General Electric Company

Schenectady, N.Y.

RAILWAY DEPARTMENT

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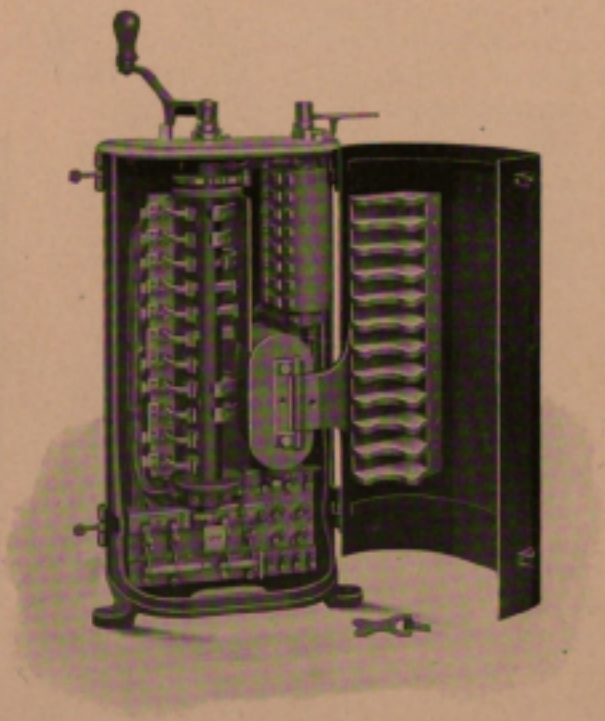
RAILWAY MOTOR CONTROLLERS

The advance that electrical engineering has made in the transportation industry has not been surpassed in any of the many other fields to which it has been applied. In a great measure this has been brought about by the excellent construction and careful design of the various details of electric car equipments. In these the controller is one of the most vital parts, since the success of the rest of the equipment practically depends on its proper operation.

The continually increasing power and higher voltages, that are coming into favor in electric roads, have imposed new and more severe conditions on the controller equipment. These requirements have been met by improving the design of controllers and also by the development of improved controllers specially adapted to altered operating practice, so that the Company is always in a position to furnish controllers which are suited to any and all service conditions.



The K-10 Controller

The object of this bulletin is to describe in a comprehensive manner the essentials of the various standard controllers that are manu-

*Supersedes Bulletin No. 4320.

factured for railway service with special reference to the operating conditions for which each type is suited.

The following features which have been incorporated in all railway cylinder controllers have been largely responsible for their successful operation.

Magnetic Blow-outs with which all the controllers described in this bulletin are provided and which are recognized as the only reliable type of arc-disrupting device.

Cut-out Switches arranged so that either motor on two-motor equipments or either pair of motors on four-motor equipments can be cut out of circuit without affecting the operation of the remaining motor or motors.

Interlocks, which, to a great extent, prevent the misuse of the controller by the motorman, since they prevent any of the handles being moved unless the remaining handles are in the proper position.

Interchangeability of Parts insuring ready renewals or repairs and economy of operation.

The controller parts are put together by skilled mechanics and the most approved machinery is used in the construction of the various details. Each controller is thoroughly tested by competent inspectors before leaving the factory.

Several forms of controllers are manufactured to suit the various conditions of service. They are divided into four general classes for convenience, each class being designated by an arbitrary letter.

