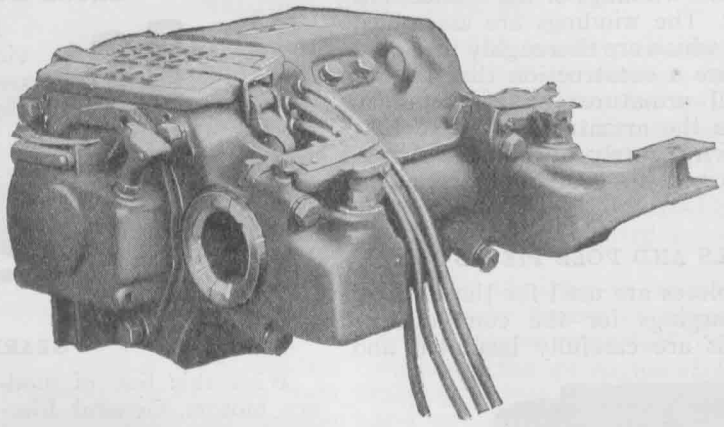
RAILWAY APPARATUS

Standard Railway Motors



GE-265 Railway Motor

This Company manufactures a standard line of railway motors ranging in capacity from 25 h.p. to 140 h.p. at 600 volts. There are eight sizes so graded that a standard motor is available to meet service requirements encountered on most electric railways. This Company also manufactures motors for special applications, including motors for use on large locomotives, subway and elevated lines, narrow gauge railways, trolley busses, gas-electric cars, etc.

Marked advances in G-E railway motors have been made by the use of improved materials, refinement in design, increased ventilation, and reduction in weight. The use of this higher grade material, together with the use of commutating poles, cast steel motor frames, and the effective self-ventilating systems, has resulted in more output per pound of material than before accomplished in the construction of railway motors.

Modern construction and the reduction in weight possible for a given output has resulted in the replacement of many of the older design motors at a great saving in maintenance and operating costs.

The successful operation of this standard line of railway motors under severe operating conditions is best shown by the fact that there are in operation more than 50,000 G-E ventilated motors.

The manufacture of a standard line of motors, together with the large demand for each of these standards, has resulted in lower prices and more prompt deliveries.

Particular attention has been given in the design of this standard line of motors to secure long life and low maintenance. Some of the improvements incorporated are described here.

Heat treated steel is used in the armature shafts. The quality of steel in the gears and pinions has been improved, and improved methods of heat treatment have been developed. Bearing metals are of tin base babbitt of the highest quality obtainable. High-grade varnishes are used for insulating purposes. Axle brackets are overhung in such a manner that a large part of the weight of the motor is taken off the axle cap bolts.

The frame heads are made to a driving fit in recessed openings in the ends of the magnet frame and are held in place by tap bolts securely locked. Each frame head is provided with two tapped holes diametrically opposite each other, into which bolts can be screwed for forcing the heads off each other.

BEARINGS AND LUBRICATION

The armature bearing linings are made of bronze, lined with a thin layer of babbitt, and are designed to prevent injury to the armature or pole pieces in case the bearings become overheated. The axle linings are of bronze or malleable iron, babbitted, depending upon the size of the axle. A sheet-steel cover is clamped between the axle caps, entirely enclosing the axle and protecting the linings from dirt. Oil and waste lubrication is used.

ARMATURES

Railway Motor Armature

The armature core is built up of soft sheet steel on laminations keyed to the armature shaft and so constructed that the shaft may be removed

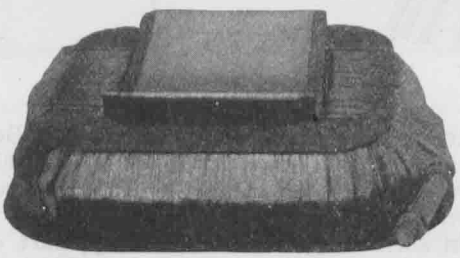
RAILWAY APPARATUS

Standard Railway Motors

without disturbing the windings or the connections to the commutator. The windings are assembled in units or polycoils which are thoroughly insulated and treated to secure a construction that insures reliable service. All armatures have temporary bands put on while the armature is hot so that coils are drawn down securely in position. Armatures are then allowed to cool and permanent banding applied.

