ENGINEERING REPORT

ON

CONTROL EQUIPMENT

Oct. 1, 1926

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CONTROL EQUIPMENT

Car equipments are divided into two general classifications:

1st Drum or platform type control.
2nd Remote or multiple unit control.

The most generally used of the drum controllers is known as the "K" type. The characteristic feature of the "K" controller is the parallel combination of motor connections. "K" controllers are used principally for single car operation. Under certain conditions, the "K" type of controller can also be arranged to operate two cars in a train using either two large or four small motors on each car. This adapts its use to city service where it is required to operate two cars in train during rush hour periods.

Remote control includes Type M, PC, and PCM. This control covers the field where some of the following conditions are to be met:

(a) Train operation.
(b) Use of larger motors than can be handled with a "K" controller.
(c) High voltage operation.
(d) High accelerating rates.

Trolleys

The US-24-A trolley base is standard for all car equipments.

The pole recommended is the seamless steel trolley pole and is 12 ft. 4 inches long, making with harp and wheel, a 13 ft. trolley equipment. A form 31 wheel (4 1/2 in. size) with the form 25 harp is standard for equipments having a total motor capacity of 200 hp. at 600 volts or less. With equipments of greater capacity, the form 48 (6 in. size) wheel with the form 30 harp is furnished.

Lightning Arresters

The MD-3 lightning arrester is standard for 600-volt car equipments and the aluminum cell, type A Form A for 1200- and 1500-volt equipments. When the aluminum cell type is used on 600 volts, an additional price per equipment must be secured. Where lightning is infrequent, we supply two MD-3 arresters connected in series for 1200 volts. These are cheaper than the aluminum cell type.

The advantages of the aluminum cell lightning arrester where lightning is prevalent are too well known to require description. The use of reactors is no longer recommended.

Reactor Core

Reactor cores are not furnished as part of a standard equipment, as these cores are merely a piece of wood around which a few turns of the trolley cable is wrapped and when used can be as easily made as the wood base upon which the trolley is set.

FUSE BOXES

A main line fuse box is not furnished with standard 600-volt K control equipments but is included with all PC control equipment.

With 1200- and 1500-volt equipments, both K and PC control, a main line fuse box is furnished.

MOTOR RESISTORS

On all city and interurban car equipments, the type of cast grids known as the BG resistor, cf the edgewise-wound resistor known as the EW type, is furnished.

In ordering motor resistors, Car Equipment Resistor Data Sheet, form 11485 must be filled cut and sent to the Railway Equipment Engineering Department.

As a general rule a BG form A-4 resistor will take care of the following capacity motors (based on an hourly rating at 600 volts).

Express cr freight car	35 to 50 hp. per resistor box
City or interurban service	45 to 65 hp. per resistor box
Suburban, elevated or subway service	60 to 75 hp. per resistor box

A BG form A-8 resistor will take care of 50 per cent greater hp. than the BG form A-4.

CAR EQUIPMENT RESISTOR DATA SHEET

The following information must be furnished to the Railway Equipment Engineering Dept. to obtain proper motor resistors for car equipments:

CUSTOMER ..... REQ .....

LOCATION ..... DATE .....

No. of motors on car ..... Type of motor .....

Line voltage, average ..... Wheel dia. ..... in.

Line voltage, maximum ..... Gear ratio .....

Type of control .....

Give type and form of platform or multiple unit controller. If resistors are for a multiple unit control of other manufacture than General Electric, a wiring diagram of car equipment should be furnished.

Seating capacity of car .....

Weight of motor car, equipped ..... lb.

" " " " with aver. load ..... lb.

" " " " " max. load ..... lb.

Trail cars:

Number .....

Weight ..... lb. each

Class of service:

Passenger { City / Interurban / Elevated or Subway

Baggage or express.

Freight.

REMARKS: .....

.....

.....

.....

SIGNED .....

Cable Data Sheet Oct. 1, 1926

Req. No. .....

Data Sheet on Car Controller Cables

(Make out a separate sheet for each size of cable needed)

The made-up cables to be furnished to.....for use on.....cars are to be made according to dimensions given hereon.
(Quantity)

Length of car over all.....ft.

Weight of car body and trucks.....

Single or double truck car.....

