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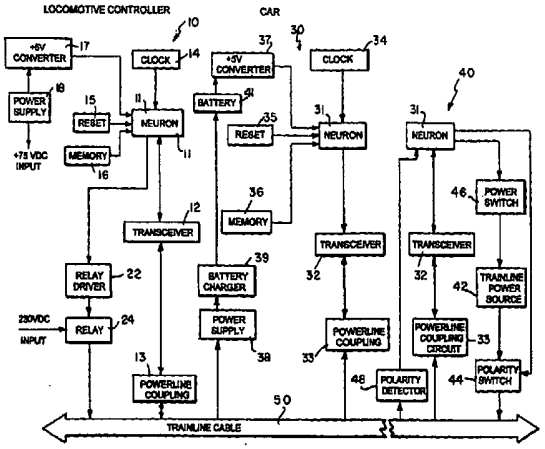


(57) Abstract

A method of powering a train powerline with a second source including using a local power controller in the trainline to determine the polarity of the power lines which run through the trainline. The local power controller then connects the second power source to the power lines with the determined polarity. Finally, the local power controller powers the power lines with a second power source once the connection of the appropriate polarity has been made.

TRAINLINE POLARITY DETECTOR WITH POWER SOURCE POLARITY SWITCHING

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates generally to electrified trains and more specifically to a method and apparatus for connecting a power source to an energized power line of the train.

Electro-pneumatic train braking requires electrical current to be transmitted over wires, serially connected between each car over the entire length of the train or consist from the locomotive. A typical electro-pneumatic (EP) brake system requires from 1200 watts to 2500 watts of power operating at voltages in the range of 230 volts DC.

In trains of substantial length, for example, freight trains, which may extend for a mile and a half to two miles and includes over one hundred cars, there exists a need to provide power sources other than the one at the head locomotive to maintain the current and voltage levels along the trainline. The composition of the train varies continuously. The proposed use of hermaphroditic connectors between the cars increases the changes of polarity reversals throughout the length of the trainline. While this has not caused a problem with respect to any of the equipment on the individual cars, it would cause a problem if additional power sources were connected to the trainline without knowing the appropriate polarity of the trainlines. Multiple power sources on passenger trains charged off a 600 volt DC third rail is known from U.S Patent 5,293,632.

According to one aspect of the present invention there is provided a method of powering with a second power source the power lines in a train, the train including at least one locomotive and a plurality of cars, each car being serially connected electrically to an adjacent car by a trainline having at least two power lines powered by a first power source and having a local controller controlled by a

master controller in said locomotive, the method including the steps of automatically:

determining the polarity of the power lines;

connecting said second power source to said power lines with the determined polarity; and

powering said power lines with said second power source.

According to another aspect of the invention, there is provided a train including at least one locomotive and a plurality of cars, each car being serially connected electrically to an adjacent car by a trainline having at least two power lines powered by a first power source and having a local controller controlled by a master controller in said locomotive, including a second source, the train including:

a local power controller which determines the polarity of the power lines, connects said second power source to said power lines with the determined polarity, and powers said power lines with said second power source.

The master controller at the locomotive preferably transmits a power command to the local power controller to initiate determining the polarity, connecting the proper output lines, and applying power to the trainline. The power command may be transmitted over the trainlines and preferably over the power lines. To determine the polarity, the local controller preferably places parallel, opposed diodes across the power lines and determines conduction of one of the diodes. This will indicate the polarity of the lines. The local power controller preferably uses a switch to place the diodes across the power lines and the switch may be either relay or transistor switches. The local power controller may determine conduction of the diode through an electro-optic isolator. The local power controller may also use a switch to connect the second power source to the power lines with the determined polarity. The switch may be a relay controlling two sets of form C contacts or may be transistor switches. The local power controller preferably also uses a switch to control the powering of the power lines with the second power source.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when

considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic of a train incorporating the principles of the present invention.