FIELD COILS AND POLE PIECES

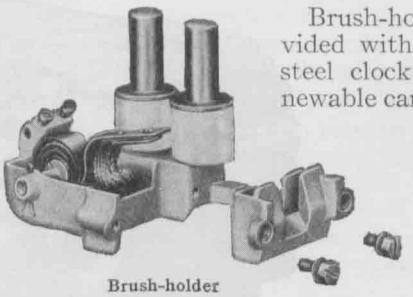
Laminated pole pieces are used for the exciting fields, and drop forgings for the commutating fields. All field coils are carefully insulated and



Exciting Field Coil Assembled with Pole Piece and Flange

impregnated with insulating compound by the vacuum process. Both commutating and exciting field coils are held firmly by spring tension to prevent movement of coils on the pole pieces.

BRUSH-HOLDERS



Brush-holder

Brush-holders are provided with an adjustable steel clock spring and renewable carbon-way boxes.

GEARING

With this line of modern motors, General Electric heat-treated gears and pinions are furnished. This gearing is universally recognized as the best finished product that modern factory and machine shop methods have developed.

Forged Pinion

VENTILATION

In the ventilation of these motors, both intake and exhaust openings are so arranged that there is a minimum liability of admission of either moisture or dirt.

HORSE POWER AND WEIGHTS OF STANDARD RAILWAY MOTORS

Type	H.P., 1 Hr. Rating, 600 Volts	Dia. Car Wheels in In.	Approx. Wt. Complete in Lb.
GE-264-A	25	24–26	1000
GE-264-B	25	30–33	1130
GE-265-A	35	24–26	1415
GE-265-C	35	30–33	1500
GE-247-A	40	24–26	1740
GE-247-D	40	30–33	1870
GE-203-P	50	33	2280
GE-275-A	60	26–28	2410
GE-275-D	60	30–33	2640
GE-263-A	65	33	3050
GE-240-A	110	33	3840
GE-254-A	140	33	4515

SELECTION OF MOTORS

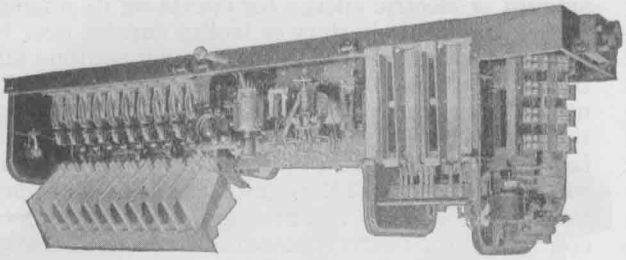
As the reputation of the General Electric Company's motors, and the interest of its customers are affected by the proper selection of motors for any given service, the Company desires to aid and cooperate with its customers in selecting motors best adapted for their service. The Company's experience enables it to render valuable assistance, and long experience has shown that coöperation is mutually beneficial.

For complete information, refer to our nearest Sales Office.

RAILWAY APPARATUS

Controllers

MULTIPLE UNIT—TYPE PC

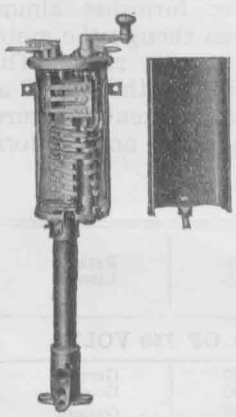


Type PC, 600-volt Controller

The General Electric multiple unit control system was designed primarily to permit a train of motor cars when coupled in any combination to be operated as a single unit from either end of any car of the train. It is also used extensively on individual equipments.

Fundamentally, the system for each motor car may be considered as consisting of a motor controller, master controller, resistor, motors, and cables. The motor controller comprises a set of apparatus which handles directly the current for the motors, while the master controller merely governs the operation of the motor controller and consequently does not handle the larger currents necessary in the motor circuit.

Type PC, multiple unit controllers are furnished in two general sizes. The small size for city and light interurban service may be installed on the modern city car with low steps and 24-in. wheels. The large size is for elevated, subway, or heavy interurban service. These two sizes are necessary, owing to the difference in current capacities required. Each size possesses the features of sturdiness, accessibility, and safety.