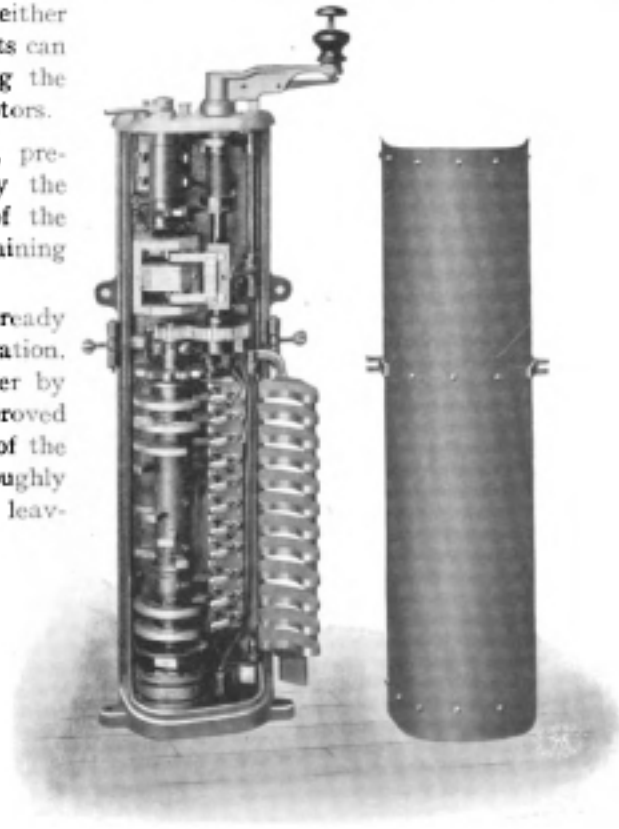
Type B Controllers which include the necessary contacts and connections for electric braking. They may either be of the series parallel or rheostatic type.

Type K Controllers are of the series parallel type. The K-34 and K-35 are provided with "bridge" connections so that full current is maintained through all motors during the transition period from series to parallel. In all other controllers of this type one of the motors is shunted or short-circuited when changing from series to parallel connection.

Type L Controllers are also of the series parallel type, but completely open the power circuit when changing from series to parallel.

Type R Controllers are of the rheostatic type and are designed to control the motor speeds by means of resistance only.

The Sprague-General Electric Type M Control System has been developed for the operation of motor cars in trains or for the operation of large equipments where the size and weight of the cylinder type controller are objectionable. This control is also used in a modified form for industrial purposes such as coal and ore hoists, and in rolling mills and other places where the operating conditions are severe and very large currents are handled.



The C-6 Master Controller

Fundamentally, this system comprises a set of electrically-operated switches on each motor car with heavy contacts for handling the motor current, and small master controllers on the car platforms, which admit current to control wires leading to the operating coils of the electrically-operated switches or contactors and reverser, as they are called. For train operation, suitable cable couplers are used to connect corresponding control wires together on all motor cars, so that when these wires are energized by any master controller, similar results are obtained simultaneously on all motor cars in the train.

The contactors are of simple and substantial design, and are provided with a very effective magnetic blow-out capable of handling the excessive currents encountered during short circuits. The master controllers are small, compact, and easily operated and are provided with magnetic blow-outs, interlocking handles, etc.

Four forms of Type M control have been developed to meet various service conditions. They are known as follows:

Hand or non-automatic control,
Semi-automatic control,
Automatic master control,
Relay automatic control,

For a detailed description of the above, reference should be made to a separate publication on Sprague-General Electric Type M Control.

The K-28 J Controller

CONTACTOR EQUIPMENTS FOR CYLINDER CONTROLLERS

An auxiliary equipment adapted for use with practically all standard cylinder controllers is now manufactured. This consists essentially of two standard Type M Control Contactors connected in the main trolley circuit and additional contacts in the controllers for opening and closing the contactors when the controller is turned off or on respectively. Heavy arcing is thus eliminated from the

controllers since the power circuit is always opened by the contactors. Consequently, the wear and tear on the controller fingers and contact surfaces are diminished, repairs minimized and the possibility of burnt out controllers practically prevented.

The auxiliary contactor equipments are specially adapted for large electric railway systems where higher voltages are used and where therefore the control apparatus is subjected to a greater strain due to arcing in the case of a grounded motor or derangement of other apparatus.