Figure 2 is a schematic of the polarity detector with power source polarity switching incorporating the principles of the present invention.

Figure 3 is a schematic of the flow chart of the method according to the principles of the present invention.

Figure 4 is a block diagram of a multiple locomotive consist for use with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A train consist, as illustrated in Figure 1, includes a locomotive 10, a plurality of cars 30 and a car 40 with a second power source by trainline 50. The trainline, preferably is a pair of power lines, but may also include other signal lines. The system described provides communications over the power lines but the power and communication lines may be separate lines within the trainline 50. The locomotive 10 communicates and controls the braking and monitors the health of the individual cars using a master brake controller or communications chip 11 which is a Neuron chip as part of a LonWorks communication system, designed by Echelon Corporation of Palo Alto, California.

The Neuron chip 11 can communicate via transceiver 12 connected to the trainline 50 via power line coupling circuit 13. The power line coupling circuit 13, for example, can be a transformer and capacitor circuit, to provide DC isolation, the processor consists of a Neuron chip 11, clock 14, reset 15, and memory 16. The Neuron chip 11 is powered by a voltage converter 17 which is connected to a power supply 18. As illustrated, the 75 volt DC input available on the locomotive is conditioned by power supply 18 and provides a 24 volt DC supply to the converter 17. The DC to DC Converter 17 provides 5 volt DC output from the 24 volt DC input. The Neuron chip 11 controls powering or energizing of the power lines on the trainline 50 by a relay driver 22 and a relay 24. The high voltage DC power source on

the trainline is connected as an input to the relay 24 and provided on the trainline cable 50 under the control of the relay 24. Typically, the available power source is 230 volts DC.

Each of the individual cars 30 includes a local brake controller or Neuron chip 31, communicating over the trainline 50 via power line transceiver 32 and power line coupling circuit 33. Other components of the controller include the Neuron chip 31, a clock 34, a reset circuit 35, and memory 36. A power supply 38 connected to the trainline 50 receives power from the trainline and charges the battery 41 through the battery charger 39. The battery 41 provides power as an input to the converter 37 which powers the Neuron chip 31.

It should be noted that the Neuron chip 11 and the LonWorks is a preferred communication method. Other communication methods may be used. The communication, control and monitoring system at the locomotive and at the individual cars may include additional elements or pieces of electronics, but those disclosed are those needed to perform the method of the present invention.

Although each of the cars 30 and 40 include a battery 41, the system operates from a 120-240 volts AC or DC with a power level of 1200 to 2500 watts over the trainline 50. The trainline 50 is a serially connected trainline running car to car through an appropriate connector. The battery 41 on each car has sufficient power to operate the Neuron chip 31 and its transceiver 32.

Car 40 includes a Neuron chip or controller 31 connected to the trainline 50 by transceiver 32 and coupling circuit 33. It also includes power supply 38, battery charger 39, battery 41 and converter 37, clock 34, reset 35 and timing 36 not shown for sake of clarity. Car 40 also includes a trainline power

source 42 which is connected by polarity switch 44 to the trainline cable 50. The trainline power source 42 is activated by power switch 46 controlled by Neuron controller 31 as is the polarity switch 44. The Neuron controller 31 with a polarity detector 48 detects the polarity of the power lines in the trainline 50 and sets the appropriate polarity by polarity switch 44. Once this is completed, the power switch 46 activates or connects the trainline power source 42 to the polarity switch 44. The flow chart for this process is illustrated in Figure 3 and begins with the receipt of a power command received by Neuron 31 in car 40 from the locomotive controller Neuron 11.

It should be noted that car 40 represents a secondary power source for the trainline which may be on a car or on an additional locomotive within the train consist. The Neuron 31 may be dedicated only to the secondary power source 42 or may be part of the system which is available on the cars for controlling and monitoring other elements including EP brakes.