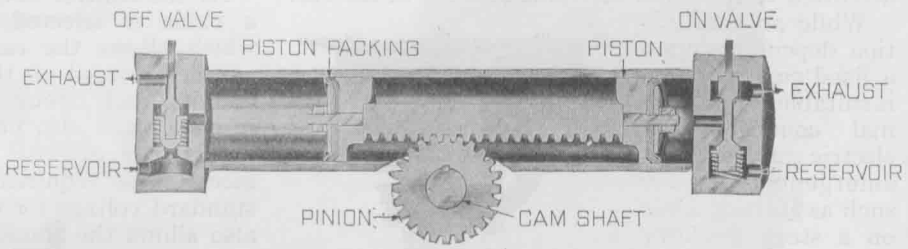


Master Controller

Various forms of each size of controller cover the car equipment field, which includes cars with two full-field motors, cars with two tap-field motors, and the same combinations using four motors. These various forms differ only in the reversers, motor cutouts, and wiring. The four-motor, full-field controller is used with four tap-field motors by adding a separate switch for tapping the fields.

The line breaker, reverser, and contactors are actuated by air pressure controlled by magnet valves. The line breaker and reverser are provided with individual magnet valves and air cylinders, while a single cylinder with a double piston and two valves is used for the operation of the contactors. The contactors are operated by cams mounted on a shaft which is rotated by a rack and pinion as shown.

Air is admitted to or exhausted from the air cylinder by means of magnet valves controlled by the master controller. The diagrammatic illustration of the air engine shows the position of the magnet valves and the pistons when the master and motor controllers are in the "off" position. In this position the air pressure is applied to the "off" piston through the "off" magnet valve, while the "on" magnet valve allows any air in the "on" cylinder to pass through to atmosphere. When the master controller is turned on and the reverser throws, the line breaker closes, and both the "on" and "off" magnet valves are energized. This applies air pressure to the "on" piston and allows air to escape from the "off" cylinder; the rack moves toward the "off" magnet valve rotating the pinion and cam shaft until the "off" magnet valve is de-energized. When this occurs air pressure is applied to the "off" piston and as the "on" magnet valve applies air pressure to the "on" piston, all movement of the rack and pinion ceases with the motor controller in the first operating position. Subsequent positions on the motor controller are obtained by alternately energizing and de-energizing the "off" magnet valve. When the master controller is turned off, the "on" and "off" magnet valves are de-energized and air pressure is applied to the "off" piston and released from the "on" piston. This causes the rack to move toward the "on" magnet valve and rotates the pinion and cam shaft, turning the motor controller to the "off" position.



Rack and Pinion Operating Mechanism

The cam controller is more like the simple drum controller than any previous multiple unit control, as the cams absolutely insure a definite sequence and fixed relationship of closing and opening the contactors, unobtainable with individually-operated contactors.

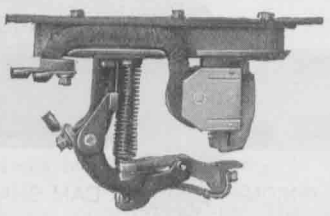
RAILWAY APPARATUS

Controllers

MULTIPLE UNIT—TYPE PC

The use of cams and cam shaft is of particular advantage in that it substitutes mechanical interlocking for the electrical interlocking required with individually operated contactors of previous control systems. This feature makes a strong appeal to the operating man who has experienced trouble with the small contacts of electric interlock switches.

The simple arrangement of control circuits with the cam-type control has made it possible to use automatic control for all classes of car equipment. This has proved of advantage in saving power and reducing shocks to the equipment, and as a smooth acceleration is obtained without any attention from the motorman, greater comfort results for the passengers. The motorman can give his undivided attention to signals or to traffic in front of the car.



Contactor

While an acceleration depending upon a fixed current value is suitable for all normal conditions of electric car operation, emergencies arise, such as starting a car on a steep grade or on a curve, where some means of increasing the torque on the motors is essential. Provision is made in the cam system control for such emergencies by including on the master controller a separate handle or advance lever. The control is so arranged that pushing this lever forward advances the motor controller one step, independently of the current flowing through the accelerating relay. By releasing the advance lever and again pushing it forward, the motor controller will advance another step. If desired, the motor controller may be advanced through its entire progression in this manner, independently of the current in the accelerating relay.