Distance between truck centers.....

Wheel base of trucks.....

Motors mounted "A" or "B" (i.e., inside or outside of axles) .....

Type of motors.....

No. of motors per car.....

Location of motors on trucks *.....

Type of controllers.....

No. 1 End

No. 2 End

Locate on above sketch, taps to motors, rheostats, and other apparatus, giving distances between all sets of leads, total lengths of cables between bottoms of controllers, and lengths of taps. Unless otherwise ordered, motor taps will be furnished 3 feet long and resistance taps 6 feet long.

The trolley wire to controllers will not be included in made-up cables unless indicated.

Length of ground wire from controller to controller, including taps to motor frame, is.....ft.

(Ground wire will be furnished 20 ft. longer than cables, unless otherwise specified.)

Signed..... Date.....

NOTE.—The total length of cable should be measured from bottom to bottom of controllers, as the leads at each end will be of proper length to connect to controller binding posts. If the car body has been built, a convenient way for measuring lengths of cables is to lay a small rope in the proposed position of the cables; on this mark the position where the taps should emerge and measure their needed length; then remove rope, lay it in a straight line and measure the several portions of the length and fill in same on above sketch. Allow three inches extra for any corner around which cable has to be bent. Do not allow too much margin for fear you will measure cables short, because slack can always be secured by running cables diagonally at end of car. Cables will be built exactly as specified above.

* Considering the car axles to be numbered consecutively from No. 1 end of car, give the numbers of axles on which motors are placed.

CAR CABLES

While the former practice was to furnish made-up cables, our customers have more and more requested that the cable be furnished in uncut lengths, in as much as when furnished this way it can be made to fit the car better, and where conduit is used as is the general practice a much easier installation is made. This practice is now standard. Unless the Engineering Department is advised on the requisiton that customer requires the cables made up in canvas hose and receives the required information on Cable Data Sheet No. 10242 (see previous page) the cable will be shipped in uncut lengths.

It was formerly the practice on "K" controller equipments to furnish extra flexible cable for motor lead taps. As the National Electric Code specifies that the motor leads must be cleated to the car body on both sides of the motor lead connector, the use of extra flexible cable from the controller cable to the motor lead connector is unnecessary, and standard car wiring cable is furnished for this purpose.

MOTOR LEAD CONNECTION BOXES

Motor lead connection boxes are not furnished as a part of standard control equipments but can be furnished at an additional price in place of the motor lead connectors.

FIELD CONTROL

With either Type K or PC equipments using two tap field Motors, the connections for tapping the motors are made in the motor controller.

With four motor car equipments the connections for the tapping the motors are made by a separate electro-pneumatically operated field control switch. The motors are tapped in the parallel position only. The field switch being controlled by a current limit relay preventing the fields being tapped until the motor current has reached the proper value.

LIGHTING EQUIPMENT

Standard lighting equipments furnished with car equipments are:

18—LAMP EQUIPMENT—CONNECTIONS—K-1636295 Page 9.
On all two-motor equipments up to and including 125 H.P., 600 volt motors.
29—LAMP EQUIPMENT—CONNECTIONS—K-1636296 Page 10.
On all four-motor equipments up to and including 65 H.P., 600 volt motors.
34—LAMP EQUIPMENT—CONNECTIONS—K-1920962 Page 11.

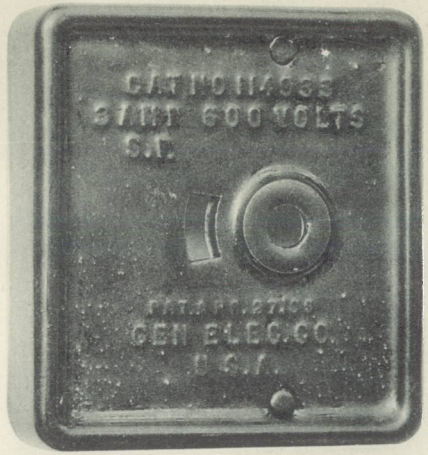
On equipments with:
Two-motors exceeding 125 H.P.
Four-motors exceeding 65 H.P.