An implementation of the system for car 40 is illustrated in Figure 2, the polarity detector 48 includes a pair of parallel opposed diodes D1 and D2 connected between trainline 1 and trainline 2. The diodes D1 and D2 are selectively connected and disconnected across the trainlines by contacts 80 controlled by relay 82 which is driven by relay driver 84 controlled by the Neuron controller 31. When the Neuron controller 31 receives its command to connect the second power source 42, it activates the relay 82 and closes contacts 80 placing the diodes D1, D2 in parallel opposition across the train power lines. In series with diodes D1 and D2 are electro-optic isolator 86 which determine conduction by one of the two diodes, D1 and D2 and communicates this to the Neuron controller 31. If trainline 1 is positive compared to trainline 2, diode D1 conducts. If

trainline 2 is positive with respect to trainline 1, diode D2 conducts. Using this information, the Neuron controller 31 can determine which of the polarity of the trainlines.

The polarity switch 44 is illustrated as two sets of Form C contacts 70 and 72 selectively connected to the positive and negative terminals of the trainline power source 42. The position of contacts 70 and 72 are controlled by relay 74 which is driven by relay driver 76 which is controlled by Neuron controller 31. Based on the polarity determined by Neuron controller 31, the relay 74 is either activated or deactivated. In the deactivated position shown, the positive terminal of the trainline power source 42 is connected to trainline 1 and the negative terminal is connected to trainline 2. If the opposite polarity is detected, the Neuron 31 activates relay 74 through relay driver 76 to change the position of contacts 70 and 72 from that shown and connects via contact 70, trainline 1 to the negative terminal of the trainline power source 42 and via contact 72, trainline 2 to the positive terminal of the trainline power source 42.

The power switch 46 may include a transistor switch connected to the remote "turn on" circuitry of the trainline power source 42. Closing this power switch 46 energizes a relay within the trainline power source 42 which applies power to the trainline through the previously configured polarity switch 44.

Although the polarity detector 48 and the polarity switch 44 are shown in Figure 2, as being controlled by relays, the same could be implemented using power transistor switches. The Neuron controller 31 would drive these switches through drivers equivalent to 84 and 76 which would place the diodes D1 and D2 across and disconnect them from being across the trainlines 1 and 2 as well as determining

the connection of the polarity of the trainline power source 42 to the trainlines.

A train may include more than one locomotive as illustrated in Figure 4. Two locomotives, for example, 10A and 10B are shown interconnected by an EP trainline 110 to be connected to the trainline 50. Each locomotive has a respective EP trainline connector 108, 112 and 118. The lead locomotive 10A has an EP brake controller 100 and an operator interface unit 102 connected to the trainline communication controller 104. The trainline communication controller 104 would include elements 11-18 of Figure 1. A locomotive color display 106 is optional. The trainline communication controller 104 is connected to the EP trainline 110 by EP trainline connector 108 of the lead locomotive 10A. The trainline communication control 104 communicates over EP trainline 110.

In the trailing locomotive 10B, a power line supply 116 is connected to trainline power controller 114. EP trainline connectors 112 and 118 connected the trainline controller 114 to the to the EP trainline 110. The trainline power controller 114 includes elements 11, 22 and 24 from Figure 1. The trainline power controller 114 provides the high powered voltage connection to the EP trainline 110 and 50.

Although the present invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only, and is not to be taken by way of limitation. The spirit and scope of the present invention are to be limited only by the terms of the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of powering with a second power source the power lines in a train, the train including at least one locomotive and a plurality of cars, each car being serially connected electrically to an adjacent car by a trainline having at least two power lines powered by a first power source and having a local controller controlled by a master controller in said locomotive, the method including the steps of automatically:

determining the polarity of the power lines;

connecting said second power source to said power lines with the determined polarity; and

powering said power lines with said second power source.

2. The method according to Claim 1, including a local power controller connected to said second power source and said trainlines; and said local power controller performing said determining, connecting and powering.