The cam controller requires only a very small amount of electric energy for operating its magnet valves, and either battery or trolley current may be used as a source of supply. On 600-volt equipments, trolley potential is used with resistor tubes connected in series with the operating coils to reduce the current to a value low enough for the satisfactory operation of the coils. In special cases where some other feature of the equipment has determined the control voltage, as automatic electric couplers, controllers for battery potential have been manufactured.

The ability to operate the control with very little electric energy, and from almost any voltage, is particularly advantageous in 1500-volt equipments, where some low-voltage source of power is essential for the auxiliary circuits.

As the control does not determine the voltage, a value is selected for these auxiliary circuits which allows the car lights to be connected in parallel instead of the usual practice of several circuits, each circuit having five lamps connected in series, and also permits the use of a headlight without an external resistance. Thirty-two volts meets these requirements admirably, as this is a standard voltage for train lighting lamps, and as it also allows the filament of a headlight lamp to be concentrated near the focal point of the reflector. A headlight with one of these lamps gives a powerful beam on the tracks with sufficient side diffusion to show up objects readily along the sides of the railroad.

MOTOR-GENERATOR

The current for these auxiliary circuits is supplied from the trolley through a unique type of motor-generator set. This set furnishes almost constant generator voltage even though the motor voltage may vary through a wide range. This regulation is accomplished without the use of an external regulator. The constant potential insures a powerful and brilliant headlight and uniform interior lighting of the car.

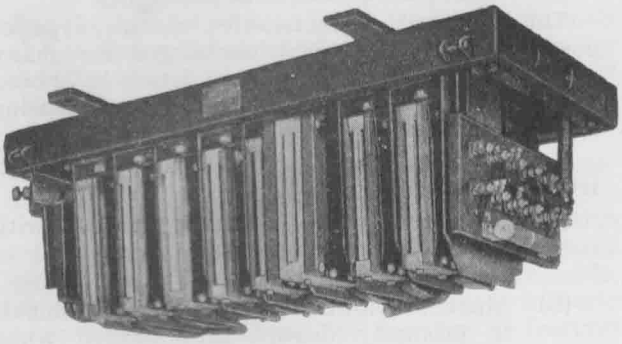
Controller	No. of Motors	MAXIMUM ALLOWABLE CAPACITY OF EACH MOTOR		Field	Weight in Lb.	Return Circuit
		Hourly Rating H.P. on 600 Volts	Continuous Rating Amperes			
TYPE PC CONTROLLERS FOR 600-VOLT SERVICE WITH MAXIMUM PEAKS OF 750 VOLTS						
PC-5	4	75	75	Full	530	Ground
PC-6	2	150	140	Full	530	Ground
PC-10	2	250	220	Full or Tap	1027	Ground
PC-12	4	150	140	Full	980	Ground
PC-13	2	250	220	Full	1025	Metallic
PC-14	4	125	115	Full	1000	Metallic
TYPE PC CONTROLLERS FOR 1200/1500-VOLT SERVICE WITH MAXIMUM PEAKS OF 1650 VOLTS						
PC-101	4	150	140	Full	1140	Ground
TYPE PC CONTROLLERS FOR 1500-VOLT SERVICE WITH MAXIMUM PEAKS OF 1650 VOLTS TWO MOTORS CONNECTED PERMANENTLY IN SERIES, LINE BREAKER EXTERNAL						
PC-103	4	270 on 750 Volts	220	Full	1050	Ground

RAILWAY APPARATUS

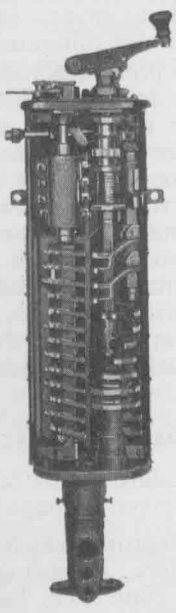
Controllers

MULTIPLE UNIT—LIGHT-WEIGHT—TYPE M

General Electric lightweight, Type M, multiple unit control system offers many advantages for all classes of cars. It incorporates those desirable features of design and construction which have passed the test of long periods of operation under severe conditions, and is simple, durable, and accessible for maintenance and inspection.



