Instructions for Installing and Operating

Car- Body Equipment

for

Electric Street Rilways

Sydney Tramway Museum Archive



INSTRUCTIONS FOR INSTALLING AND OPERATING

CAR-BODY EQUIPMENTS

FOR

ELECTRIC STREET RAILWAYS.

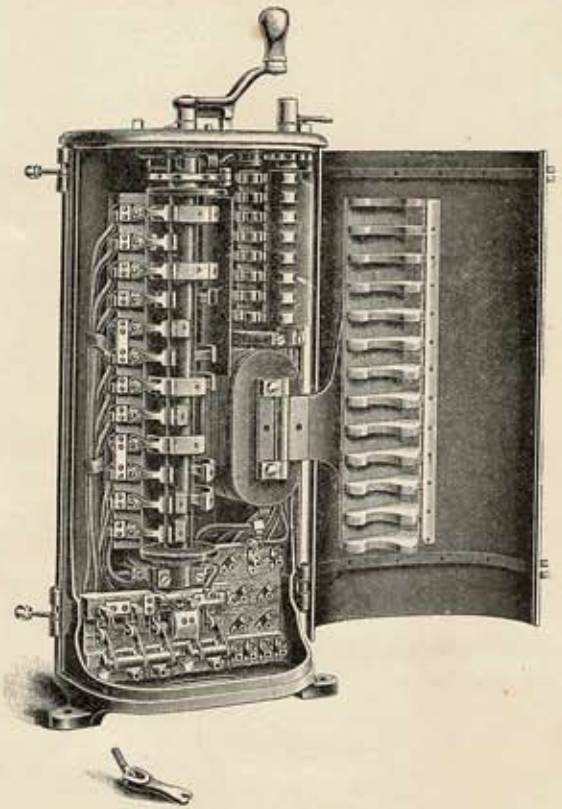
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NO. 8009. SEPT. 3, 1895.



SERIES-PARALLEL CONTROLLER,
FORM K2.

Description and Location of Apparatus.

K2 CONTROLLER.

On account of the greater speed and higher potential employed by many of the later electric roads, we have slightly modified the standard K controller in order to insure a smoother acceleration.

The modified controller when used with two motors is called the K2 controller. It is the same as the K in outward appearance, and is the same width and thickness, but it is about two inches higher, being 35 inches, not including handle, over all. It has one additional rheostatic point in the series and also one in the parallel combination of the motors.

Circuit combinations made by the K2 controller, point by point, are as follows:

1st Point (1)-Full resistance in series with motors (full field) in series.
2nd Point (2)-$\frac{1}{2}$ resistance in series with motors (full field) in series.
3rd Point (3)-$\frac{1}{3}$ resistance in series with motors (full field) in series.
4th Point (4)-No resistance in series with motors (full field) in series.
5th Point (5)-No resistance in series with motors (shunted field) in series.
(6)-$\frac{1}{2}$ resistance in series with motors (full field) in series.
(6½)-$\frac{1}{2}$ resistance in series with No. 1 motor (full field) No. 2 motor shunted.
(7)-$\frac{1}{4}$ resistance in series with No. 1 motor (full field) No. 2 motor open circuited.
(8)-$\frac{1}{3}$ resistance in series with No. 1 motor (full field) No. 2 motor open circuited.
6th Point (9)-$\frac{1}{2}$ resistance in series with motors (full field) in parallel.
7th Point (10)-$\frac{1}{3}$ resistance in series with motors (full field) in parallel.
8th Point (11)-No resistance in series with motors (full field) in parallel.
9th Point (12)-No resistance in series with motors (shunted field) in parallel.

NOTE:—Numbers in brackets correspond to numbers on diagram of cylinder development.

Motor cut-out switches, by means of which either motor can be entirely cut out of circuit, are placed at the base of each controller. When it is desired that both motors be in circuit, as is ordinarily the case, both switches should be down. In place of our former instruction card, the following is now used:—

> **To CUT OUT MOTOR No. 1** (motor nearest **THIS**—**THE OTHER**—end of car) throw up left hand switch as far as it will go.
>
> **To CUT OUT MOTOR No. 2** (motor nearest **THIS**—**THE OTHER**—end of car) throw up right hand switch as far as it will go.

After the controllers are in place, the words "THIS" and "THE OTHER" are to be crossed off, corresponding respectively to the wiring and location of the No. 1 and the No. 2 motor, so that the card in one controller will appear thus:—

> **To CUT OUT MOTOR No. 1** (motor nearest **THIS**—[redacted]—end of car) throw up left hand switch as far as it will go.
>
> **To CUT OUT MOTOR No. 2** (motor nearest [redacted]—**THE OTHER**—end of car) throw up right hand switch as far as it will go.

and in the other controller, thus:—

> **To CUT OUT MOTOR No. 1** (motor nearest [redacted]—**THE OTHER**—end of car) throw up left hand switch as far as it will go.
>
> **To CUT OUT MOTOR No. 2** (motor nearest **THIS**—[redacted]—end of car) throw up right hand switch as far as it will go.

When using the controller at one end of the car, the position of the cut-out switch in the other controller is immaterial, if the idle controller is at "off" position.

A stop is placed on the controller spindle with which a pin (which is raised into position by the throwing up of either cut-out switch) engages, preventing movement of the controller cylinder beyond the fifth point when running on a single motor.

Reversing a car is accomplished by means of a cylinder switch located within the controller. The handle by which this cylinder is rotated is so arranged that it cannot be taken off or put on except when the cylinder is at mid position, the armature leads being then open circuited. An interlocking arrangement prevents any movement of the reversing handle, except when the power cylinder is at "off" position, and also prevents any movement of the power cylinder, except when the reversing handle is thrown either fully forward or backward. Connections to this reversing switch should be so made that the position of the reversing handle will indicate the direction in which the car will move.

Resistance Boxes for the K2 Controller, two in number, are called the K and K2 and are of the dimensions shown in diagram No. 13201.

The K resistance is composed of six panels of sheet iron ribbon, three of these panels, beginning at R1, having a resistance of about 1½ ohms each. The remaining three measure about ½ ohm each.

The K2 resistance contains only four panels, the two central ones each measuring about ¼ ohm each, are connected in series with the K resistance, the six panels of the K and the two in the K2 thus constituting the starting resistance. Additional binding posts are provided to admit of varying the resistance for special conditions. Ordinarily with two motors the connections should be as shown in diagram No. 13200.

The shunt method of weakening the motor fields for high speed is now used with the GE motors and the outer panels on either side of the K2 resistance are provided for the purpose of shunting the motor fields.