3. The method according to Claim 2, including transmitting a power command from said master controller to said local power controller to initiate said determining, connecting and powering.

4. The method according to Claim 3, wherein said power command is transmitted over said trainlines.

5. The method according to Claim 3, wherein said power command is transmitted over said power line.

6. The method according to Claim 1, wherein determining said polarity includes placing parallel, opposed diodes across said power lines and determining conduction of one of said diodes.

7. The method according to Claim 6, wherein said diodes are placed across said power lines by a switch activated by a local power controller.

8. The method according to Claim 1, wherein connecting said power source to said power lines with the determined polarity includes controlling a condition of a switch by a local controller.

9. The method according to Claim 8, wherein said local power controller also controls powering said power lines with said second power source.

10. The method according to Claim 9, including transmitting a power command from said master controller to said local power controller to initiate said connecting and powering.

11. A train including at least one locomotive and a plurality of cars, each car being serially connected electrically to an adjacent car by a trainline having at least two power lines powered by a first power source and having a local controller controlled by a master controller in said locomotive, including a second source, the train including:

a local power controller which determines the polarity of the power lines, connects said second power source to said power lines with the determined polarity, and powers said power lines with said second power source.

12. The train according to Claim 11, wherein said master controller transmits a power command to said local power controller to initiate said determining, connecting and powering.

13. The train according to Claim 12, wherein said power command is transmitted over said trainlines.

14. The train according to Claim 12, wherein said power command is transmitted over said power line.

15. The train according to Claim 11, including a switch activated by a local power controller placing parallel, opposed diodes placed across said power lines, and said local power controller determines said polarity by determining conduction of one of said diodes.

16. The train according to Claim 15, including electro-optic isolators connecting said diodes to said local power controller.

17 The train according to Claim 15, wherein said switch includes a relay having a pair of contact in series with each of said diodes.

18. The train according to Claim 15, wherein said switch includes a semiconductor switch in series with each of said diodes.

19. The train according to Claim 11, including a first switch controlled by said

local power controller to connect said second power source to said power lines with the determined polarity.

20. The train according to Claim 19, wherein said first switch includes a relay controlling a pair of Form C contacts connecting said second power source to said power lines.

21. The train according to Claim 19, wherein said first switch includes semiconductor switches connecting said second power source to said power lines.

22. The train according to Claim 19, including a second switch controlled by said local power controller to connect said second power source to said first switch to power said power lines with said second power source.

23. The train according to Claim 22, wherein said second switch includes a solid state switch driving a relay with two normally open contacts and connecting said second power source to said first switch.

24. A train substantially as hereinbefore described with reference to the accompanying drawings.

25. A method of powering the power lines in a train substantially as hereinbefore described with reference to Figure 3 of the accompanying drawings.