Contactor Box (Cover Removed)

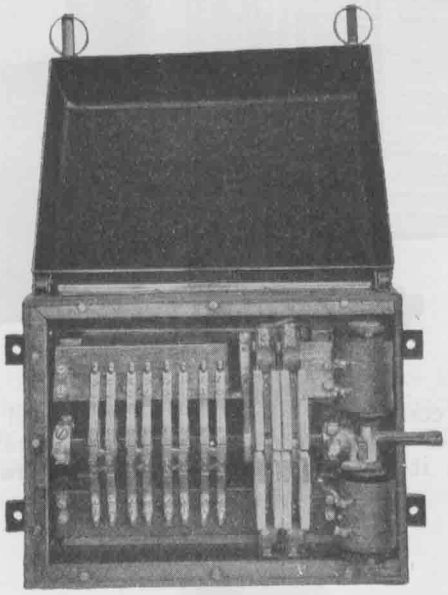


Controller

In instances where more than one car is to be operated in train, the system is particularly appreciated, for, if desired, the train may be operated as a single unit from either end of any car in the train—a valuable means of handling the demands of a varying traffic.

For single car operation, the use of Type M control makes possible a decided economy of space within the car and the removal of all power circuits from the platform.

The various circuit connections for Type M control are made by means of a number of independent contactors provided with powerful magnetic blowouts. These contactors are grouped together in one contactor box, and their sequence of operation is governed by a master controller located in each operating cab. The contactor box weighs only 363 pounds and is less than 17 inches in depth.



Reverser (Cover Open to Show Construction)

One of the contactors functions as a line breaker by means of an overload tripping device. The latter is mechanically connected to the armature of the contactor, so that, in addition to opening the control circuits, it exerts a pull on the line breaker armature. This causes the arc to be ruptured in a minimum time with consequent less burning of the contact tips. The contactors are of the armature type with only two moving parts and two bearing pins. The pins are held fast in one casting, so that wear is reduced to a minimum.

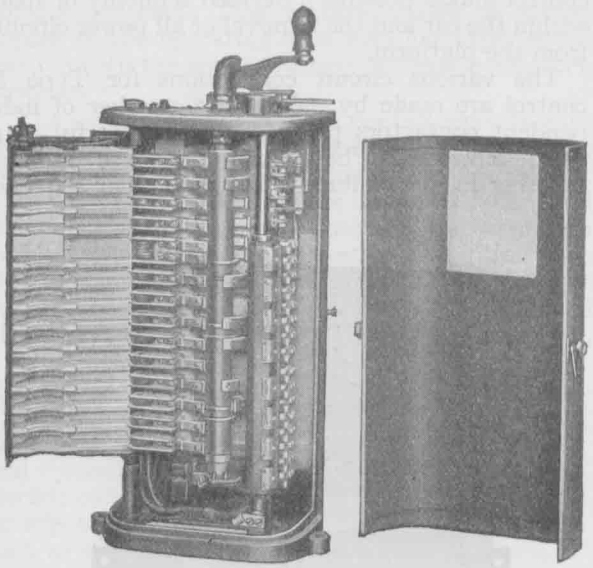
For complete information, refer to our nearest Sales Office.

RAILWAY APPARATUS

Controllers

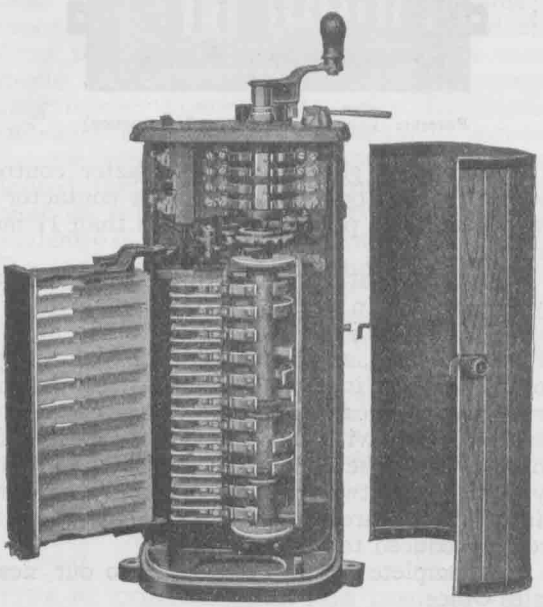
DRUM OR PLATFORM TYPE

The most generally used drum controller is known as the K type. The characteristic feature of this type is the series parallel combinations of



Type K-35 Controller

motor connections. This controller is used principally for single-car operation. Under certain conditions it can also be arranged to operate two



Type K-68 Controller

cars in each 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 trains during rush hour periods.