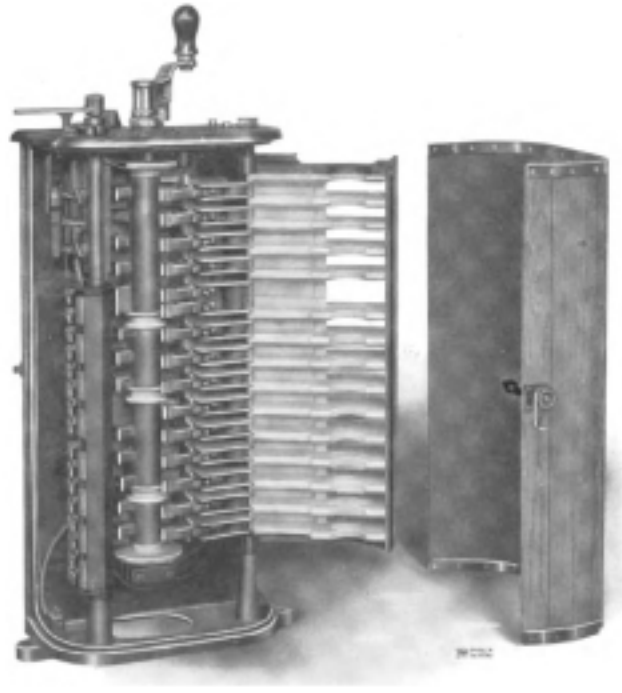
These equipments may include overload devices, known as MU tripping switches for automatically interrupting the energizing circuit of the contactor coils on overload and a switch and fuse for opening and protecting the circuit of the contactor operating coils, etc.

The additional contacts for operating auxiliary contactor equipments are included in the following controllers: K-6-H, K-10-H, K-11-H, K-12-D, K-14-E, K-28-F, K-28-J and L-4-C.

A separate bulletin entitled "Auxiliary Contactor Equipments for Cylinder Controllers" gives a detailed description of the various devices used in these equipments and their functions.

NEW CONTROLLERS

Three controllers, known as K-34, K-35 and K-36, have recently been developed which contain improved magnetic blow-outs and other details adapting them for use on systems in which the voltage peaks reach over 600 volts.



The K-35 Controller

The K-34 controller is suitable for use with either two 150 h.p. or four 75 h.p. motors. The K-35 is for use with either two 100 h.p. or four 50 h.p. motors and less. The K-36 is used with two 60 h.p. motors (or less), only.

In the K-34 and K-35, as already mentioned, bridge connections are used, by which

means a smooth acceleration is obtained and the strain on motors and gearing reduced. As will be seen from the illustration, the reverse switch is located at the left of the controller handle instead of at the right, in order to accomodate the new style of blow-out.

Individual blow-out coils and arc chutes for each contact finger are provided in these controllers in order to produce a powerful magnetic field for extinguishing the arc formed between the segment and finger on breaking contact. The design and construction of these blow-out coils and chutes are such that the arc is promptly extinguished under all operating conditions and burning and consequent repairs are reduced to a minimum.

Terminals. The terminals for the leads entering the K-34, K-35 and K-36 controllers are directly attached to the finger bases, thereby obviating the necessity for a separate connection board. The terminals are of the clamp form which does not require the use of solder or set screws. As the clamps are completely accessible, the leads can always be quickly connected or disconnected when required.

Location of Reverser Fingers. The omission of the connection board provides additional space in the controller. Advantage has been taken of this, in the case of the K-34 and K-35, to lengthen the reversing cylinder, thus allowing all fingers with their attachments to be located on the outer side where they are immediately accessible for inspection and repairs.

CONTROLLER RATINGS

The rated capacities of controllers are based on the maximum horse-power of the motors with which they can be used, the motors being rated in accordance with standard practice for railway work; that is, by the output which can be obtained for one hour with a rise of temperature in the motor not exceeding 75 degrees C. Such rating is for intermittent service.

All controller ratings are based on a potential of 500 volts. If they are used on lower voltages the horse-power ratings will be proportionally less.