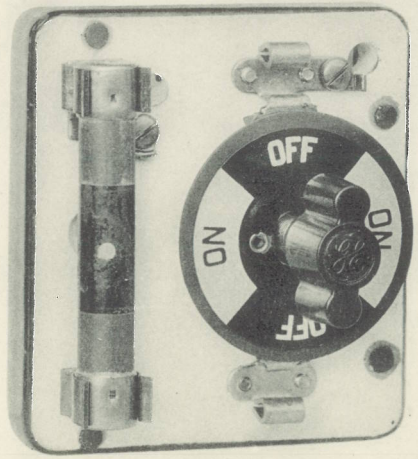
Page 8 shows photographs of socket, lamp and switches.

EQUIPMENT WITH REFLECTOR—CONNECTIONS—K-1636294 PAGE 12.

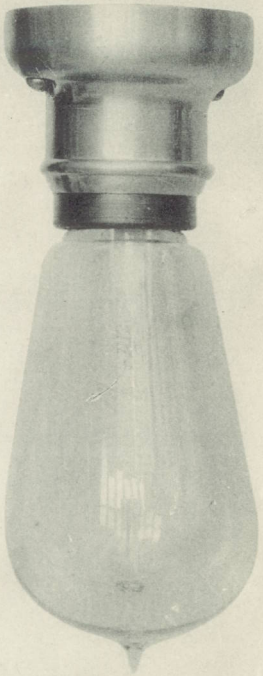
Lighting equipment with reflectors and holders can be furnished at an increased price over the standard equipment.

3 WAY SNAP SWITCH
CAT. 89596

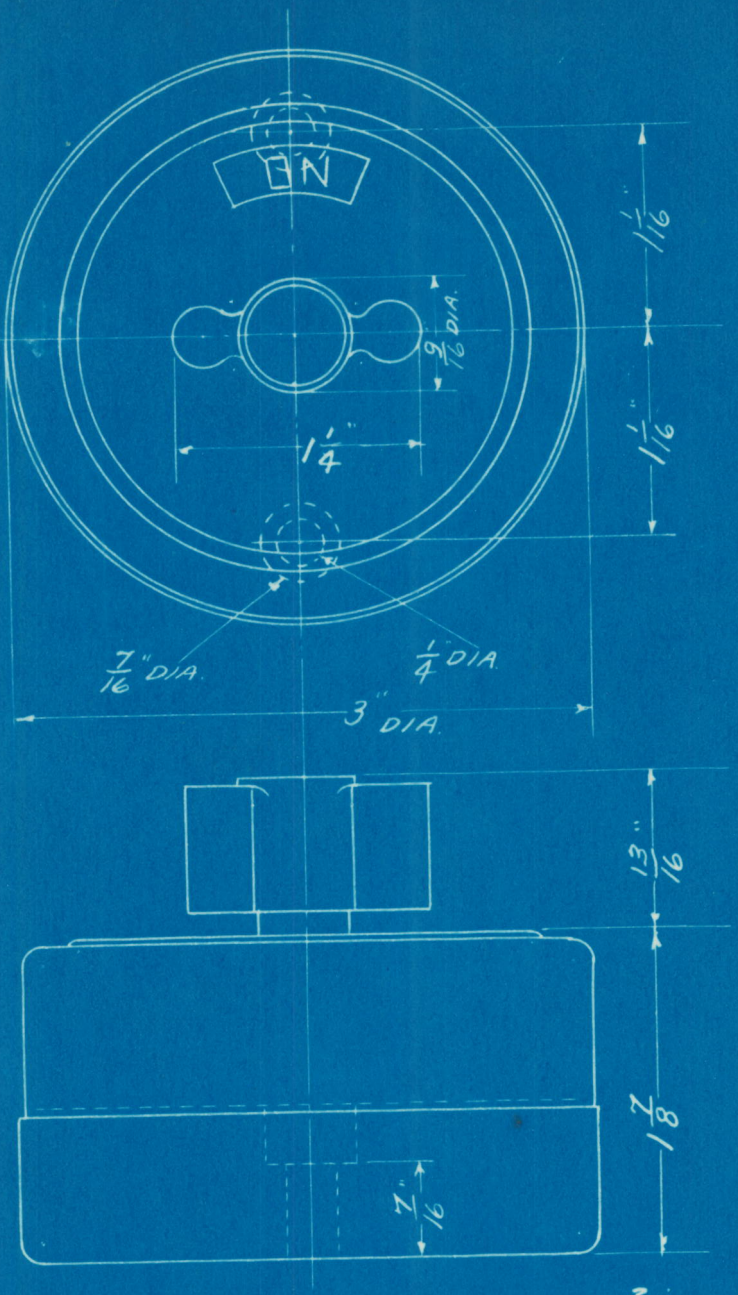




COMBINATION
SWITCH AND
CUTOUT CAT.
GE-933 FUSE
CAT. 28839.