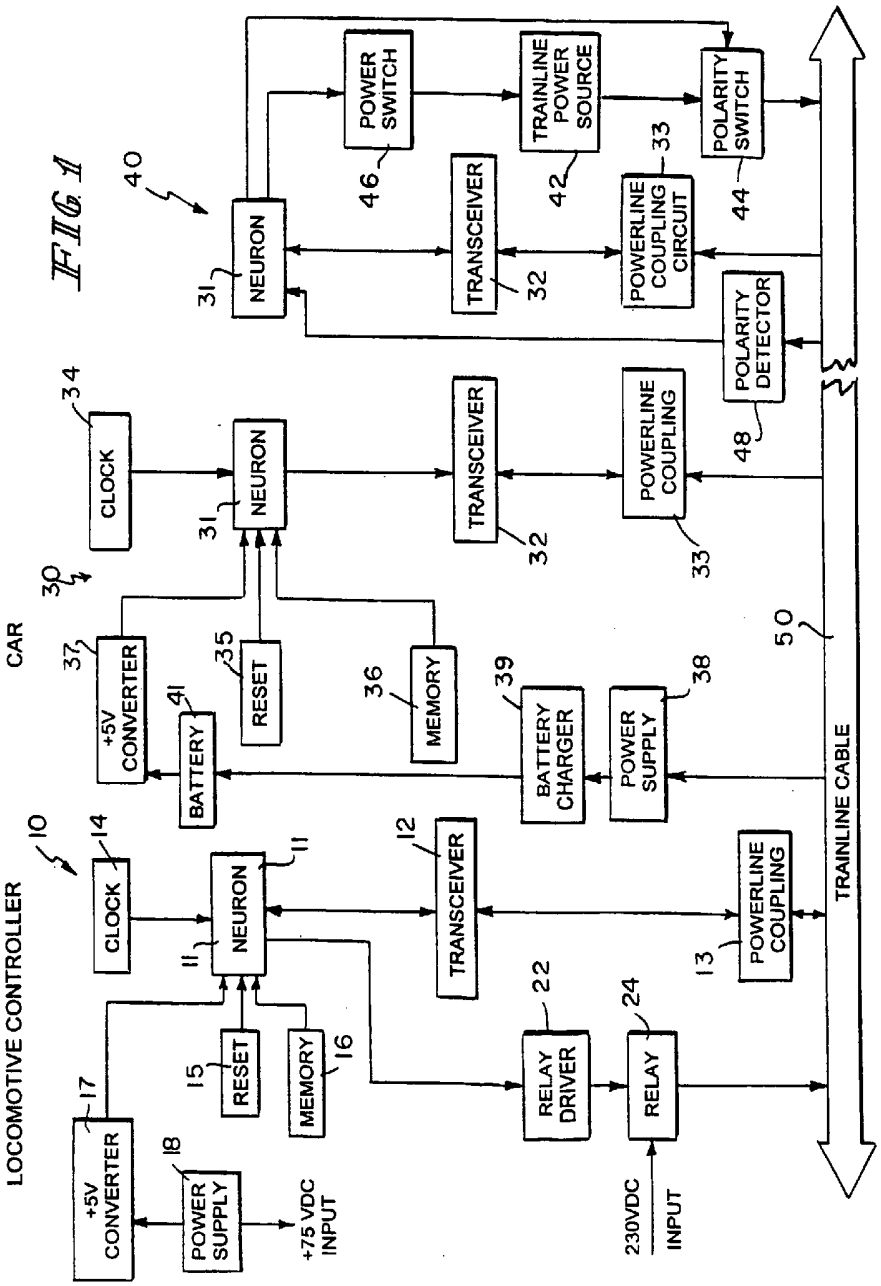
Dated: 11 January 2001

Freehills Carter Smith Beadle

Patent Attorneys for the Applicant

NEW YORK AIR BRAKE CORPORATION

FIG 1


LOCOMOTIVE CONTROLLER
CAR
TRAINLINE CABLE
CLOCK
NEURON
TRANSCEIVER
POWERLINE COUPLING
+5V CONVERTER
POWER SUPPLY
+75 VDC INPUT
RESET
MEMORY
BATTERY
BATTERY CHARGER
RELAY DRIVER
RELAY
230VDC INPUT
POWER SWITCH
TRAINLINE POWER SOURCE
POLARITY SWITCH
POWERLINE COUPLING CIRCUIT
POLARITY DETECTOR
10
11
12
13
14
15
16
17
18
22
24
30
31
32
33
34
35
36
37
38
39
40
41
42
44
46
48
50