While nominally designed for 500 volts, all controllers can be successfully used at a maximum potential not exceeding 600 volts. The K-34, K-35 and K-36 controllers, which have been specially developed for use on 600 volts nominal and 750 volts maximum, are an exception to this general statement.

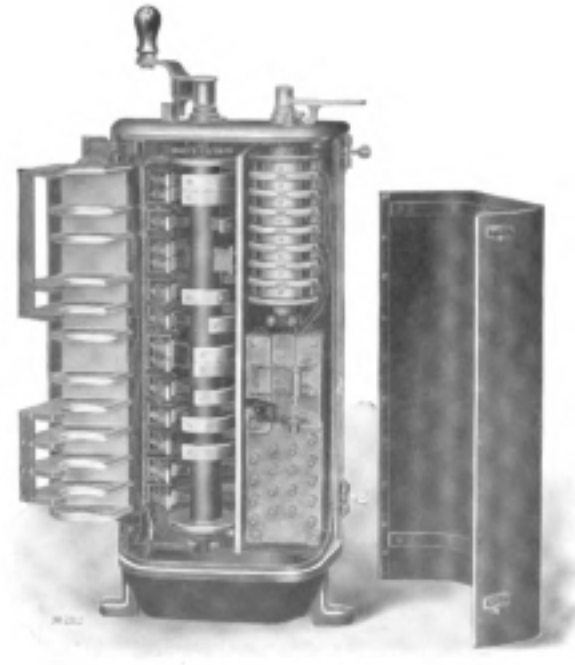
CONTROLLER DIMENSIONS

The principal dimensions of all cylinder controllers will be found at the end of this bulletin.

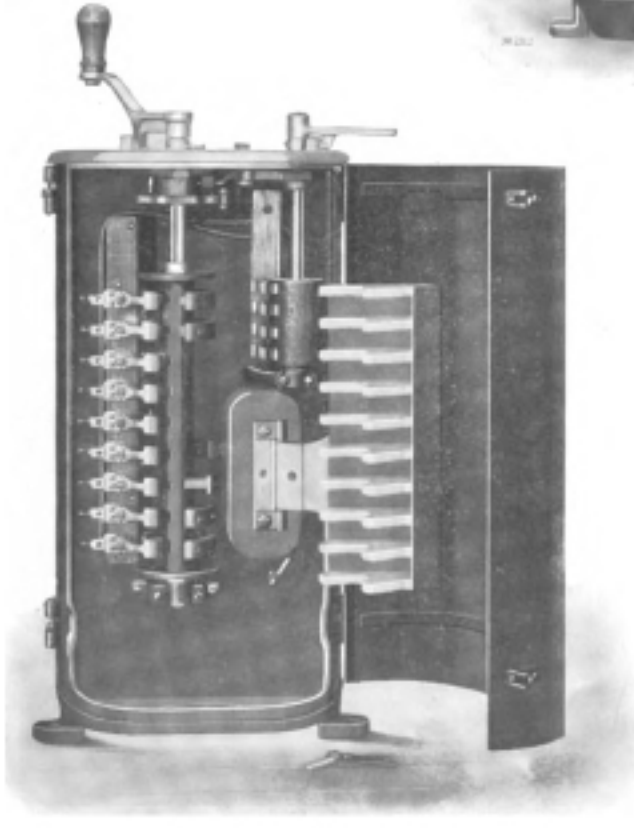
LIST OF CONTROLLERS

The following list of various types of cylinder controllers has been prepared, which gives their general characteristics and distinguishing features.