KEYLESS RECEPTACLE
CAT. GE-009 WITH
23 WATT MAZDA LAMP.



WEIGHT- 3/4 LB.

OUTLINE

600 VOLT SNAP SWITCH

CAT. GE 921

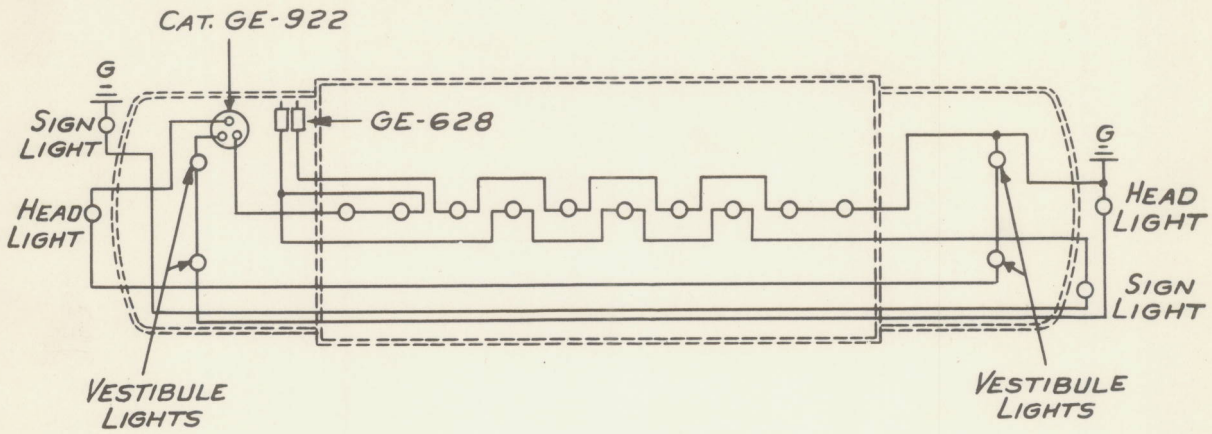
K-763118

DRAWN BY C.L. Smith Mar 16-1922 INSPECTED BY M.M. McELHANEY MAR. 17-22

A.B

GENERAL ELECTRIC COMPANY

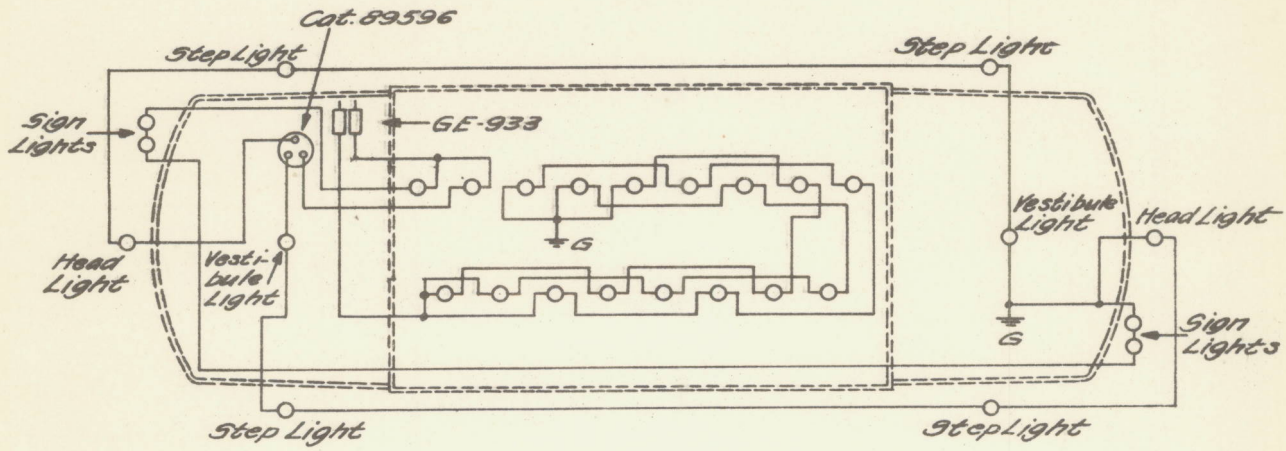
FF 449 2M 4-15-21



300 Ft. No.14 B & S Cable Weatherproof Finish SI-53080.
18-23 Watt 110 Volt Railway Mazda Lamps With S-17 Bulb & Medium Screw Base No.102.
16 Keyless Receptacles Cat. GE-009.
2 Combination Switches & Cutouts GE-628.
4-3 Amp. Fuses Cat. 28839.
