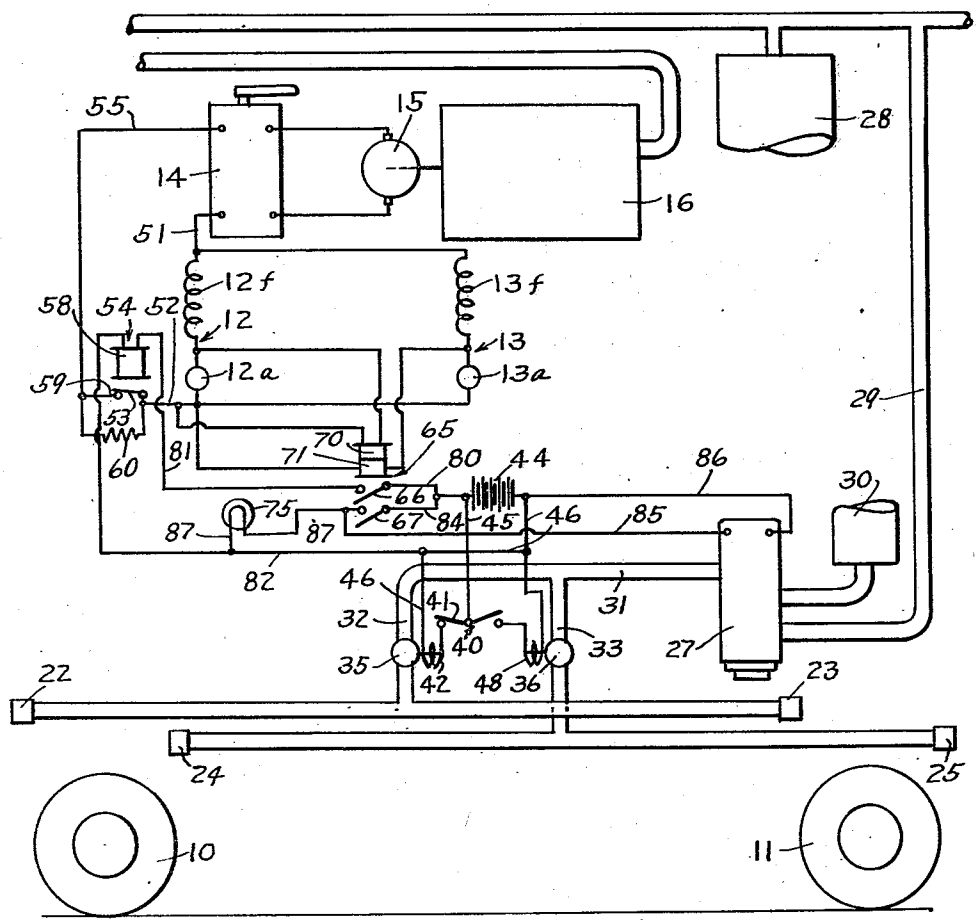
June 16, 1942. C. M. HINES 2,286,680

LOCOMOTIVE SANDING CONTROL APPARATUS

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Fig. 1.