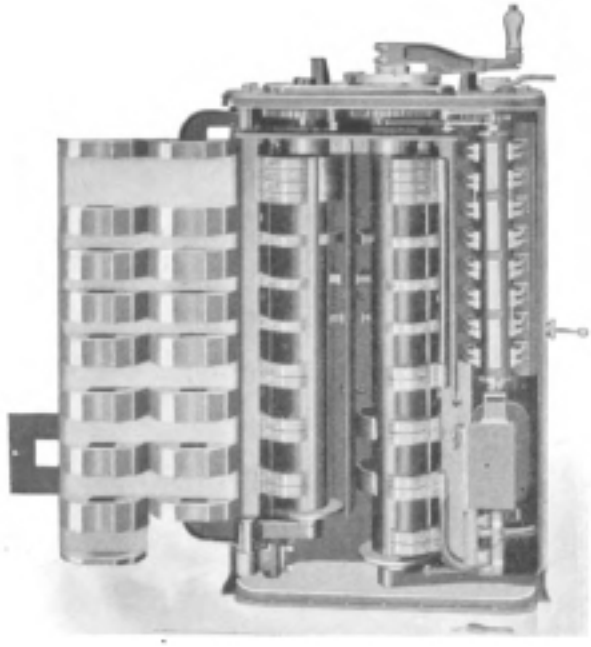
4578-6 Railway Motor Controllers



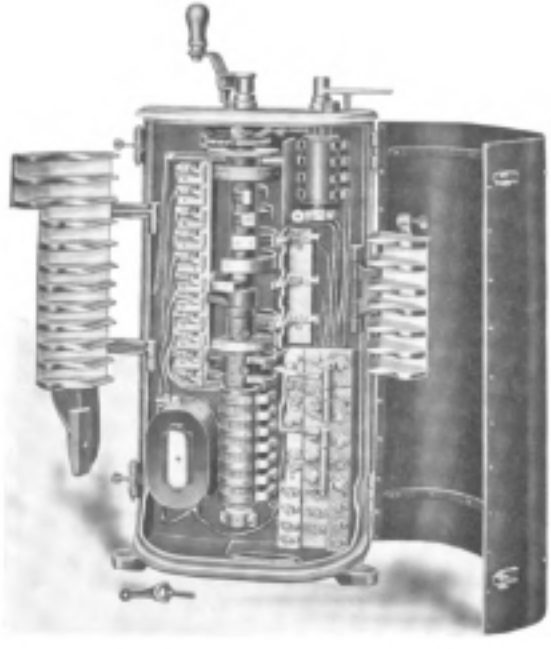
The K-28B Controller



The R-17 Controller



The L-3 Controller



The B-18 Controller

SERIES PARALLEL CONTROLLERS

TITLE	CAPACITY	POINTS CONTROLLING	SPECIAL FEATURES, ETC.
K-2-A	Two 40 h.p. motors	5 series 4 parallel	For motors using loop or shunted field.
K-2-B	Two 40 h.p. motors	5 series 4 parallel	For motors using loop or shunted field. (Emergency reverse.)
K-4-A	Four 30 h.p. motors	5 series 4 parallel	For motors using loop or shunted field.
K-6-A	Two 80 h.p. motors, or Four 40 h.p. motors	6 series 5 parallel	Superseded for general use by K-28-B.
K-7-A	Four 30 h.p. motors	5 series 4 parallel	K-12-A adapted to non-grounded return system.
K-8-A	Two 60 h.p. motors	5 series 4 parallel	K-9-A with increased capacity.
K-9-A	Two 40 h.p. motors	5 series 4 parallel	K-10-A adapted to non-grounded return system.
K-9-B	Two 40 h.p. motors	5 series 4 parallel	Emergency reverse.
K-10-A	Two 40 h.p. motors	5 series 4 parallel	
K-10-D	Two 40 h.p. motors	5 series 4 parallel	Emergency reverse.
K-10-H	Two 40 h.p. motors	5 series 4 parallel	Includes contacts for operating auxiliary contactors.
K-11-A	Two 60 h.p. motors	5 series 4 parallel	K-10-A with increased capacity.
K-11-C	Two 60 h.p. motors	5 series 4 parallel	Emergency reverse.
K-11-H	Two 60 h.p. motors	5 series 4 parallel	Includes contacts for operating auxiliary contactors.
K-12-A	Four 30 h.p. motors	5 series 4 parallel	Similar to K-11 but for 4 motors.
K-12-D	Four 30 h.p. motors	5 series 4 parallel	Includes contacts for operating auxiliary contactors.
K-13-A	Two 125 h.p. motors	7 series 6 parallel	Superseded for general use by K-34-A.
K-14-A	Four 60 h.p. motors	7 series 6 parallel	Superseded for general use by K-34-A.

