 153A inclusive may be produced by the modified apparatus shown in Figure 3 wherein the shaft 34 is not directly coupled to the pointer 55 as is the case in Figure 1 but the shaft 34 is coupled to the pointer 55 through a cam 157 mounted on shaft 34, cam follower 160 at one end of the rack member 158 pivoted at 159, and a pinion gear 162 affixed to the same rotatable shaft 163 upon which the pointer 55 is mounted, the shaft 163 being normally biased in the clockwise direction to normally maintain the pointer 55 against the stop member 66 by the action of the torque spring 164 having one of its ends affixed to shaft 163 and the other one of its ends stationarily mounted at 165. This spring 164 also serves to maintain positive engagement between the cam 157 and the cam follower 160. While I prefer to shape the cam 157 in Figure 3 to produce a parabolic type of variation represented by the lines 150A to 153A inclusive, it is within the scope of the present invention to impart other configurations to the cam 157 to produce other types of retardation curves.

While the particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

I claim:

1. In a control system arranged for the safe passage of a train around a curve, a first triggering means located at the beginning of an approaching zone to a curve, a second triggering means located at the end of said approaching zone; a pair of indicating hands concentrically mounted for indepedent relative pivotal movement in opposite directions toward one another, means responsive to the speed of said train arranged to vary the position of one of said hands accordingly, means responsive to the first triggering means to vary the position of said other hand at a predetermined rate and responsive to said second triggering means to terminate movement of said other hand, whereby the final position of said other hand is determined by the physical spacing between said first and second triggering means; and indicating means including a pair of switch contacts relatively movable with respect to each other and in accordance with the relative position of said pair of indicating hands, said indicating means being actuated when said pair of hands substantially overlie one another to produce an indication upon closure of said switch contacts.

2. In a control system arranged for the same passage of a train around a curve, a first triggering means located at the beginning of an approaching zone to a curve, a second triggering means located at the end of said approaching zone; a pair of indicating members concentrically mounted for independent relative pivotal movement in opposite directions toward one another, means responsive to the speed of said train arranged to vary the position of one of said members accordingly, means responsive to the first triggering means to vary the position of said other member at a predetermined rate and responsive to said second triggering means to terminate movement of said other member, whereby the final position of said other member is determined by the physical spacing between said first and second triggering means; and indicating means including a pair of switch contacts relatively movable with respect to each other and in accordance with the relative position to each pair of indicating members, said indicating means being actuated when said pair of members substantially overlie one another to produce an indication upon closure of said switch contacts.

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