The principal characteristics of this type of controller have remained unchanged for many years, although improvements in details have been made from time to time to meet the increasing requirements of service.

Certain features are common to all K type controllers. These are:

(a) Separate power and reverse cylinders with their handles mechanically interlocked to prevent improper operation.

(b) Magnetic blowouts and arc resisting shields to promptly disrupt arcs formed when breaking circuits.

(c) Cutout switches for disconnecting a damaged motor or pair of motors and still permit operation of the remaining motors.

(d) Asbestos-lined wood covers, which can be removed quickly.

(e) Easy removal and replacement of parts subjected to wear, such as fingers and segments, at a minimum expense.

(f) When the power has been lost, an emergency stop can be made with either the four-motor or two-motor controllers by using the motors as generators. In the case of the four-motor controllers it is necessary only to throw the reverse switch to the position which would give the opposite direction of motion with power on. In the case of two-motor controllers, in addition to turning the reverse switch as above, the circuit breaker must be opened and the controller turned to some parallel position.

STANDARD K CONTROLLERS

The present standard forms of K controllers with ratings, etc., are given on page 945.

Following are features which are embodied in all later K controllers, excepting Types K-63 and K-75. As these controllers have been developed more recently, they are described separately.

Individual magnetic blowouts are provided for each main finger or group of fingers. These are so located that the arc is blown outward.

Contact fingers embodying changes in design which have tended to considerably prolong their life.

RAILWAY APPARATUS

Controllers

DRUM OR PLATFORM TYPE

A cylinder construction and method of insulating the shaft by means of removable insulation, thoroughly tested for many years, are now recognized as standard for railway controllers.

The wiring has been greatly simplified by omitting the connection board and providing terminals at the finger bases to which incoming leads are directly connected. This eliminates a number of soldered connections.

K-63 CONTROLLER

The K-63 controller was developed especially for use on small, light-weight cars.

In the design of this controller special attention has been given to the elimination of unnecessary weight, and considerable reduction has been made, compared with controllers that have hitherto been available, without the sacrifice of features essential to successful operation and low maintenance cost. The type of cylinder construction, fingers, terminals, and wiring, similar to other standard controllers, is incorporated in the K-63, but as it is very much smaller than the others and is for use only with small motors, the arcs can be effectively disrupted by means of a single blowout coil. This coil is of sufficient length to distribute the flux over all the main fingers.

TYPE K-75, LOW, LIGHT-WEIGHT CONTROLLER

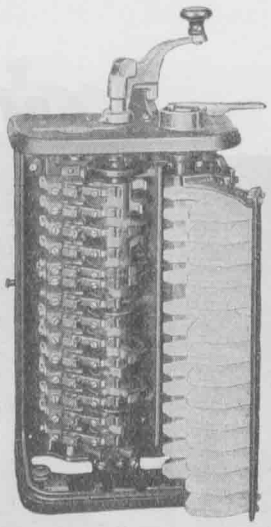
The K-75 controller has been developed to meet the demand for a four-motor controller suitable for use with the modern light-weight car. Although smaller and lighter than other standard controllers, the K-75 has the latest improvements and strength of construction essential for successful operation in railway service. It has sufficient capacity for four 50-h.p., 600-volt railway motors, and weighs 145 pounds.

The operating handle of the controller is sufficiently low so that the motorman may remain seated while operating the car and at the same time have an unobstructed view of the road. When used in service where the motorman always stands, the controller is mounted on a light sheet-steel pedestal box.

The K-75 controller has five points series and three parallel with a shunt resistance transition of the motors from series to parallel. The motor resistors are in one group connected in the circuit ahead of the motors. The controller reverses the motor fields and is arranged for ground return circuit.

The controller frame and cap plate are made of aluminum alloy. This results in an appreciable saving in weight. Troughs are cast for cable ways in the back of the frame at both sides. This construction provides sufficient space for all the cables without crowding or chafing, and permits a very neat arrangement of the wiring.