SERIES PARALLEL CONTROLLERS—Cont'd

TITLE	CAPACITY	CONTROLLING POINTS	SPECIAL FEATURES, ETC.
K-14-E	Four 60 h.p. motors	7 series 6 parallel	Includes contacts for operating auxiliary contactors.
K-27-A	Two 60 h.p. motors	4 series 4 parallel	For use on non-grounded return system.
K-28-B	Four 40 h.p. motors, or Two 80 h.p. motors	5 series 5 parallel	
K28-E	Four 40 h.p. motors, or Two 80 h.p. motors	5 series 5 parallel	K-28-B adapted for conduit wiring.
K-28-F	Four 50 h.p. motors (When used with auxiliary contactor equipment)	5 series 5 parallel	Has extra heavy wiring and includes contacts for operating auxiliary contactors.
K-28-J	Four 50 h.p. motors (When used with auxiliary contactor equipment)	5 series 5 parallel	K-28-F adapted for conduit wiring.
K-29-A	Four 40 h.p. motors	6 series 5 parallel	For non-grounded return, similar to K-6.
K-31-A	Four 30 h.p. motors	4 series 4 parallel	Similar to K-27 but for 4 motors.
K-32-A	Two 40 h.p. motors	4 series 4 parallel	K-27 with decreased capacity.
K-34-A	Four 75 h.p. motors, or Two 150 h.p. motors	6 series 4 parallel	For systems in which the voltage peaks reach over 600 volts.
K-35-A	Four 50 h.p. motors, or Two 100 h.p. motors	5 series 3 parallel	For systems in which the voltage peaks reach over 600 volts.
K-36-A	Two 60 h.p. motors	4 series 4 parallel	For systems in which the voltage peaks reach over 600 volts.
L-2-A	Two 175 h.p. motors	4 series 4 parallel	
L-3-A	Four 150 h.p. motors	8 series 7 parallel	
L-4-A	Four 100 h.p. motors	4 series 4 parallel	

ELECTRIC BRAKE CONTROLLERS

TITLE	CAPACITY	CONTROLLING POINTS	SPECIAL FEATURES, ETC.
B-8-B	Four 60 h.p. motors	6 series 5 parallel 7 brake	Has separate braking handle.
B-13-A	Two 40 h.p. motors	5 series 4 parallel 7 brake	For use with disc brakes.
B-18-C	Two 40 h.p. motors	4 series 4 parallel 6 brake	For use with magnetic track brake.
B-19-A	Four 40 h.p. motors	5 series 4 parallel 7 brake	Has separate braking handle.
B-23-A	Two 60 h.p. motors	5 series 4 parallel 7 brake	B-13 with increased capacity.
B-35-B	Two 50 h.p. motors	4 series 4 parallel 6 brake	B-18-C with increased capacity.

RHEOSTATIC CONTROLLERS

R-17-A	One 50 h.p. motor	6 forward 6 reverse	
R-19-A	Two 50 h.p. motors	6 forward 6 reverse	