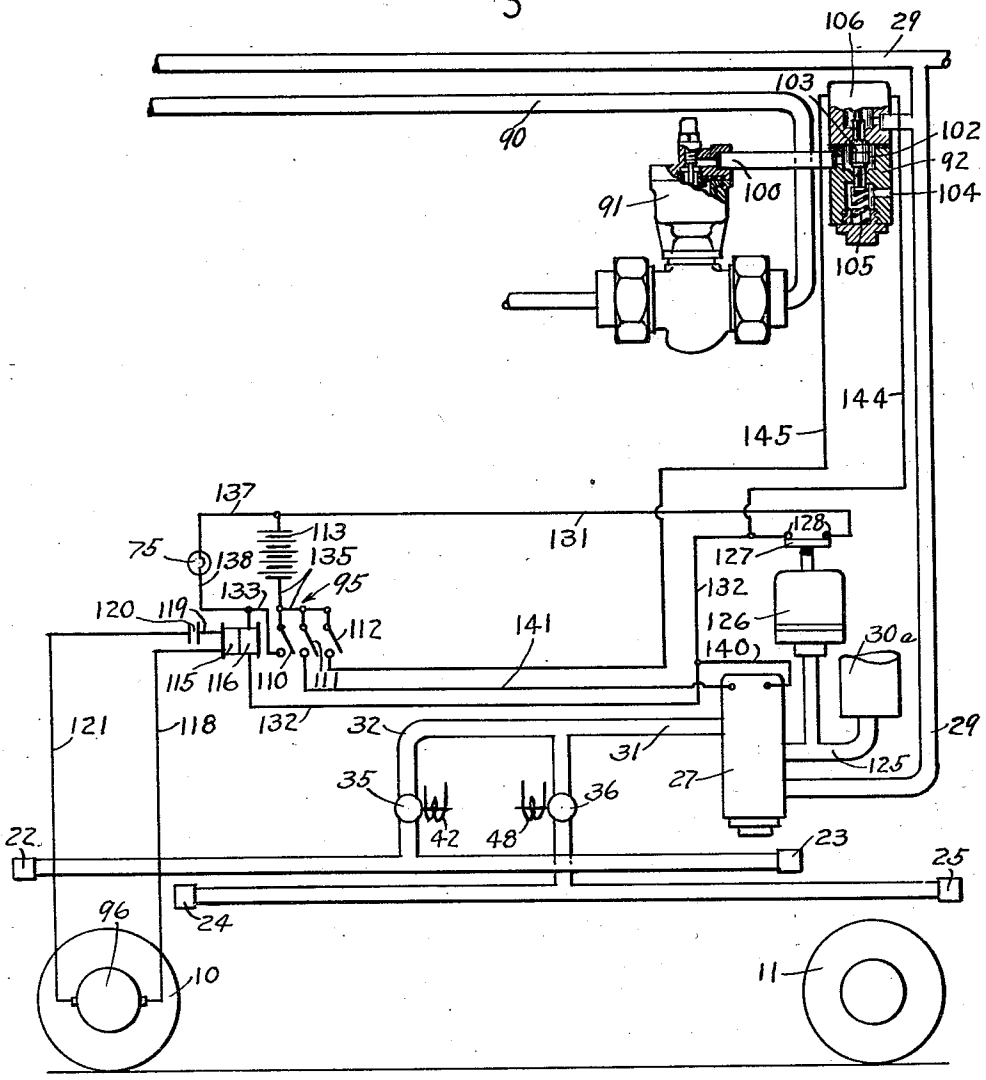
INVENTOR
CLAUDE M. HINES
BY A. M. Higgins
ATTORNEY

June 16, 1942. C. M. HINES 2,286,680

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Fig. 2



INVENTOR
CLAUDE M. HINES
BY
ATTORNEY

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LOCOMOTIVE SANDING CONTROL APPARATUS

Claude M. Hines, Pittsburgh, Pa., assignor to The Westinghouse Air Brake Company, Wilmerding, Pa., a corporation of Pennsylvania

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4 Claims. (Cl. 291—2)

This invention relates to acceleration control systems for locomotives and other traction vehicles, and more particularly to apparatus including sanding means automatically operable to minimize slipping of the driver wheels of a locomotive.

In the operation of a locomotive upgrade under load, it is sometimes difficult for the locomotive engineer to detect a tendency of the drivers to slip and thus to determine the most favorable time to begin sanding of the rails. As a result, the engineer may be compelled to use sand and sanding air too soon or in excessive amounts, in order to ensure against stalling of the train. On the other hand, when the locomotive is driven at a high speed, or in excess of seventy-five miles per hour for example, the engineer may be unaware of an incipient slipping condition of the drivers, with the result that the locomotive may be driven with excessive waste of power for a long period of time. Another undesirable condition may be brought about if the engineer learns that the drivers are slipping and attempts to take the locomotive out of the slip by the unsafe practice of supplying sand alone, without quickly reducing the supply of steam or other power to the locomotive.