The main cylinder is of the usual drum controller construction—an insulated shaft upon which the cylinder body castings are mounted. The shaft is made of hexagonal steel fitted with renewable insulation. The brass alloy castings are keyed to the shaft. The cylinder segments of hard rolled copper are provided with lap-type renewable burning tips.



Type K-75, Low, Light-weight Controller

Type K-75 Controller with LB-4 Line Breaker Handle

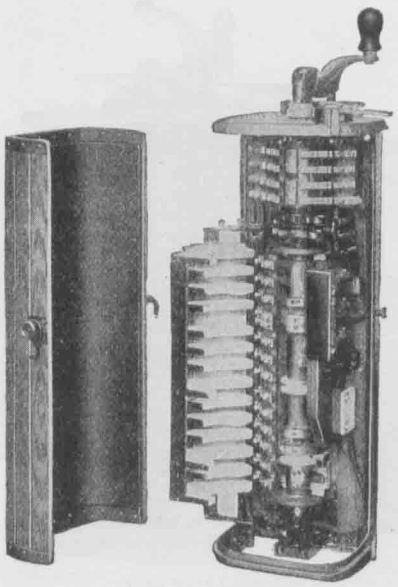
K CONTROLLER FOR 1200 VOLTS

In most cases where high voltages are used, operating conditions are such that some type of remote control is the most suitable, but where the platform type of control is desired the K-47 controller has been developed for use on 1200-volt lines.