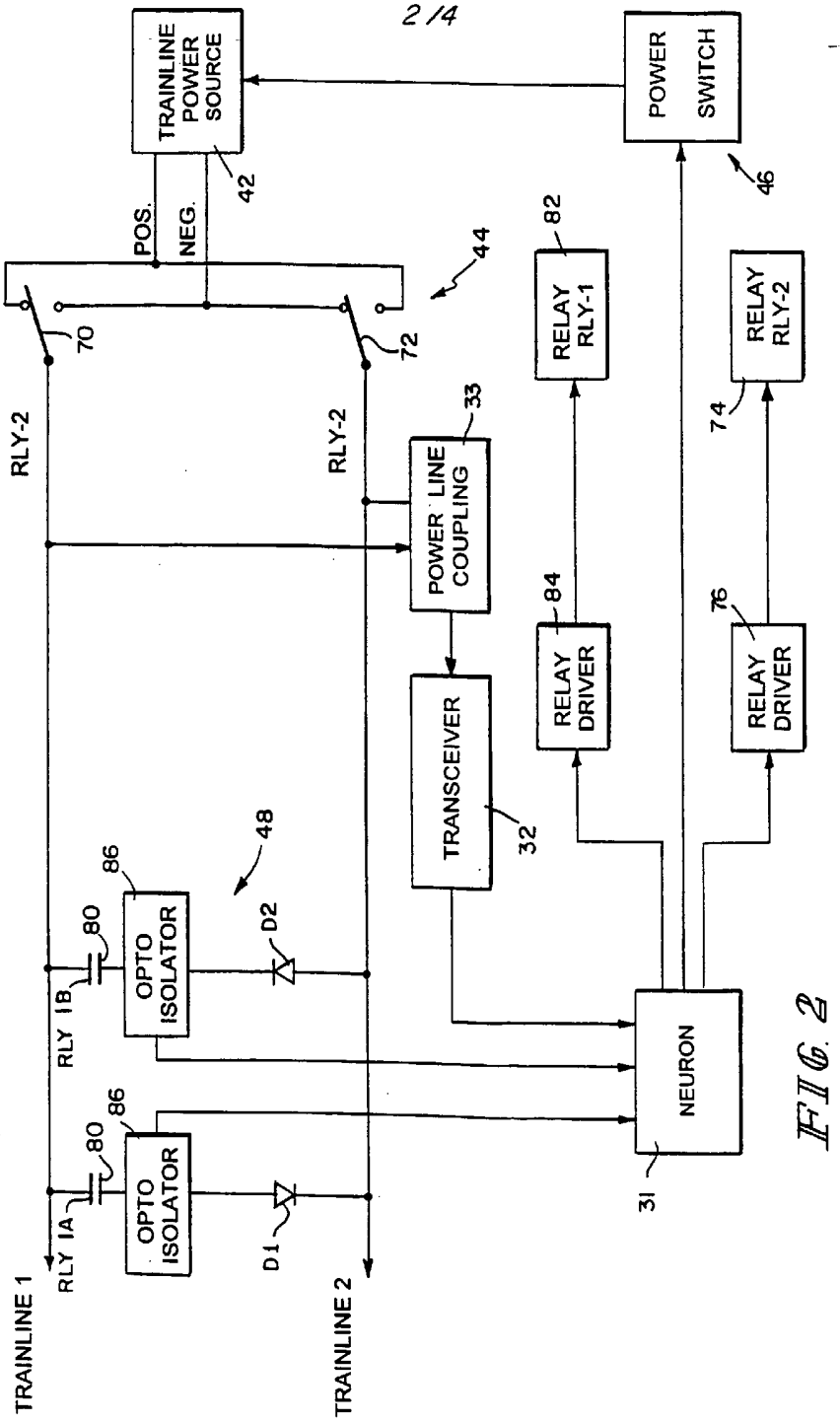