Each shunt panel measures 1.8 ohms; a binding post in the middle of panel and another one-third of the distance between the middle and top divide the panel, commencing at the bottom, into one section of .9, one section of .3 and one section of .6 ohms. These sections are connected together in series and by properly arranging the connections it is possible to get resistances of 1.8, 1.5, 1.2, .9, .6, .3 ohms, and by connecting the halves of each panel in parallel, .45 ohms.

By means of these various combinations the same shunt panels are adapted to various types of motors and windings, as specified in diagram No. 13200.

The K2 controller (although primarily designed for use with two motors) is also adapted, by reason of the additional rheostatic points, to the *operation of a single motor*. This is a special advantage where a single and double motor equipment are each used a part of the time on the same car.

When operating a single motor with a K2 controller, the smoothest starting can usually be secured by connecting the R1 lead to the second R1 binding post.

KR CONTROLLER.

The KR controller supersedes the types 51 and 83 rheostats for rheostatic methods of control and is particularly adapted to single motor railway equipments.

In general appearance the KR resembles the K2 controller, being of the same width and thickness but about two inches shorter.

As ordinarily constructed, the KR controller has a single reversing switch adapted for one motor only.

If desired to operate two motors by rheostatic control, a double reversing switch can easily be included in the KR controller.

Resistance boxes for the KR controller when used with the GE–800 or GE–1200 motors, are forms G and H. The latter box contains one panel of shunt resistance similar to that in the K2 resistance.

When used with the GE–2000 motor, resistances forms L and M are used. As the GE–2000 is not shunted these resistances contain no shunt.

K4 CONTROLLER.

The K2 controller can easily be modified for use with 4 motors by the substitution of another reversing switch. It is then known as the K4 controller.

The motors are connected in groups of two in parallel, each group corresponding to a single motor with the K2 controller.

For connections see diagram No. 13188.

The standard K4 controller is adapted for use with four motors only when two motors are permanently connected in parallel. Where greater variation in speed is desired, as for instance, high speed gearing, with motors grouped in permanent series connection for city work and changed to permanent parallel connection for suburban work, the K4B controller is used.

K4B CONTROLLER.

This controller, together with a commutating switch, admits of the motors being operated four in series or parallel groups of two in series, and by changing the switch, series groups of two in parallel or four in parallel.

The commutating switch is designed to be placed under the car seat or platform, and is operated by a handle or key entirely separate from the controller.

For wiring and connections for the K4B controller with commutating switch see diagram No. 13191.

TROLLEY.

The trolley base should be firmly bolted to a trolley board attached to the roof of the car.

MOTOR CIRCUIT SWITCHES.

One motor circuit switch, to enable the motorman to entirely cut off the current, is placed at each end of the car, where there is a controller at each end, but only one is used on cars with one controller and then at the same end. These switches are customarily placed directly over the door, except in cases where the handle would be so low as to interfere with persons entering the car, in which case the switches may be fastened to the hood. These switches should be placed so as to be easily reached by the motorman.

MAIN CUT-OUT.

On closed cars this should be placed on the side of the outside platform sill, under one corner of the car (see diagram No. 13201), or on one of the cross sills (or a block screwed to the floor) under the platform near enough the dasher to be readily accessible from the ground in front. It is not good practice to place this piece of apparatus under the seats or on either platform. It should be so secured to the car that the cover will hang vertical and swing upward. This will bring the trolley and motor terminals on the under side. The method of

support may be either a back board or angle iron, as best suits the conditions.

On open cars the cut-out should be placed on one of the cross sills or a block as described above. The practice of putting the cut-out at the side of a car opposite the opening between the running board and car sill is not good, as the blowing out of the fuse may burn a passenger standing on the running board.

LIGHTNING ARRESTER.

This should be placed under the car in a position where it will be protected from mud and water thrown by the wheel. It is advisable that a piece of sheet asbestos be placed between the arrester and car bottom or adjacent timbers to protect them from the arc.

Use of the Type R lightning arrester has been discontinued, and in its place is used the Type M Form C, which is the one that has proved so satisfactory on feeder panels. This arrester is placed in shunt to the circuit instead of being in series with it, and as there is no current flowing through it normally its capacity is not limited as in the Type R. Reactance of the blow-out coil is practically eliminated by an air gap of $\frac{1}{32}''$ in shunt to the coil. This gap forms a non-inductive path for the lightning, and the line current, should it follow, being deflected through the coil, ruptures its own arc.

Included as a part of the arrester is a non-inductive resistance in series with the discharge. This resistance does not affect the efficiency as a lightning arrester but limits the line current to about 250 amperes. This lessens burning of the discharge points and prevents sudden and extreme fluctuations of current.

Installation of Apparatus.

IN GENERAL.

In locating the various parts of the equipment and in wiring the car, particular attention should be taken to secure the following results:

1. Maintenance of high insulation.
2. Exclusion of all foreign material, particularly grease, dirt and water, from the electrical equipment.
3. The avoiding of fire from arcs, naturally occurring at fuse box, lightning arrester, etc.
4. The prevention of mechanical injury to the parts.
5. The placing of the parts so as to be accessible for operation and inspection, and yet out of the way of passengers.

PREPARATION OF THE CAR BODY.

The floor should be provided with a trap door of such size as to allow as free access as possible to the motors. Particular attention is called to the advisability of having the bar across the car between the trap doors removable in order that the top of either motor can be thrown back.

The roof should be provided with a trolley board (see diagram No. 13201) which strengthens it and protects it in case the trolley is thrown off; it also deadens the noise. A firm support should be provided for the light clusters. Grooves should be cut for the leading wires in the roof moulding and also in two of the corner posts, one for the trolley wire, the other for the ground wire of the lighting circuit.

On a closed car four 2″ holes should be bored through the car floor under the seats, one as near each corner of the car as possible. (See diagram No. 13201).

On one side of the car, four $\frac{5}{8}$″ holes should be bored in a line and 4″ apart, to receive the taps from the cable to the leads of motor No. 1. The exact location of these holes depends on the type of motor used. The distance from the centre of the axle to the centre of this group of holes should be about two and one-half feet for GE motors. On the same side of the car and in the same line four other $\frac{5}{8}$″ holes should be bored 4″ apart, to receive the taps from the cable to the resistance boxes. On the other side of the car three $\frac{5}{8}$″ holes in a line and 4″ apart, should be bored to receive the taps from the cable to the leads of motor No. 2, and on same side of car and in the same line five other $\frac{5}{8}$″ holes 4″ apart should be bored to receive the taps for the trolley, resistance, and shunt for motor No. 2.

Reference should be made to diagram No. 13201 in order that each set of holes shall be on the proper side of the car, and at such a distance from side sills as to be out of the way of wheel throw.

Measuring about 38″ from the brake staff and a suitable distance inside of the dash rail, an oval hole 5″ x $2\frac{3}{4}$″ should be cut in each platform to receive the cables.

On an open car no holes need be bored for the floor wiring except those through the platform.