1-3 Way Snap Switch Cat. GE-922.
Weight 23½ Lbs.

CONNECTIONS
Standard Lighting Equipment Using 18-23 Watt Mazda Lamps

K-1636295



450 ft No.14 B & S Cable weatherproof finish EB-11439-G
29 - 23 Watt 110 Volt Railway Mazda Lamps with S-17 Bulb & Medium Screw Base No.102
27 Keyless Receptacles Cat. GE-009
2 Combination Switches & Cutouts GE-933
4 - 3 Amp. Fuses Cat. 28839
1 - 3 Way Snap switch Cat. 89596

Weight · 34½ lbs.

(3) REVISED APR-19-'26 R.W.L.
(2) REVISED JUNE 14, 1918

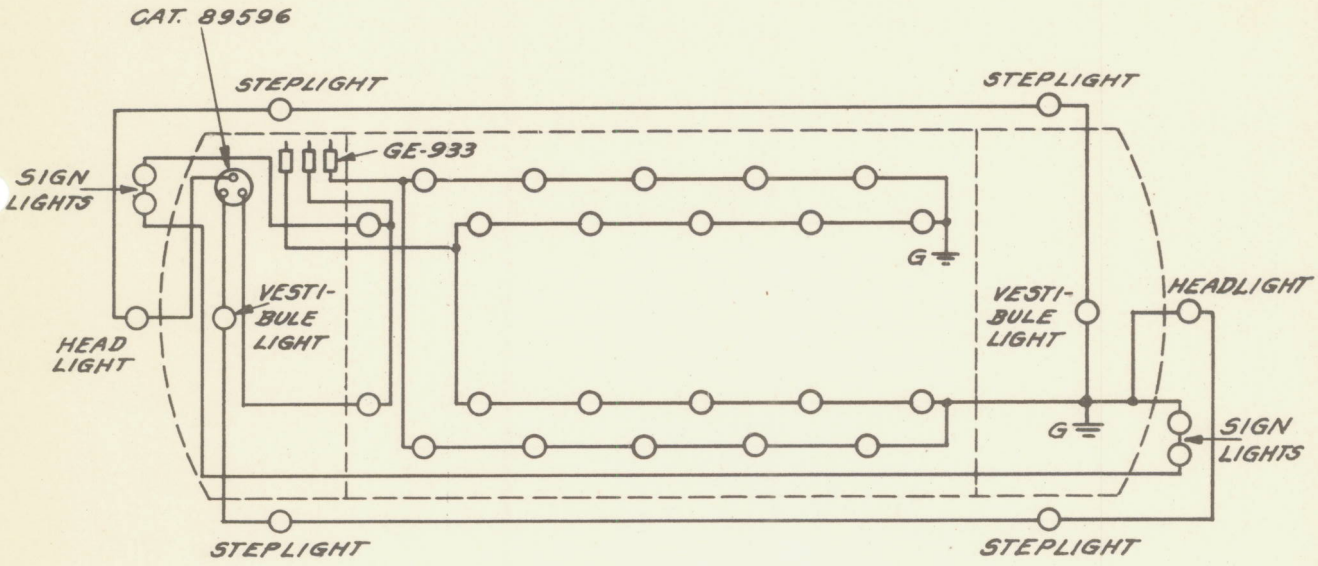
CAR EQUIPMENT
Standard Lighting Equipment
using 29-23 Watt Mazda Lamps