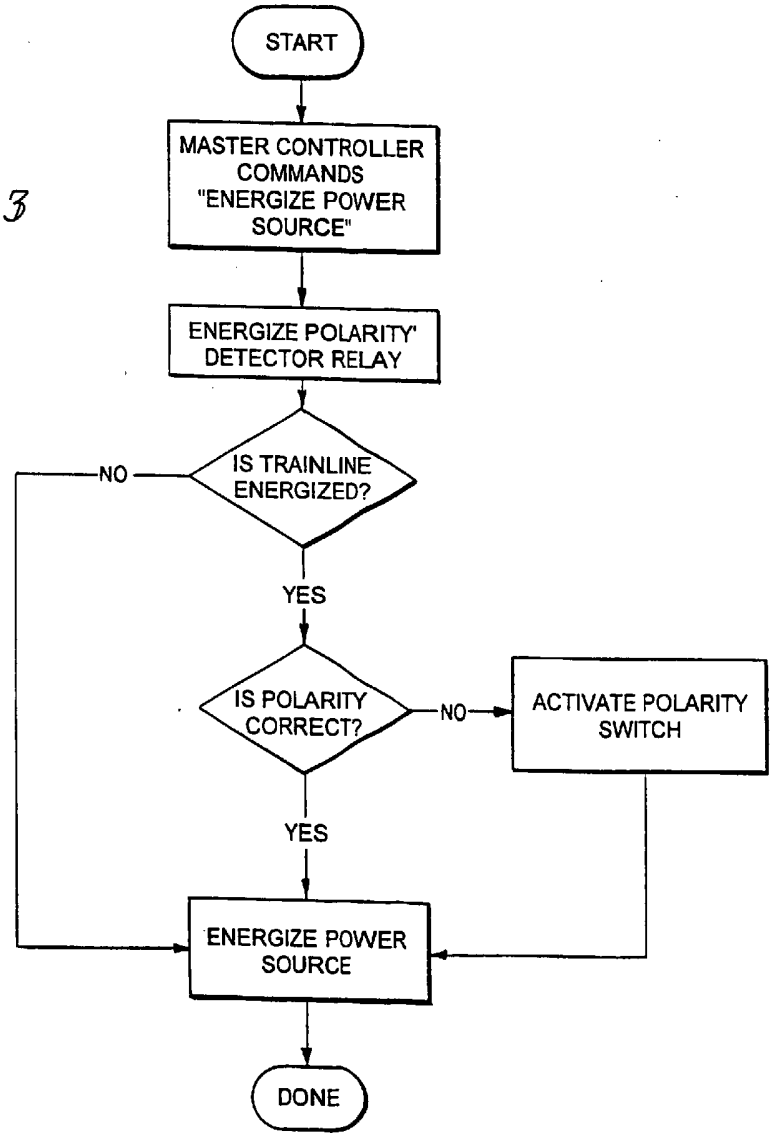