INSTALLING CONTROLLERS.

In the standard car equipment one controller is placed on each platform on the side opposite the brake handle, in such a position that the controller spindle

KICKING COIL.

This consists of ten turns of the main circuit wire wound about a wooden core 2″ in diameter and 6″ in length. It should be connected as shown in diagram No. 13200 between the lightning arrester and controller.

The above recommendations for locations for the various devices apply particularly to four and six-wheeled cars, being substantially the same whether on closed or open bodies. On eight-wheeled cars with swivelling trucks, it is often more convenient to put the fuse box, lightning arrester, resistance boxes, etc., under the middle portion of the car.

WIRING CABLES.

Cables complete with suitable taps for connecting together controllers, resistances and motors for the shunt method of control are preferably made up at the factory and shipped to customers ready for use. These cables are manufactured in lengths of 30, 32, 34 and 36 feet. Two cables are required for double motor cars, each containing seven wires; in addition to these a separate ground wire is required. Each wire in the cables is composed of seven strands of small tinned wire to make it flexible and not easily broken. Brass sleeve tags are secured to the leads, and stamped to correspond to binding posts on the controller connection boards. Two-way connectors should be used in connecting taps to motor leads, these connectors being soldered to the latter.

The taps in the middle portion of the cables are brought out conveniently for motors on a single truck with 6 to 7 foot wheel base.

A data sheet (of which a sample is attached hereto) should be filled out and forwarded with each order. This clearly specifies the dimensions required by the factory in manufacturing the cables and when accurately filled out insures promptness and correctness in the shipment of orders. In cases where this blank can not be used it is advisable to specify the actual length of the cables required in preference to giving the dimensions of the car body itself. In ordinary cases the required length of cable will be 6 feet longer than the over-all length of a closed car, and 4 feet longer than the over-all length of an open car, measured in both cases from dasher to dasher.

and the brake staff shall not be less than 36″, nor more than 40″ apart. The exact position depends somewhat on the location of the sills sustaining the platform. The feet of the controller are designed to allow a slight rocking with the spring of the dasher. Two ½″ bolts secure the feet to the platform. An adjustable angle iron is furnished to be used in securing the controller to the dash rail. A wire guard is also furnished, to be secured to the platform in such a position that the cables pass through it into the controller. A rubber gasket is furnished with each controller to be placed between the wire guard and the platform to exclude water. For dimensions of controller see diagram No. 13201.

WIRING.

This work can be conveniently divided into two divisions; namely, **roof wiring** and **floor wiring.**

Roof wiring includes the running of the main circuit wire from the trolley through both main motor switches down the corner posts of the car, to a suitable location for connecting to the lightning arrester and fuse box; also wiring the lamp circuit complete, leaving an end to be attached to the ground. Whenever wires lie on the top of the roof, they need not be covered with canvas or moulding except to exclude water where they pass through the roof. In such cases a strip of canvas the width of the moulding, painted with white lead, should be laid under the wire, and over this and the wire should be placed a piece of moulding extending far enough in either direction to exclude water. The moulding should be firmly screwed down and well painted.

The above wiring should be done if possible while the cars are being built.

Floor wiring may be done after the car is completed without injuring the finish.

Made up cables give far better protection to the wiring and are easier to install than separate wires and should be used in the floor wiring if possible.

The accompanying diagrams show the position of such cables. The simplest way of installing them on box cars seems to be as follows:

After the car bodies are prepared according to the above instructions, the cables (one on each side of the car) should be run through holes in the platform and the connections made to the motors and controllers, as shown in the diagrams.

After making connection to the controllers all slack should be pulled up inside of the car under the seats and held in place, preferably against the side of the car, by canvas or leather straps. Motor taps should project through the sills for attachment to the flexible motor leads just far enough to permit easy connection, leaving as little chance as possible for vibration. No rubber tubing will be required on taps as they all have a weather-proof, triple braided cotton covering outside of the rubber insulation to prevent abrasion. All joints should be thoroughly soldered and well taped. The portions of the cables passing under the platforms should be supported by leather straps screwed to the floors or sills. Cables should never be bent at a sharp angle. The ground wire should run under the car floor rather than under the seats.

On open cars all wires and cables must be run under the car and should be well secured to the floor with cleats or straps.

A good joint can be made by separating the strands of the tap wire and wrapping the two parts in opposite

directions around the main wire. Both Okonite and rubber tape are furnished. It is desirable that Okonite should be used first and rubber tape put over it as the latter will not loosen and unwrap as Okonite will. All openings in the hose should be sewed up as tightly as possible around the wires.

Separate wires can be installed if necessary, observing the following directions:

The floor wires on box cars should be placed under the seats as much as possible. In the few places where it is necessary for wires to cross, wood should intervene in preference to a piece of rubber tubing or loop in the air. This rubber tubing is not necessary where wire is cleated under the floor (as on open cars), if it does not pass over iron work or is not exposed to mud and water. Where so exposed it should be covered with moulding, but where moulding is used it should be carefully painted inside and out with good insulating compound to exclude water. The wire passing to the fuse box should be looped downward to prevent water running along the wire and into the box. Care should be taken to avoid metal work about the car in running the wires and that nails or screws are not driven into the insulation.

In general, it is not desirable to use metallic staples and cleats for car wiring except about the roof or inside the car. Where wires are subject to vibration, as between the car bodies and motors, flexible cable must always be used. A certain amount of slack should be left in the leads from the motor to the car body, depending on their length. On cars with swivelling trucks a greater amount of slack is necessary. As slack gives greater opportunity for abrasion, care should be taken to leave only what is absolutely necessary.

LIGHTING CIRCUIT.

The usual arrangement of the lighting circuit is shown in the accompanying car wiring diagrams.

OPERATION AND CARE OF K2 CONTROLLER.

When starting, regulate the movement of the handle from point to point so as to secure a smooth acceleration of the car.

Do not run between points.

The resistance points 1st, 2nd, 3rd, 6th and 7th, are intended only for the purpose of giving a smooth acceleration and should not be used continuously.

For continuous running, use the 4th, 5th, 8th and 9th points, which are shown by the longest bars on the dial.

When using the motor cut-out switches be sure that they are thrown up as far as they will go.

In case the trolley is off and the hand brakes do not hold the car, an emergency stop may be accomplished by reversing the motors and turning the power handle to the full speed or next to full speed point.

To examine the controller, which should be done regularly, open the cover, remove the bolt with wrench attached and swing back the pole piece of the magnet.

The contact surfaces and fingers should be kept smooth and occasionally treated with a small amount of vaseline to prevent cutting.

All bearings should be regularly oiled.

A repellant compound, paraffine, rosin and vaseline, equal parts by weight, placed in the water caps of the power and reversing shafts, is an efficient protection against water.