For a locomotive constantly operated under service conditions in which these problems are encountered, it is desirable to provide an automatic sanding control equipment including means for operating a signal in response to driver slippage, and means for reducing or throttling the locomotive power supply while causing sanding of the rails in time to avoid dangerous racing of the drivers or loss of control of the locomotive.

One object of the invention is to provide an automatic driver slip control apparatus for a traction vehicle comprising means operable to detect initial slipping of the drivers when accelerating power is applied thereto, and further operable to effect the supply of sand in advance of the slipping drivers.

Another object of the invention is to provide an anti-driver-slip control equipment including means operative in response to initial slipping of a locomotive driver for energizing a signal device and for also actuating an associated sanding apparatus while effecting a reduction or throttling of the power applied to the driver.

A still further object of the invention is to provide a control equipment of the above description which may be adapted for use with various types of steam locomotives and electrically driven locomotives.

Other objects and advantages of the invention will appear in the following more detailed description thereof, taken in connection with the accompanying drawings, in which

Fig. 1 is a schematic view of one form of locomotive sanding control apparatus constructed in accordance with my invention and associated with certain elements of a Diesel-electric locomotive; and

Fig. 2 is a schematic view of another embodiment of the invention in association with operating elements of a steam locomotive.

Apparatus shown in Fig. 1

Referring to Fig. 1 of the drawings, certain elements of a locomotive are therein illustrated in diagrammatic form, including separate driver assemblies 10 and 11, driving motors 12 and 13 arranged in operative relation with the driver assemblies, respectively, a controller 14 for governing the power supply to the driving motors, and a suitable source of electrical energy such as a generator 15 and a Diesel-engine 16.

The locomotive is equipped with fluid pressure actuated sand supplying means, comprising sanders 22 and 23 which are adapted to deposit sand in advance of the respective driver assemblies 10 and 11 when the locomotive is operated to the left, as viewed in Fig. 1, and similar sanders 24 and 25 which are so located as to supply sand in advance of the two driver assemblies when the locomotive is moving in the opposite direction. For controlling the operation of the sanders there is provided an electro-responsive sanding control valve device 27, which is normally operative to control the supply of compressed air from a main reservoir 28 by way of a supply pipe 29 to a sanding reservoir 30. The sanding control valve device 27 is also adapted for operation to effect the supply of compressed air from the reservoir 30 to a sanding pipe 31, which has a branch 32 leading to the pair of sanders 22 and 23, and another branch 33 connected to the other sanders 24 and 25.

The branch pipes 32 and 33 are provided with normally open cut-off valves 35 and 36, respectively, one of which can be held in open position while the other is closed, the operation of the valves being determined by the direction in which the locomotive is operated. For controlling the cut-off valves 35 and 36 there is provided an automatic direction selector switch 40, which comprises a movable contact 41 that is operative

in one position to maintain the valve 35 closed by energization of a magnet 42 through a circuit including the positive terminal of a battery 44, a conductor 45, the switch contact, the coil of the magnet, and a conductor 46 connected to the negative terminal of the battery. The movable contact 41 is also operative in another position, when the vehicle is moving in the opposite direction, to effect closure of the valve 36 by energization of a magnet 48 through the medium of the same circuit.

As shown diagrammatically in Fig. 1, the driving motor 12, comprising a field winding 12*f* and an armature 12*a*, and the driving motor 13, comprising a field winding 13*f* and an armature 13*a*, are connected in parallel in a circuit which includes a conductor 51 having connection with one of the supply terminals of the controller 14, the respective motor windings, a conductor 52, a normally closed switch contact element 53 forming part of a power reducing switch 54, and a conductor 55 connected to the other terminal of the controller 14. The power reducing switch 54 is interposed in the circuit just described as a means for effecting quick reduction of the accelerating power applied to the drivers in response to slipping thereof, as hereinafter more fully explained, and comprises a magnet 58 adapted to be energized for raising the movable contact element 53 out of engagement with a stationary contact element 59, and a resistor 60 which is disposed in shunt or parallel relation with the contact elements.