K 1636296

Checked W.J.D. H.C.H. Approved Rwy. Equip. Dept

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

DRAWN BY T.T. Hopkins Jr. 2 Mar. 1917 INSPECTED



500 FT. NO.14 B & S CABLE EB-11439
34-23 WATT 110 VOLT RAILWAY MAZDA LAMPS WITH S-17 BULB & MEDIUM SCREW BASE NO.102
32 KEYLESS RECEPTACLES CAT. GE-009
3 COMBINATION SWITCHES AND CUTOUTS CAT. GE-933
6-3 AMP. FUSES CAT. 28839
1-3 WAY SNAP SWITCH CAT. 89596

WEIGHT 36 LBS.

(1) REVISED APR. 19-'26 R.W.L.
CAR EQUIPMENT

STANDARD LIGHTING EQUIPMENT
USING 34-23 WATT MAZDA LAMPS

K1920962

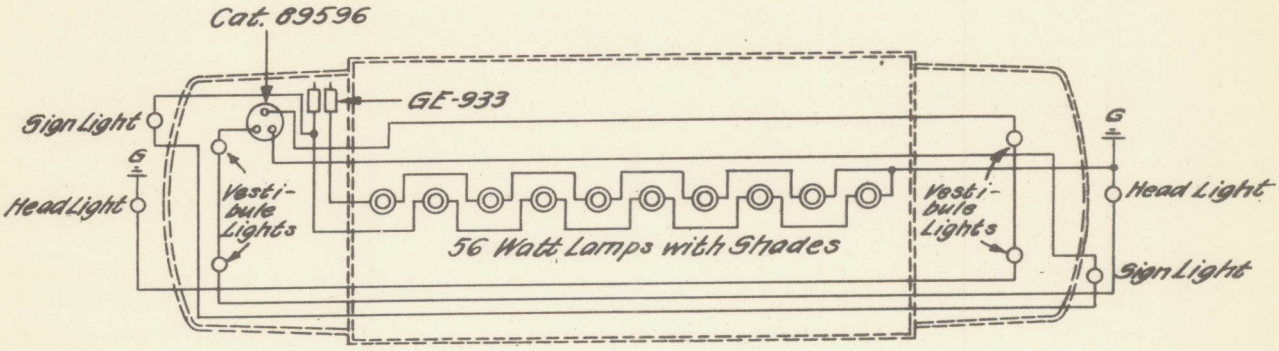
CHECKED F.S.T.B. C.A.B.

APPROVED RWY. EQUIP. DEPT.

GENERAL ELECTRIC COMPANY, SCHENECTADY, N.Y.

R.C.

DRAWN BY T.J. HOPKINS JR. APR. 30, 1919 INSPECTED May 3-1919



400 ft. No. 14 B & S Cable, weatherproof finish E.B. 11439-G
10-56 Watt-110 Volt Railway Mazda Lamps
8-23 " " " " " "
10 Combination sockets and shade holders Cat. 153755
10 Sudan Shades Cat. 6047-7
6 Keyless Receptacles Cat. GE-009
2 Combined switches and cutouts Cat. GE-933
4-3 Amp. fuses Cat. 28839
1-3 Way snap switch Cat. 89596

Weight 68 lbs.

(2) REVISED July 2-26 J.J.
(1) REVISED JUNE 14, 1918

CAR EQUIPMENT
Car Lighting Equipment
using 10-56 Watt Lamps with Shades and Auxilliary Circuit of 23 Watt Lamps

K1636294

Checked W.J.O. N.C.K. Approved Rwy. Equip. Dept.

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

DRAWN BY T.E. Hopkins Jr. 2 Mar. 1917 INSPECTED

K.1636294

COUPLERS

The couplers here described pertain only to connecting electric circuits between adjacent cars. They consist of coupler sockets, fastened permanently to the car, and jumpers, made up of two coupler plugs connected with extra flexible cable. Coupler sockets are made in two general types known as dashboard and platform. As may be inferred from these names, the dashboard type is arranged for mounting either in the car dash or letter board, while the platform type is mounted underneath the platform, on the drawhead or car roof.