Dirt must not be allowed to collect inside of the controller.

EQUIPMENT LISTS.

The following is a list of material required for the electrical equipment of one car fitted with two K2 controllers and two GE–800 or GE–1200 motors.

QUANTITY.		CAT. NO.
1	Trolley Pole, Form C,	16560
1	Trolley Base, Form D2,	17499
2	Motor Circuit Switches,	15509
1	Type M Form C Lightning Arrester,	17198
1	150 Ampere Magnetic Cut-out (Fuse Box),	17428
1	Resistance Box, Form K,	16957
1	Resistance Box, Form K2 (Includes Field Shunt),	17429
1	Core for Kicking Coil,	16959
2	S.P. Controllers, Form K2 (Includes Wire Guard and Gasket, Supporting Bracket, Cap Screws and Washers for fastening to Dasher),	17161
1	Controlling Handle,	16921
1	Reversing Handle,	16922
	One of each of these handles is always shipped with each pair of controllers unless specified to the contrary.	
75 ft.	No. 6 B. & S. Strand Wire (7-.064"), for roof wiring.	
20	100 or 150 Ampere Fuses.	
10	Two-way Connectors, ¼" hole, No. 6,	17436
30	Brass Corner Cleats, $\frac{7}{16}$" slot,	17195
25	Brass Flat Cleats, $\frac{7}{16}$" slot,	17438
110	½" No. 4 R. H. Brass Wood Screws for Brass Cleats.	
25	Wood Cleats, ½" slot,	17322
25	Wood Cleats, ⅝" slot,	16850
100	1¼" No. 8 R. H. Blued Wood Screws for Wood Cleats.	
1 lb.	Solder.	
1 lb.	⅝" Okonite Tape.	
1 lb.	1" Adhesive Tape.	
	Material for set of cables as follows:	
480 ft.	No. 6 B. & S. Strand Wire (7-.064"), single braid.	
100 ft.	No. 6 B. & S. Strand Wire (7-.064"), triple braid for taps.	
41	Brass Marking Tags,	17562
64 ft.	1½" Cotton Hose.	
1¼ lbs.	Rubber Tape.	
4 lbs.	Paragon Tape.	
1½ lbs.	Solder.	
	This material will be made into a "set of cables" without extra charge if required dimensions are furnished in ample time before shipment.	
1	Car Lighting Equipment as per list on Page 22.	

NOTE:—For GE-1200 motors with "two turn" armatures, cables and roof wiring should be No. 4 B. & S. Wood cleats should be $\frac{7}{16}$" slot (Cat. No. 16849) and $\frac{3}{16}$" slot (Cat. No. 17439).

The following is a list of material required for the electrical equipment of one car fitted with two KR controllers, and one GE–800 or GE–1200 or GE–2000 motor.

QUANTITY.		CAT. NO.
1	Trolley Pole, Form C,	16560
1	Trolley Base, Form D2,	17499
2	Motor Circuit Switches,	15509
1	Type M Form C Lightning Arrester,	17198
1	150 Ampere Magnetic Cut-out (Fuse Box),	17428
1	Resistance Box, Form G,	16964
1	Resistance Box, Form H, (Includes Field Shunt),	16965
1	Core for Kicking Coil,	16959
2	Controllers, Form KR, (Includes Wire Guard and Gasket, Supporting Bracket, Cap Screws and Washers for fastening to Dasher),	16967
1	Controlling Handle,	16921
1	Reversing Handle,	16922
	One of each of these handles is always shipped with each pair of controllers unless specified to the contrary.	
75 ft.	No. 6 B. & S. Strand Wire (7-.064"), for roof wiring.	
20	100 or 150 Ampere Fuses.	
5	Two-way connectors, ¼" hole, No. 6,	17436
30	Brass Corner Cleats, $\frac{7}{16}$" slot,	17195
25	Brass Flat Cleats, $\frac{7}{16}$" slot,	17438
110	½" No. 4 R. H. Brass Wood Screws for Brass Cleats.	
25	Wood Cleats, ½" slot,	17322
25	Wood Cleats, ⅝" slot,	16850
100	1¼" No. 8 R. H. Blued Wood Screws for Wood Cleats.	
1 lb.	Solder.	
1 lb.	⅝" Okonite Tape.	
1 lb.	1" Adhesive Tape.	
	Material for set of cables as follows:	
400 ft.	No. 6 B. & S. Strand Wire (7-.064"), single braid.	
70 ft.	No. 6 B. & S. Strand Wire (7-.064"), triple braid for taps.	
22	Brass Marking Tags,	17562
32 ft.	1½" Cotton Hose.	
1 lb.	Rubber Tape.	
3 lbs.	Paragon Tape.	
½ lb.	Solder.	
	This material will be made into a "set of cables" without extra charge if required dimensions are furnished in ample time before shipment.	
1	Car Lighting Equipment as per list on Page 22.	

NOTE:—For GE-2000 motor, cables and roof wiring should be No. 4 B. & S. Wood Cleats should be $\frac{7}{16}$" slot (Cat. No. 16849) and $\frac{3}{16}$" slot (Cat. No. 17439), and instead of resistances Forms G and H, resistance Form L (Cat. No. 17572), and resistance Form M (Cat. No. 17573).

ELECTRICAL EQUIPMENT FOR LIGHTING ONE CAR WITH FIVE OR TEN LIGHTS.

FIVE LIGHTS.

QUANTITY.		CAT. NO.
1	Combination Switch and Cut-out,	17162
1	Three-light Cluster,	16425
3	Keyless Sockets,	9324
2	Wall Keyless Sockets, Chocolate Base,	50983
5	Spiral Anchored Filament Lamps.	
2 ft.	3 Ampere Fuse Wire.	
3 ft.	No. 16 GE Fixture Wire.	
50 ft.	No. 16 U. S. Wire.	
50	Brass Cleats for No. 16 U. S. Wire,	17196
100	½" No. 4 R. H. Brass Wood Screws for Brass Cleats.	
4	⅜" No. 8 R. H. Brass Wood Screws for Three-light Cluster.	
4	1¼" No. 6 R. H. Brass Wood Screws for Wall Keyless Sockets.	
2	1¼" No. 6 R. H. Brass Wood Screws for Combination Switch.	
1	1½" No. 6 R. H. Brass Wood Screw for Combination Switch.	

TEN LIGHTS.