According to the invention, both the switch magnet 58 and the operating magnet of the sanding control valve device 27 are adapted to be energized by operation of a control relay 65, which comprises a pair of normally open contact members 66 and 67, and a pair of opposed magnet coils 70 and 71 for actuating both contact members simultaneously. The coil 70 is adapted to be energized by the counter-electromotive force developed by the motor 12, while the coil 71 is arranged for energization by the counter-electromotive force of the motor 13, the two coils being so disposed as to direct magnetic flux in opposite directions with respect to the magnetically responsive contact members 66 and 67. It will be understood that since the speed and voltage characteristics of the two motors are substantially identical, the resultant or total flux produced by the opposing coils 70 and 71 will normally be at a minimum. However, upon a sudden increase in speed of either of the motors, due to slipping of the corresponding drivers, the opposing fields of the coils 70 and 71 will be put out of balance, so that the increased flux produced by the over-energized coil will be effective to move contact members 66 and 67 to their respective circuit closing positions.

The relay 65 is also operative to control a signal lamp 75, which is adapted to be mounted in a convenient location in the locomotive cab and functions to indicate initial slipping of the locomotive drivers, as hereinafter explained.

Operation of apparatus shown in Fig. 1

It will now be assumed that the controller 14 is operated to supply current to the driving motors 12 and 13 by way of the motor circuit comprising conductor 51, the motor field and armature windings, conductor 52, switch contact elements 58 and 59, and conductor 55, and that the drivers 10 and 11 are thereby operated to propel the locomotive toward the right, as viewed in Fig. 1. It will be understood that the directional control switch contact 41 will be accordingly positioned as shown for effecting energization of the coil 42, thus closing the valve 35. The valve 36 is at the same time disposed in its normal open position, so that the sanders 24 and 25 in advance of the drivers are conditioned for operation.

So long as the driver assemblies 10 and 11 are rolling along the rails without slipping, the driving motors 12 and 13 are operative at the same speed and consequently develop identical counter-electromotive forces. It will be understood that the current supplied to the coil 70 is a measure of a counter-electromotive force developed in the motor 12, while the current supplied to coil 71 is likewise a measure of the counter-electromotive force developed by motor 13. Each of the opposed coils thus tends to produce a flux substantially balancing that produced by the other, so that the resultant or total flux acting on the relay contact members 66 and 67 is thus maintained at a minimum. While this condition prevails, the contact members 66 and 67 are permitted to remain in their normal or open positions, as shown in the drawings.

If either of the locomotive driver assemblies 10 and 11 begins to slip, however, the load of the corresponding driving motor is quickly decreased with the result that the motor is free to operate at increased speed, and to develop correspondingly greater counter-electromotive force. When one of the coils 70 or 71 thus receives greater energizing current than the other due to the increased counter-electromotive force produced by the motor operating the slipping or racing driver assembly, the equilibrium of the flux forces acting in the relay 65 is upset, and the contact members 66 and 67 are quickly moved to their respective circuit closing positions.

Operation of the relay 65 causes energization of the power reducing switch 54 by way of a circuit which includes the positive terminal of the battery 44, a conductor 80, the relay contact member 66, a conductor 81, the coil 58, a conductor 82, and the conductor 46 leading to the negative terminal of the battery. Upon energization of the coil 58, the contact element 53 is moved away from the stationary contact element 59, thereby connecting the resistance 60 into the circuit through which power is supplied to the driving motors 12 and 13. The driving torque developed by the driving motors 12 and 13 is thus automatically reduced in time to check the tendency of the drivers to slip or race.

At the same time, movement of the relay contact member 67 into circuit closing position establishes a circuit for energizing the electroresponsive sanding control valve device 27, which circuit comprises a conductor 84 connected to the positive terminal of the battery 44, the contact member 67, a conductor 85, the magnet winding of the sanding control valve device, and a conductor 86 leading to the negative terminal of the battery. The operating elements of the sanding control valve device 27, not illustrated in detail, are thereby actuated to effect supply of air under pressure from the reservoir 30 through the pipe 31 and the open valve 36 to the sanders 24 and 25, which are thus rendered operative to supply sand in advance of the driver assemblies.