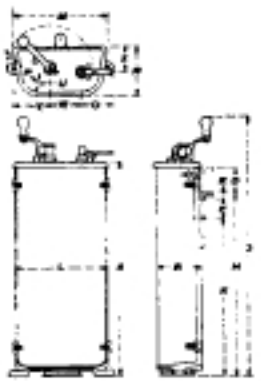


Fig. 1

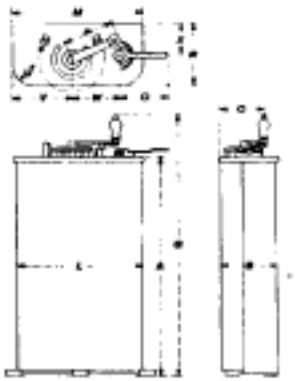


Fig. 2

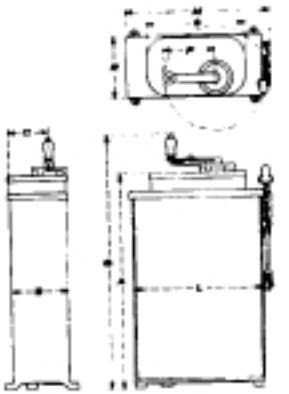


Fig. 3

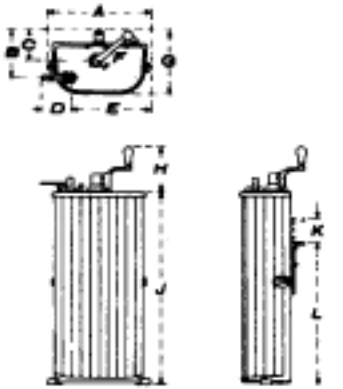


Fig. 4

DIMENSIONS OF CONTROLLERS

TYPE	FIG.	A	B	C	D	E	P	G	H	J	K	L	M	O	P	R	S	U	V	W	X
K-2-A.....	1	35 1/16	7 3/16	2 1/2	4 1/2	1	3 1/2	43 1/2	29 1/2		25 1/2	16 1/2	17 1/2	5 1/2	8	8 3/16		5 1/2	7 7/16	6 11/16	4 5/16
K-4-A.....	1	35 1/16	7 1/16	2 1/2	4 1/2	1	3 1/2	43 1/2	29 1/2		25 1/2	16 1/2	17 1/2	5 1/2	8	8 1/16		5 1/2	7 1/16	6 11/16	4 5/16
K-6-A.....	1	38 1/2	8 1/2	3 1/2	4 1/2	1	3 1/2	47 5/8	33 1/16		28 1/16	16 1/2	17 1/16	5 1/2	8	9 1/16		4 1/2	6 1/8	5 11/16	4 11/16
K-10-A.....	1	33 1/16	7 1/16	2 1/2	4 1/2	1	3 1/2	42 1/2	28 1/16		24 1/16	16 1/2	17 1/2	5 1/2	8	8 1/16		5 1/2	7 1/16	6 11/16	4 1/16
K-11-A.....	1	33 1/16	7 1/16	2 1/2	4 1/2	1	3 1/2	42 1/2	28 1/16		24 1/16	16 1/2	17 1/2	5 1/2	8	8 1/16		5 1/2	7 1/16	6 11/16	4 1/16
K-12-A.....	1	33 3/16	7 1/16	2 1/2	4 1/2	1	3 1/2	42 1/2	28 11/16		24 1/16	16 1/2	17 1/2	5 1/2	8	8 1/16		5 1/2	7 1/16	6 11/16	4 3/16
K-13-A.....	2	39	10	5 1/2				46 1/16				19	20	8 1/2	9 1/2	11		4	10 1/2	5	5 1/2
K-14-A.....	2	38 1/2	10	5 1/2				46 7/8				22 1/2	23 1/2	8 1/2	9 1/2	11		4	10 1/2	8 1/2	5 1/2
K-27-A.....	1	35 1/16	7 1/16	3 1/2	4 1/2	1	3 1/2	44 1/2	29 1/2		26 1/2	16 1/2	17 1/2	5 1/2	8	8 1/16		5 1/2	7 1/16	6 11/16	4 3/16
K-28-B.....	1	36	7 1/2	3 1/2	4 1/2	1 1/16	3 1/2	44 1/2	30 1/2		25 11/16	16 1/2	17	5 1/2	8	8 1/2		5	7 1/16	5 11/16	4 1/2
K-29-A.....	1	38 1/2	8 1/2	3 1/2	4 1/2	1	3 1/2	47 1/16	33 3/16		28 11/16	16 1/2	17 1/16	5 1/2	8	9 1/16		4 1/2	6 11/16	5 11/16	4 11/16
K-31-A.....	1	35 1/16	7 1/16	3 1/2	4 1/2	1	3 1/2	44 1/2	29 1/2		26 1/2	16 1/2	17 1/2	5 1/2	8	8 1/16		5 1/2	7 1/16	6 11/16	4 3/16
K-32-A.....	1	35 1/16	7 1/16	3 1/2	4 1/2	1	3 1/2	44 1/2	29 1/2		26 1/2	16 1/2	17 1/2	5 1/2	8	8 1/16		5 1/2	7 1/16	6 11/16	4 3/16
K-34-A.....	4	21 1/2	11 1/16	6 11/16	5 1/2	16 11/16	9 1/2	14 7/16	6 1/2	43 1/2	4 1/2	33 1/2									
K-35-A.....	4	20 1/2	9 1/16	6	5 1/2	15 1/2	8	12 1/2	8 1/2	36 1/2	4 1/2	25 11/16									
K-36-A.....	4	18 1/2	9	6	*5 1/2	*7	8	12 1/2	8 1/2	35	4 1/2	25 11/16									
L-2-A.....	3	40 1/2	10 3/4	7 1/2				48 1/2				25 1/2	27 11/16		9 1/2	11 1/2	18 1/2				
L-3-A.....	2	45 1/2	13	6 1/2				53 1/2				28 1/2	29	5 11/16	13	14		3 1/2	15 1/2	9	10
L-4-A.....	3	40 1/2	10 1/2	7 1/2				48 1/2				25 1/2	32 1/16		9 1/2	11 1/2	18 1/2				