1	Combination Switch and Cut-out,	17162
3	Three-light Clusters,	16425
9	Keyless Sockets,	9324
2	Wall Keyless Sockets, Chocolate Base,	50983
1	Three-point Snap Switch,	5627
11	Spiral Anchored Filament Lamps.	
2 ft.	6 Ampere Fuse Wire.	
9 ft.	No. 16 GE Fixture Wire.	
100 ft.	No. 16 U. S. Wire.	
70	Brass Cleats for No. 16 U. S. Wire,	17196
1 gr.	½" No. 4 R. H. Brass Wood Screws for Brass Cleats.	
4	1¼" No. 6 R. H. Brass Wood Screws for Wall Keyless Sockets.	
12	⅜" No. 8 R. H. Brass Wood Screws for Three-light Clusters.	
2	1¼" No. 6 R. H. Brass Wood Screws for Combination Switch.	
1	1½" No. 6 R. H. Brass Wood Screw for Combination Switch.	
2	1" No. 6 R. H. Brass Wood Screws for Three-point Switch.	

DIAGRAMS

and

Data Sheet on Made-up Cables.

F. N. 14.

Data Sheet on Made-up Street Car Cables for K² Controllers.

The Made-up Cables to be furnished the ..... Company for use on (..... open) (..... closed) cars now at ..... are to be made according to dimensions as shown hereon. These cables are to be used with motors of ..... type and K² controllers.

Remarks .....

.....

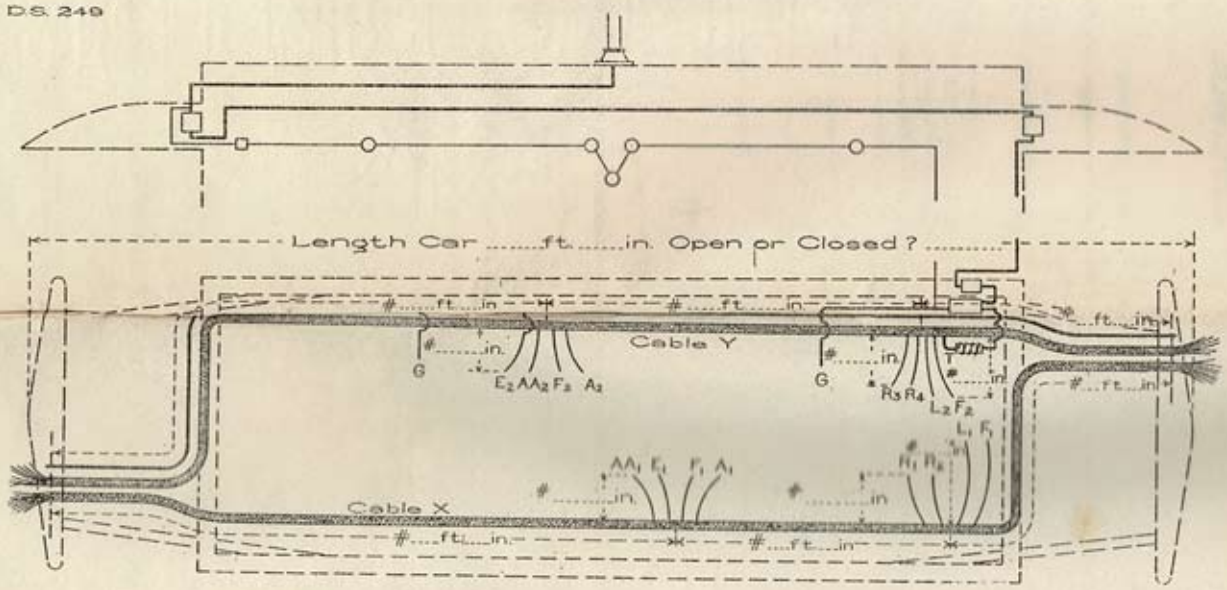
.....

.....

(Signed) .....

Date ..... 189 .....

D.S. 249



Make out one sheet for each size of Cable needed.

Length of wire from trolley to lightning arrester ..... ft.

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

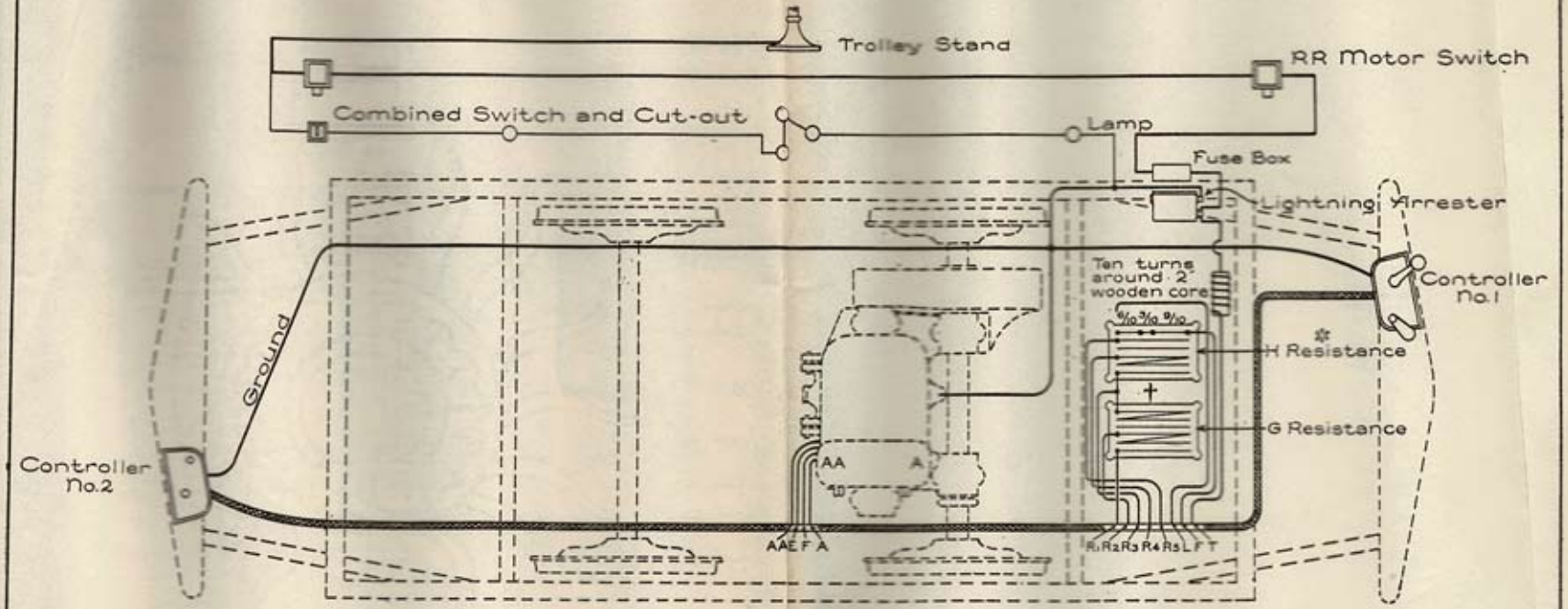
Length of No. 16 wire for lighting circuit ..... ft.