The relay contact member 67 is also effective to establish a circuit for the signal lamp 75, which circuit is energized by current from the

battery 44 by way of the contact member, a conductor 87 connected to the lamp, and the conductors 82 and 45. The locomotive engineer is thus made aware of the slipping condition developed by the drivers and of the automatic operation of the sanding control apparatus, and may then take such steps as would be deemed necessary to ensure proper control of the locomotive.

It is normally to be expected that the operation of the sanding control apparatus to supply sand to the rails and to reduce the supply of power to the locomotive driving motors as just explained will quickly cause retardation of the slipping driver assembly, until the rotative speed thereof has been brought back to approximately the speed of the other driver assembly. With the driver assemblies and the driving motors associated therewith again operating at substantially identical speeds, it will be apparent that the opposing coils 70 and 71 of relay 65 will receive substantially equal energizing currents, thus permitting the movement of the contact members 66 and 67 to the circuit opening position as shown in Fig. 1. The switch 54 is thereby rendered operative to shunt the resistant 60 out of the motor supply circuit, while the magnet of the sanding control valve device 27 is deenergized to effect termination of the supply of compressed air to the sanders.

Equipment shown in Fig. 2

In Fig. 2 of the drawings there is illustrated a different form of locomotive sanding control apparatus embodying my invention, the equipment being in this case adapted to be carried by a steam locomotive. Certain elements of the equipment shown in Fig. 2, including the sanding control valve device 27, the directional control cut-off valves 35 and 36 and the sanders associated with the driver assemblies, are similar in structure and function to those elements bearing like reference characters in Fig. 1 of the drawings. The equipment shown in Fig. 2 further comprises a steam supply pipe through which steam for driving the locomotive is conducted, a fluid pressure responsive steam throttle valve device 91 interposed in the supply pipe, a magnet valve device 92 for controlling operation of the throttle valve device, a relay 95 adapted to detect slipping of a driver assembly, and a direct current generator 96 which is operatively connected to the driver assembly 10.

The steam throttle valve device 91 is not illustrated in detail, but will be understood to comprise valve means which normally permits unimpeded flow of steam through the pipe 90 to the locomotive cylinders at the rate determined by the usual engineer's throttle valve, not shown. The throttle valve device 91 is operative by compressed air supplied to the device through a pipe 100 to reduce the flow of steam through the supply pipe. The magnet valve device 92 comprises a casing having a valve chamber 102, which communicates with the compressed air supply pipe 29 and has mounted therein a valve 103 that is adapted to control communication from the valve chamber either to the pipe 29 or to an atmospheric vent port 104. The valve 103 is normally held in an upper seated position by the force of a coil spring 105, in which position the valve maintains closed the communication between the supply pipe 29 and valve chamber 102. The valve device is provided with a magnet 106 which functions, when energized, to effect movement of the valve 103 to a lower seated position in opposition to the force of the spring 105, for thereby effecting supply of air under pressure through the pipe 100 to the steam throttle valve device 91.

According to the invention as embodied in the apparatus shown in Fig. 2, the control relay 95 comprises movable contact elements 110, 111 and 112, which are operative to control the supply of electric current from a battery 113 to the signal lamp 75, the magnet valve device 92, and the sanding control valve device 27, by way of circuits hereinafter described. The switch contact elements 110, 111 and 112 are operably associated with a pair of electro-responsive magnets 115 and 116, the latter of which constitutes a holding magnet that is arranged for energization independently of the magnet 115.

The magnet 115 is adapted to be energized by current supplied by the direct current generator 96 through a circuit which includes a conductor 118, the coil of the magnet 115, a conductor 119, a condenser 120, and a conductor 121 connected to the other lead of the generator. As will hereinafter be explained, the current energizing the magnet 115 is at all times a measure of the rate of change of speed of the driver assembly 10 associated with the generator.