Note.—K-7-A, K-8-A, K-9-A have same dimensions as K-10-A.
Dimensions of controllers with the same form numeral but different form letters are similar.
*Reverse handle on the right-hand side.
Dimensions approximate and for general information only. They must not be used for contracts or for construction without confirmation.

Fig. 5

Fig. 1

DIMENSIONS OF CONTROLLERS

TYPE	FIG.	A	B	C	D	E	F	G	H	K	L	M	O	P	R	U	V	W	X	Y	Z
B-8-B.....	5	42	11¼	5⅞	48	1	3¼	50⅞	30¼	26¼	28¾	29¼	53	9	12¼	4⅜	7¼	6¾	6⅜	9¼	8¾
		38	9	4¼	42	1	3¼	46¼	30⅜	26⅞	21¼	23¼	51	9	9⅛	5⅛	12¼	5	5⅛		
B-13-A.....	1	36½	8¼	3⅛	42	1	3½	44⅛	29⅞	24⅛	19	19½	54	8	8⅛	6¼	9⅞	6¼	4⅞	8⅛	8¾
B-18-C.....	5	36	9⅛	3⅛	48	1	3½	44¾	30¼	24¼	25	25¼	54	8	9⅛	6¼	6⅜	5⅛	5⅛		
B-19-A.....	1	38	9	4¼	42	1	3¼	46¼	30¼	26¼	21¼	22¼	51	9	9⅛	5¼	12¼	5	5⅛		
B-23-A.....	1																				
R-17-A.....	1	33⅜	7⅞	2⅛	48	1	3¼	41⅛	28⅛	24⅞	16¾	17¼	53	8	8⅜	5¼	7⅞	6¼	4⅜		
R-19-A.....	1	33⅜	7⅞	2¼	48	1	3¼	41⅛	28⅛	24⅞	16¾	17¼	54	8	8⅜	5¼	7⅞	6⅛	4⅜		

Note. B-35-B has the same dimensions as B-18-C.
Dimensions approximate and for general information only. They must not be used for contracts or for construction without confirmation.