When sockets are installed on the center line of the car or close to it, only two per car are required. When they are very far off the center line it is necessary to use four sockets per car. Our standard equipments, include only two dashboard type sockets per car. Where conditions require the additional sockets an extra price should be included.

The two general types of sockets are each divided into kinds known as bus line and train line. The bus line socket usually has a single connection to carry trolley current between cars. The train line sockets have a number of electrically separate contacts and are primarily used to connect the control circuits between adjacent cars. The train line sockets are made with 7, 9, 10, 12 and 16 separate contacts. The types "PC" and light-weight "M" controls require 7 and 9 train wires respectively and as a result the sockets with 7 and 9 contacts are standard and can be obtained more quickly than any of the others.

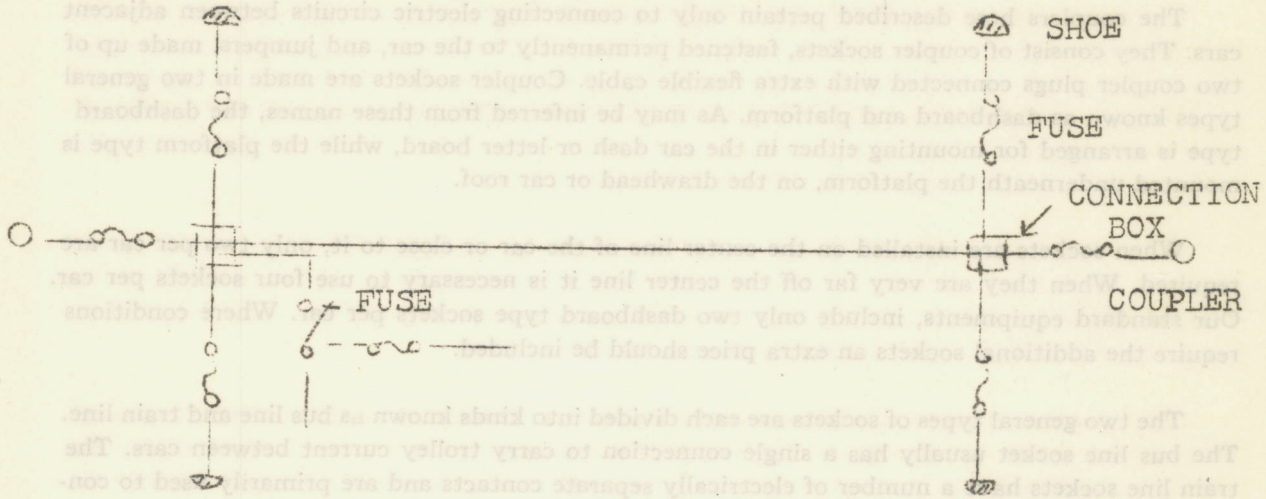
BUS LINE—Third Rail

The bus line on third rail equipments is used to connect all of the shoes in the train together and thereby span a gap in the third rail preventing interruptions of power supply to the car.

The usual method of connecting the bus line for third rail and the amount of apparatus required is shown on Page 14. Fuses are used on the third rail bus line due to the more severe short circuits, as usually third rail installations have a far greater station capacity and a much heavier distribution system.

COMMON STANDARD FOR CARS

STANDARD NO. 9A - THIRD RAIL BUS LINE CONNECTIONS



MATERIAL FOR BUS LINE

2 Coupler sockets
2 Coupler plugs with jumper cable
2 Car type fuse boxes with fuses
2 Connection boxes
1 Lot cable standard stranding

THIRD RAIL SHOE EQUIPMENT

4 Third rail shoe fuse boxes and fuses
1 Lot extra flexible cable from shoe to connection box

Capacity of all bus line cable to be same as trolley cable for a single car.

Length of cable to suit customer's car.

Cable from third rail shoe to junction box to be extra flexible and length to suit.

Cable from coupler sockets to junction box and between junction boxes to be standard stranding.

BUS LINE—TROLLEY

Bus line apparatus is not part of a standard equipment and when required will be furnished only as an extra.