As disclosed in Fig. 2 of the drawings, the sanding control valve device 27 is arranged to control the supply of compressed air from the supply pipe 29 through a pipe 125 to the sanding reservoir 30*a*, which in this case constitutes a timing reservoir having a predetermined volume. Associated with the timing reservoir 30*a* is a pneumatic switch device 126, which has a movable contact element 127 that is adapted to bridge a pair of contact elements 128, and suitable piston means, not shown, for holding the contact element 127 in circuit closing position so long as the pressure of air in the timing reservoir remains above a minimum value. It will be understood that the timing reservoir 30*a* is adapted to be charged with sufficient air under pressure to cause operation of the associated sanders for a definite interval of time, as determined by the class of service for which the sanding apparatus is desired.

Operation of equipment shown in Fig. 2

When the locomotive sanding control apparatus is conditioned for operation, compressed air is supplied in the usual manner to the supply pipe 29, from which air is supplied by way of sanding control valve device 27 through the pipe 125 to the sanding or timing reservoir 30*a* and also to the pneumatic switch device 126. With the magnet valve device 92 in its normal deenergized condition, the valve element 103 therein is positioned for venting to atmosphere the pipe 100 communicating with the steam throttle valve device 91. The throttle valve device 91 is consequently held in its normal fully open position for permitting supply of steam at any desired rate by way of the pipe 90 for operating the steam locomotive.

Assuming that the locomotive is set in motion, one or the other of the cut-off valves 35 and 36 is automatically closed in the manner explained in connection with Fig. 1, so that only the sanders in advance of the locomotive driver assemblies remain in condition for operation.

As the speed of the locomotive is increased, the direct current generator 96 is operated by the driver assembly 10 to supply current through the circuit including the conductor 118, magnet 115, conductor 119, condenser 120 and conductor 121,

it being understood that the current flow in this circuit is determined by the rate at which the condenser receives a charge of electrical energy and consequently by the rate at which the driver actuated generator is accelerated. Thus when the vehicle is operated at constant speed, the voltage of the generator 96 and of the condenser 120 remains constant so that there is at such time no flow of current in the circuit.

According to the invention, the magnet 115 is constructed and arranged to produce a small and ineffective magnetic force when energized by the relatively low current supplied to the circuit while the locomotive driver assembly and the generator 96 are accelerated at a normal rate. The locomotive may thus be accelerated under normal operating conditions, or so long as the drivers are operated in non-slipping relation with the rails, without causing operation of the relay 95.

If the driver assembly 10 should commence to slip or to race with respect to the rails, however, the speed at which the direct current generator 96 is operated is consequently increased at an excessively rapid rate, so that the resultant current flowing in the condenser circuit becomes high enough to cause effective energization of the magnet 115. The relay 95 is thereby actuated so that the movable contact elements 110, 111 and 112 are shifted to their respective circuit closing positions. The relay 95 is then maintained in operative position due to energization of the holding magnet 116 by way of a circuit which includes the positive terminal of the battery 113, a conductor 131, the switch contacts 127 and 128, a conductor 132, the winding of the magnet 116, a conductor 133, the switch contact element 110, and a conductor 135 connected to the negative terminal of the battery.

At the same time, current is supplied to the signal lamp 75 through a circuit comprising a conductor 137 connected to the positive terminal of the battery 113, the lamp, a conductor 138, the conductor 133, switch contact element 110 and conductor 135.

Movement of the contact element 111 to circuit closing position results in energization of the magnet of the sanding control valve device 27 by way of a circuit including the conductor 131, the connected switch contacts 127 and 128, conductor 132, a branch conductor 140, the winding of the sanding control valve device, a conductor 141, and the contact element 111 which is connected to the conductor 135 leading to the negative terminal of the battery. The sanding control valve device 27 is consequently rendered operative to effect the supply of compressed air from the reservoir 30a by way of the pipe 125 to the pipe 31, from which the air is delivered to the sanders in advance of the locomotive driver assemblies.