2/4
TRAINLINE POWER SOURCE
42
POWER SWITCH
46
POS.
NEG.
44
70
72
82
RELAY RLY-1
RELAY RLY-2
74
RLY-2
RLY-2
33
POWER LINE COUPLING
84
RELAY DRIVER
76
RELAY DRIVER
TRANSCEIVER
32
48
86
80
OPTO ISOLATOR
D2
RLY 1B
86
80
OPTO ISOLATOR
RLY 1A
D1
NEURON
31
TRAINLINE 1
TRAINLINE 2

FIG. 2

FIG 3


START
MASTER CONTROLLER COMMANDS "ENERGIZE POWER SOURCE"
ENERGIZE POLARITY DETECTOR RELAY
IS TRAINLINE ENERGIZED?
NO
YES
IS POLARITY CORRECT?
NO
ACTIVATE POLARITY SWITCH
YES
ENERGIZE POWER SOURCE
DONE

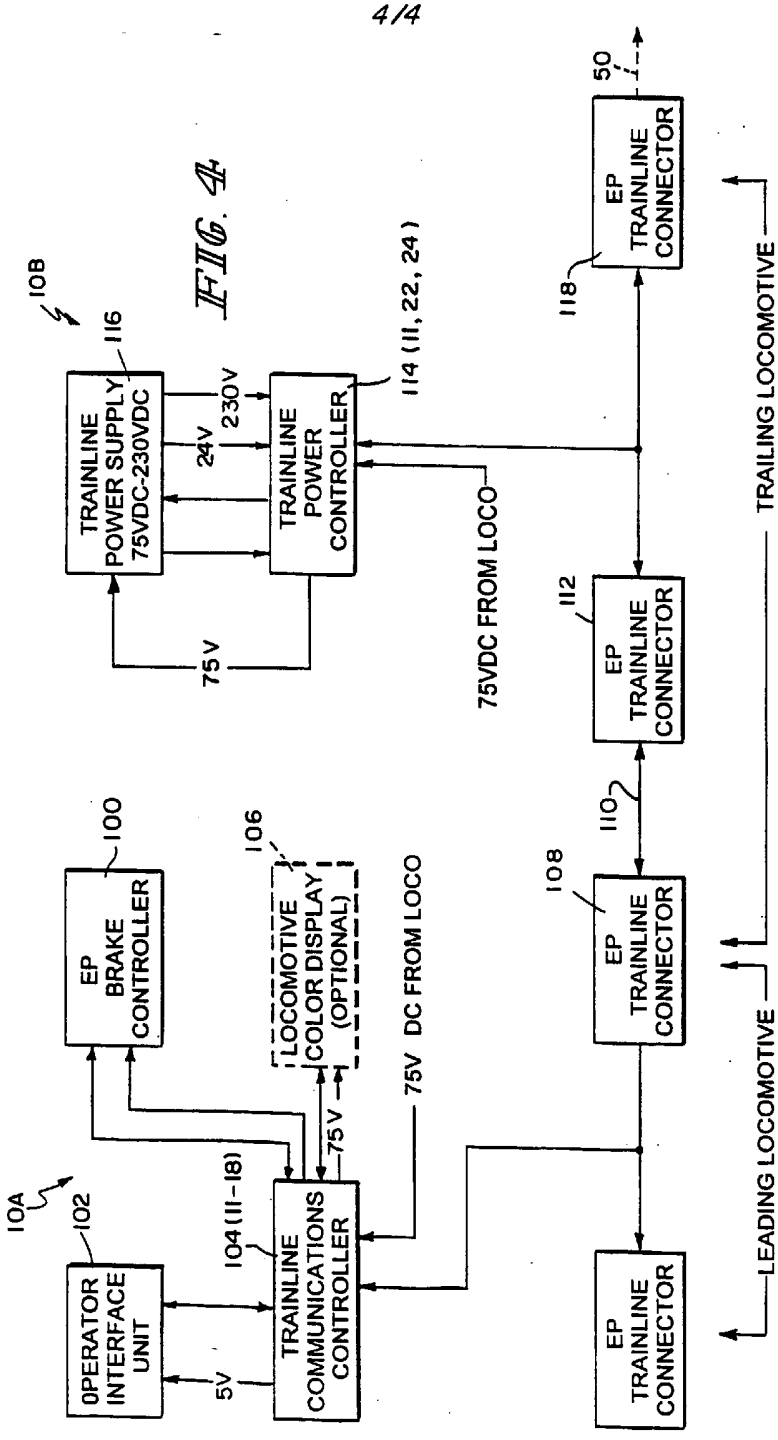

50
EP TRAINLINE CONNECTOR
118
TRAILING LOCOMOTIVE
108
TRAINLINE POWER SUPPLY 75VDC-230VDC
116
230V
24V
75V
TRAINLINE POWER CONTROLLER
114 (11, 22, 24)
75VDC FROM LOCO
112
EP TRAINLINE CONNECTOR
110
100
EP BRAKE CONTROLLER
106
LOCOMOTIVE COLOR DISPLAY (OPTIONAL)
75V
75V DC FROM LOCO
108
EP TRAINLINE CONNECTOR
10A
102
OPERATOR INTERFACE UNIT
5V
104 (11-18)
TRAINLINE COMMUNICATIONS CONTROLLER
EP TRAINLINE CONNECTOR
LEADING LOCOMOTIVE

FIG. 4