Length of tap "T" from cable "Y" to lightning arrester (allow 8 ft. extra for winding this tap on kicking coil) ..... ft.

Directions.—The length of each cable is measured to the end of the canvas hose which should reach to the bottom of the controller and wires emerging from the cables and connecting within the controller are in excess of this length. If the car-body has been built, a convenient way for measuring lengths of cables is to lay a small rope in 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 straight line and measure the several portions of the length and fill in same on above sketch. These dimensions to be filled in on the cables X and Y are for purpose of locating position of taps and their length. 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 cable more diagonally at end of car. Cables will be built exactly as specified above. The leads on these made-up cables will have two extra coverings of insulated braid for their better protection. This is used in order to avoid rubber tubing, the best of which deteriorates and should not be used.

CAR WIRING FOR K R CONTROLLERS WITH SINGLE MOTOR
SHUNT METHOD OF CONTROL



Terminals on standard cables to be connected as marked on cables.
E and R5 taps are connected to R5 wire.

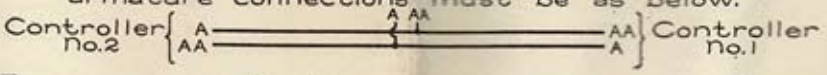
†Ordinarily connect to these binding posts. For special conditions vary resistance as may be necessary.



✲Use for shunt resistance between L and F

WP 50	3/10
WP 30	6/10
GE 800	18/10
GE 1200	18/10

To secure proper position of reversing handle armature connections must be as below.



Checked by W. B. Potter

Engineering Dept.

Approved by E. W. Rice, Jr. (Chief Engineer)

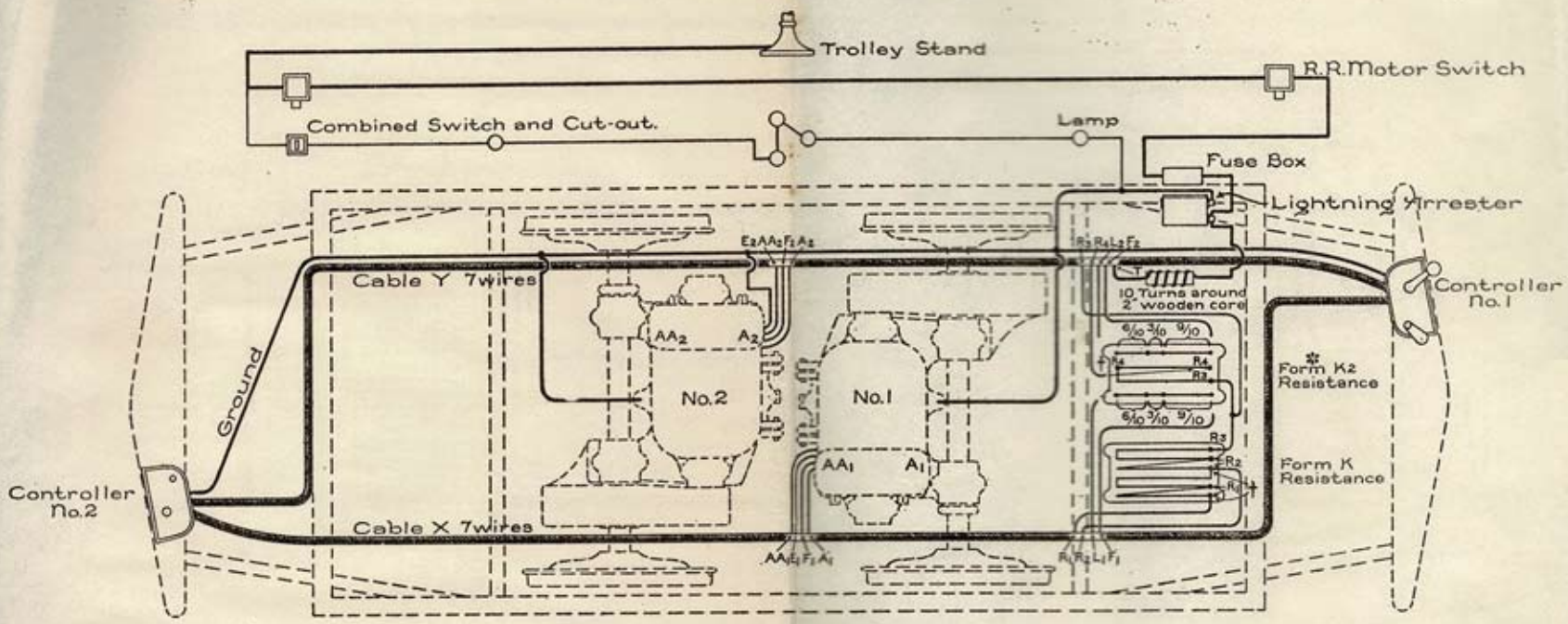
No. 13199 Supersedes No. 13190

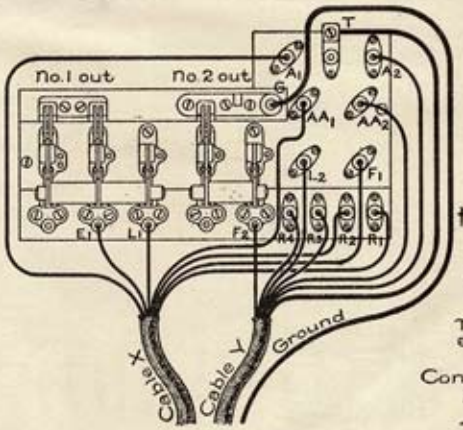
General Electric Co.

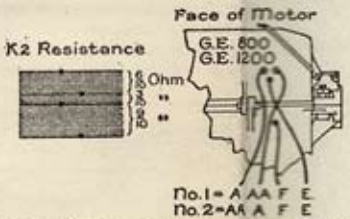
Aug. 1, '95.

SWT.

CAR WIRING FOR SP CONTROLLERS FORM K2 WITH TWO MOTORS
SHUNT METHOD OF CONTROL





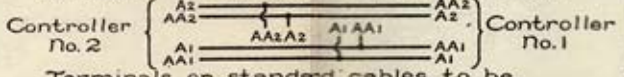


†Ordinarily connect to these binding posts. For special conditions vary resistance as may be necessary

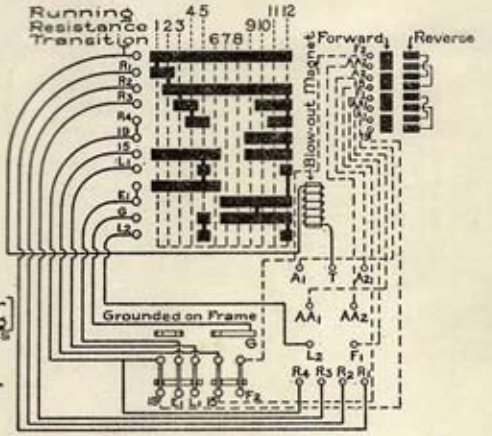
*Use for shunt resistance

between	L_2F_2	L_1F_1
WP 50	3/10	3/10
WP 30	6/10	6/10
GE 800	18/10	18/10
GE 1200	18/10 or less depending on winding	18/10 or less depending on winding

To secure proper position of Reversing Handles armature connections must be as below.