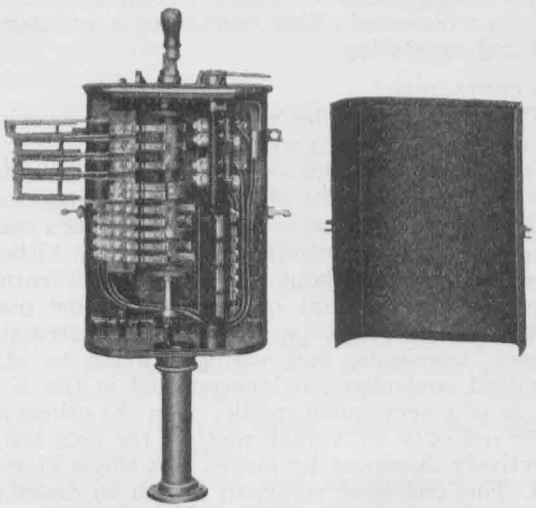
RAILWAY APPARATUS

Controllers

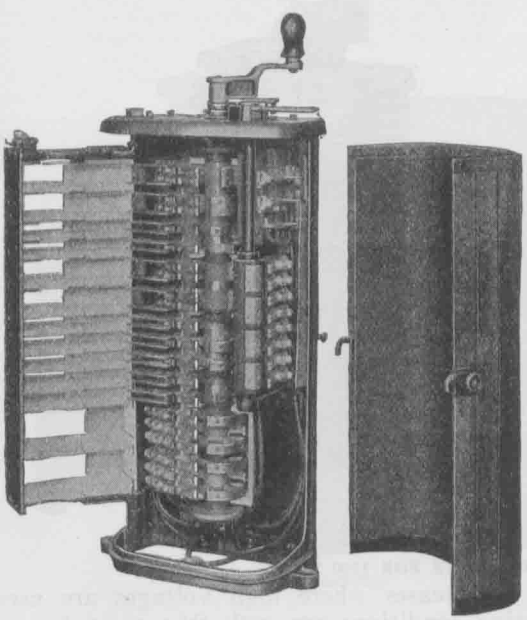
DRUM OR PLATFORM TYPE



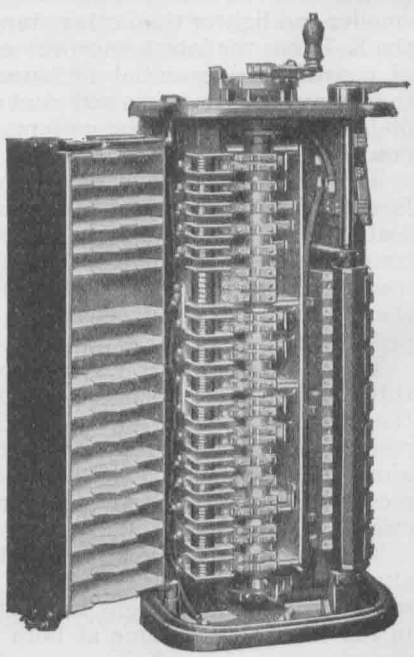
Type K-63 Controller



Type K-45 Controller



Type K-51 Controller



Type K-64 Controller

RAILWAY APPARATUS

Controllers

DRUM OR PLATFORM TYPE

RHEOSTATIC BRAKING CONTROLLERS

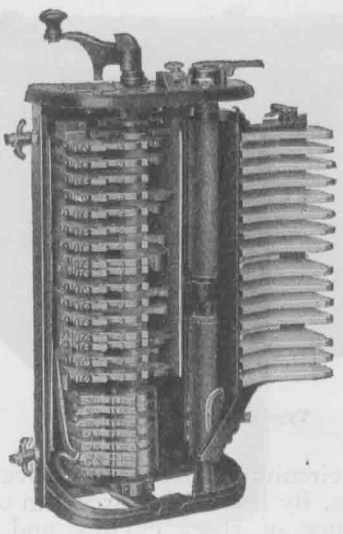
The fundamental principle on which the action of rheostatic braking is based is the conversion of the motors into generators, which derive their energy from the momentum of the car and convert it into electrical energy which is absorbed in a set of resistors. The retardation of the car is, therefore, entirely independent of the current from the trolley and is proportional to the amount of energy absorbed in the resistors. Additional braking effort may be obtained by the use of magnetic brake shoes energized by the current thus generated.

The controllers for this service are known as the B type and are essentially the same as the K type with additional contacts for establishing the circuits necessary for braking. Their operating handles may be turned forward through a number of notches, which gives series and parallel connections for power running, as in K controllers, and may also be turned in the reverse direction through a number of notches which establish the braking connections and vary the braking effort by varying the resistance in the circuit.

Types B-50, B-51, and B-54 embody the same general features as the latest standard K type controllers.

STANDARD CONTROLLERS

These controllers are standard for commutating pole motors. The ratings in the following tables are based on the hourly rating of the motors at normal voltage, and the continuous rating at three quarters normal voltage. Care must be taken, in selecting controllers for a given motor equipment, not to exceed either the hourly rating in horse power or the continuous rating in amperes.



Type B-54 Rheostatic Braking Controller

TYPE K CONTROLLERS FOR 600-VOLT SERVICE WITH MAXIMUM PEAKS OF 750 VOLTS

Type	No. of Motors	MAXIMUM ALLOWABLE CAPACITIES OF EACH MOTOR (NEITHER TO BE EXCEEDED)		NUMBER OF POINTS		Approx. Wt. in Lb.	Remarks
		Hourly Rating H.P. on 600 Volts	Continuous Rating Amperes	Series	Parallel		
K-75	4	50	50	5	3	148	Ground circuit
K-68	2	70	66	4	3	225	Ground circuit
K-39	2	70	66	4	4	230	For metallic return circuit
K-35	4	65	60	5	3	270	Ground circuit
K-40	4	65	60	5	3	280	For metallic return circuit
K-51	2	70	66	5	4	250	For tapped field motors
K-63	2	40	38	4	3	135	Ground circuit
K-64	4	110	105	6	4	450	Ground circuit

TYPE K CONTROLLERS FOR 1200-VOLT SERVICE WITH MAXIMUM PEAKS OF 1350 VOLTS

K-47-A	4	75	65	6	4	437	Two motors permanently connected in series

TYPE B CONTROLLERS FOR 600-VOLT ELECTRIC BRAKING SERVICE WITH MAXIMUM PEAKS OF 750 VOLTS

Type	No. of Motors	MAXIMUM ALLOWABLE CAPACITIES OF EACH MOTOR (NEITHER TO BE EXCEEDED)		NUMBER OF POINTS			Approx. Wt. in Lb.	Remarks
		Hourly Rating H.P. on 600 Volts	Continuous Rating Amperes	Series	Parallel	Braking		
B-50-B	4	60	53	5	4	9	492	Individual blowout coils
B-51-B	2	120	105	5	4	9	492	Individual blowout coils
B-54-C	2	70	66	4	3	7	270	Individual blowout coils
B-62	2	90	75	5	5	5	191	Individual blowout coils