Meanwhile, with the relay contact element 112 in circuit closing position, the magnet portion 106 of the magnet valve device 92 becomes energized through a circuit which includes the conductor 131 leading from the battery, the contact elements 127 and 128, a conductor 144, the magnet winding, a conductor 145, and the contact element 112 and conductor 135 leading to the negative terminal of the battery. Upon energization of the magnet in the magnet valve device 92, the valve 103 is moved to its lower seated position, thereby cutting off communication between the valve chamber 102 and the atmospheric port 104 while establishing communication from the supply pipe 29 through the valve chamber and pipe 100 to the fluid pressure responsive operating portion of the steam throttle valve device 91. This valve is thus actuated to reduce the flow of steam for operating the locomotive.

It will thus be seen that the sanding control apparatus shown in Fig. 2 is adapted to be rendered operative in response to the development of an initial slipping condition of a locomotive driver assembly for quickly reducing the power applied to the drivers and for supplying sand to the rails, so that the tendency of the drivers to continue to slip or to race is counteracted automatically. The locomotive engineer, having been informed of the slipping condition of the drivers by operation of the lamp 75, can then take further steps to regain control of the locomotive.

When the pressure of air with which the timing reservoir 30a was originally charged has been reduced to a predetermined value, due to the operation of the equipment as thus explained, the pressure responsive switch device 126 is rendered operative to break the connection between the movable contact element 127 and the stationary contact element 128, thereby opening the circuit for the magnet 106 of the magnet valve device and the circuit for the magnet of the sanding control valve device 27. The holding magnet 116 is at the same time deenergized for permitting movement of the contact elements 110, 111 and 112 to their respective circuit opening positions. It will of course be understood that the magnet 115 is also effectively deenergized, since the racing condition of the driver assembly 10 has by this time been corrected and the generator 96 is consequently not operated at a rate effecting flow of appreciable charging current in the condenser circuit. The various elements of the sanding control apparatus are thus returned to the normal condition within an interval of time determined by the volume and pressure of air in the timing reservoir 30a.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In an acceleration control system for a steam driven locomotive having a steam supply conduit and driver means, in combination, steam throttle valve means operative to reduce the flow of steam through said supply circuit, electro-responsive means for causing operation of said throttle valve means to reduce the supply of steam to the locomotive, electro-responsive sanding control means assoicated with the driver means of said locomotive, an electro-responsive relay device operable to effect energization of the first mentioned electro-responsive means and said electro-responsive sanding control means, and electrical energizing means operable by said driver means to effect operation of said relay device when a slipping condition of said driver means is indicated.

2. In an acceleration control system for a locomotive including prime mover means and driver means operable thereby, in combination, fluid pressure responsive sanding means for said driver means, electro-responsive sanding control valve means governing the supply of fluid under pressure for said sanding means, electro-responsive propulsion control means operable to reduce the energy available for operating said prime mover means, an electro-responsive relay device

operable to effect energization of said sanding control valve means and said propulsion control means, a direct current generator driven in accordance with the speed of the locomotive driver means and arranged to produce a voltage that is a measure of the speed thereof, and current controlling means including a condenser interposed in series relation between said generator and said electro-responsive relay device, whereby said generator is rendered effective to supply sufficient current to energize said relay device only when the acceleration of said driver means is at a slipping rate.

3. In an acceleration control system for a steam driven locomotive including steam supply means and driver means, in combination, a steam throttle valve device operable to control the supply of steam from said supply means, electro-responsive actuator means for said throttle valve device, electro-responsive sanding control means associated with said driver means, a relay device operable when energized to effect energization of said actuator means and said sanding control means, a generator operable by said driver means, and means connected between said generator and said relay device for effecting a current supply to said relay device that is a measure of the rate of change of the speed of said generator.

4. An acceleration control system operable to check slipping of the driver means of a locomotive during propulsion thereof, comprising electroresponsive sanding control means, electroresponsive propulsion controller means operable to limit the power applied through the medium of said driver means, a relay device operable to effect energization of both said sanding control means and said propulsion control means, means for conditioning said relay device in accordance with the rotative condition of said driver means, and means for limiting the time interval during which said relay device effects energization of said elements controlled thereby.

CLAUDE M. HINES.