Terminals on standard cables to be connected as marked on cables.



Checked by W.B. Potter

Engineering Dept.

Approved by E.W. Rice Jr. Chief Engineer

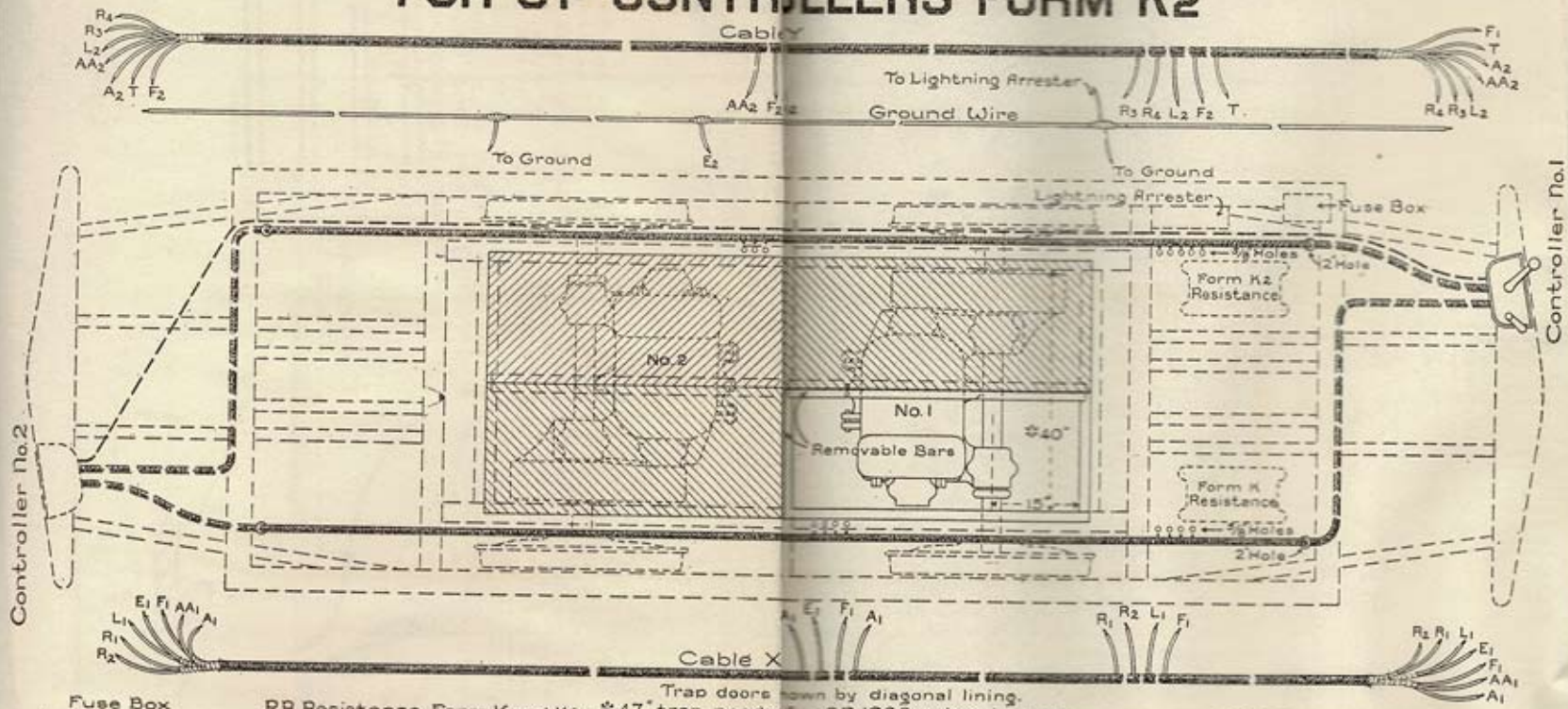
No.13200

General Electric Co.

July 24, '95.

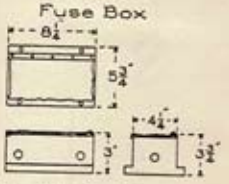
S.W.T.

STANDARD CABLES AND OPERATING DEVICES FOR SP CONTROLLERS FORM K2

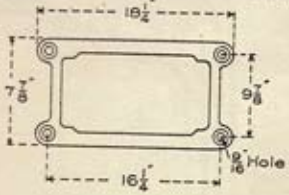


Trap doors shown by diagonal lining.
*47" trap needed for GE 1200 when handled from above. Handling from below is recommended.

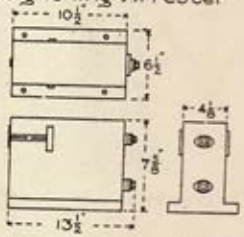
Fuse Box

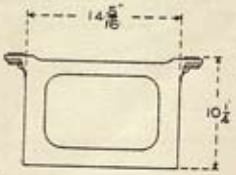


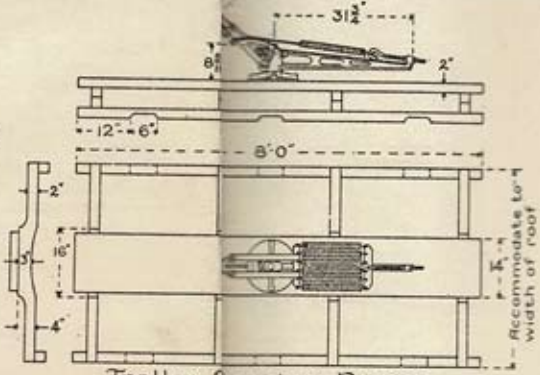
P.R. Resistance Form K and K2



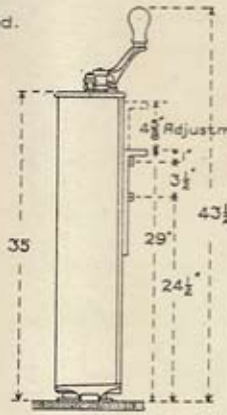
Lightning Arrester

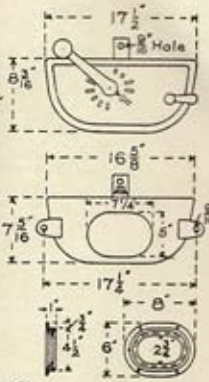






Trolley Stand on Frame





Controller Form K2

Checked by W.B. Potter

Engineering Dept.