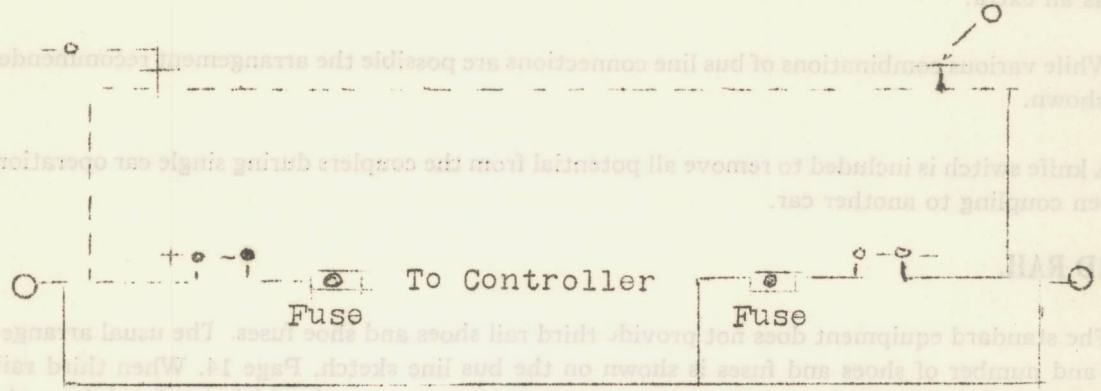
While various combinations of bus line connections are possible the arrangement recommended is as shown.

A knife switch is included to remove all potential from the couplers during single car operation or when coupling to another car.

THIRD RAIL

The standard equipment does not provide third rail shoes and shoe fuses. The usual arrangement and number of shoes and fuses is shown on the bus line sketch, Page 14. When third rail only is used the trolley bases, trolley poles and lightning arrester should be omitted from the standard equipment.

TROLLEY BUS LINE CONNECTIONS



Length of cable = 1.6L + 34 ft.

No. Motors	HP	Length of cable in ft.	No. Motors	HP	Length of cable in ft.
2	25	80	4	25	100
2	40	95	4	40	115
2	50	100	4	50	115
2	65	110	4	65	120
2	75	115	4	75	125
2	100	115	4	100	130
2	125	120	4	125	135
2	140	125	4	140	140
2	165	125	4		
2	190	130			

Capacity of all bus line cable to be the same as trolley cable for a single car.

AUXILIARY CONTROL CIRCUITS

Frequently with train operation, governor synchronizing, signal or other auxiliary circuits between the cars are desired. Our standard equipment provides circuits only for the control of the motors. Any additional circuits can be furnished only at an increased price.

As a general thing we prefer to keep the control circuit separate from any other circuits, purely as a safety measure. We do not recommend placing any wires in the control circuit that are at trolley potential, for the reason that a connection between the control wires and this wire as trolley potential may take place and make it impossible to disconnect the motors from the trolley.

CONTROL CUTOUT SWITCH

A control cutout switch is not furnished on a standard car equipment, as in case of failure of apparatus, the control jumper between cars can be removed, air supply to the PC controller shut off, or the main switch opened. When certain types of automatic electric couplers are used, a cutout switch is commonly furnished by the manufacturer of the coupler for disconnecting the train line between cars in order to kill the exposed contacts of the coupler before cars are disconnected. Another type of automatic coupler provides a protecting covering for the electric portion closing automatically, at the same time closing the train line air ports as the coupler is disconnected.

The use of the automatic coupler requires a certain amount of extra flexible jumper cable between the cutout switch or connection bus and the coupler. This cable must always be specified as it is not included in the standard equipment.

MOTOR CUTOUT

All G-E car equipments have the motor cutout switches arranged to cut out one half the motors on the car. With most "K" controllers or a two motor PC controller a rheostatic acceleration is obtained when a damaged motor is cutout. With 600 volt four motor PC equipments, or a K-75 controller, a series parallel acceleration is maintained.

"K" CONTROL CAR EQUIPMENT

The list of material comprising a standard "K" control car equipment is given in the Railway. Equipment Price and Data Book

"K" CONTROLLERS

Th e standard controllers listed on Page 21 are for service with commutating pole motors and include the up-to-date features such as fingers with long springs, burning tips, improved blowouts, etc. A very complete description is given in Bulletin 44678-A