Approved by E.W. Rice Jr.
Chief Engineer

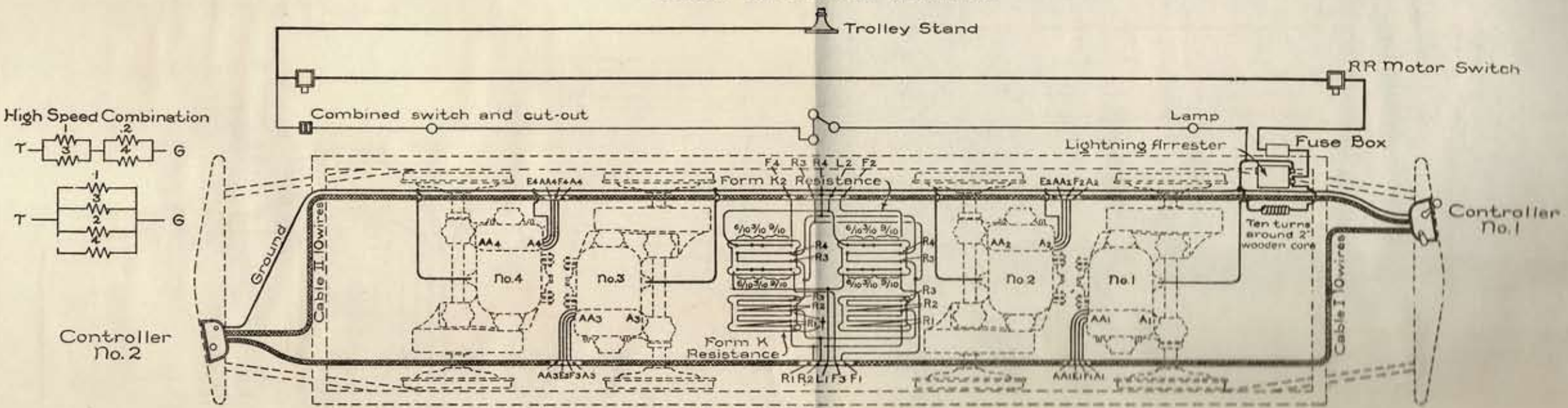
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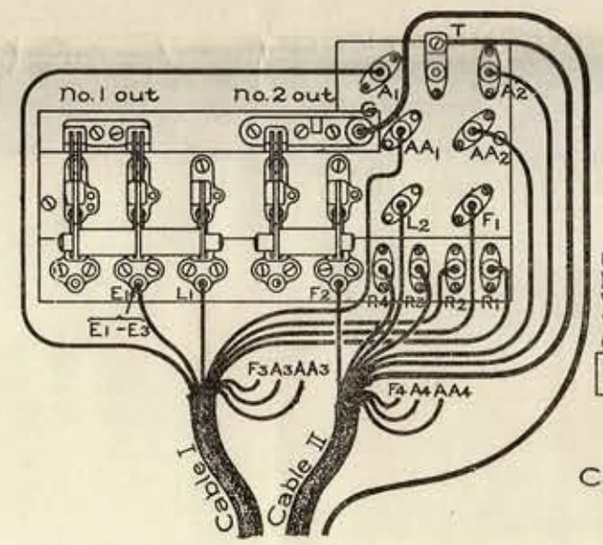
General Electric Co.

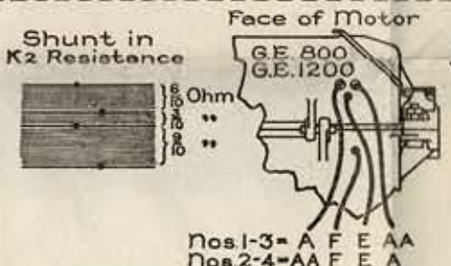
July 24, '95.
S.W.T.

CAR WIRING FOR SP CONTROLLERS FORM K4 WITH FOUR MOTORS

SHUNT METHOD OF CONTROL







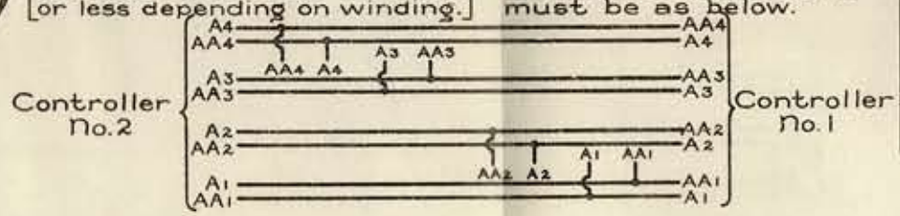
†Ordinarily connect to these binding posts. For special conditions vary resistance as may be necessary

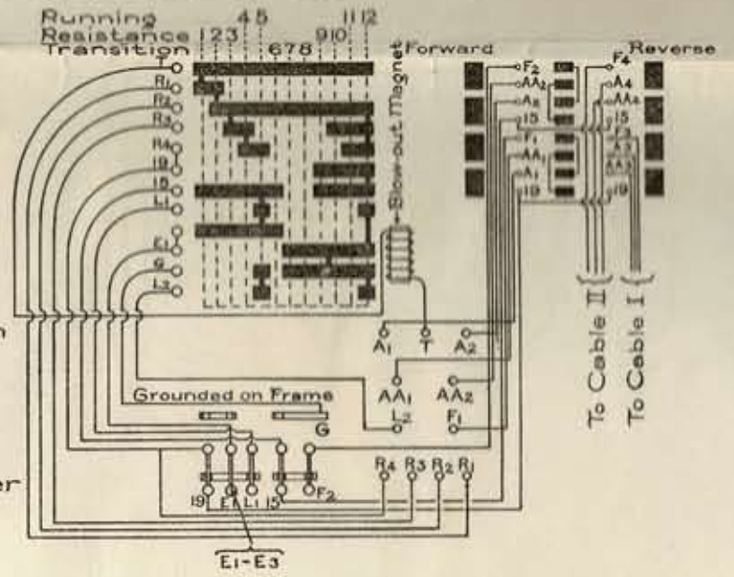
Use for shunt resistance between

	L1F1	L2F2	L1F3	L2F4
WP 50	3/10	3/10	3/10	3/10
WP 30	6/10	6/10	6/10	6/10
GE 800	18/10	18/10	18/10	18/10
GE 1200	18/10	18/10	18/10	18/10

or less depending on winding.

Terminals on standard cables to be connected as marked on cables. To secure proper position of reversing handle armature connections must be as below.





Checked by W. B. Potter

Engineering Dept.

Approved by E. W. Rice Jr.

No. 13188

General Electric Co.

Changed Aug. 1, '95.

Apr. 21, '95.