

General Electric Company Schenectady, N.Y.

SUPPLY DEPARTMENT

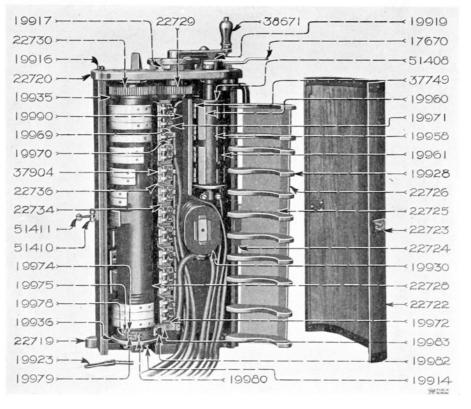
February, 1907

Bulletin No. 4493

PARTS OF R CONTROLLERS

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Parts of R-6-A Controller



Cat. No.

Description

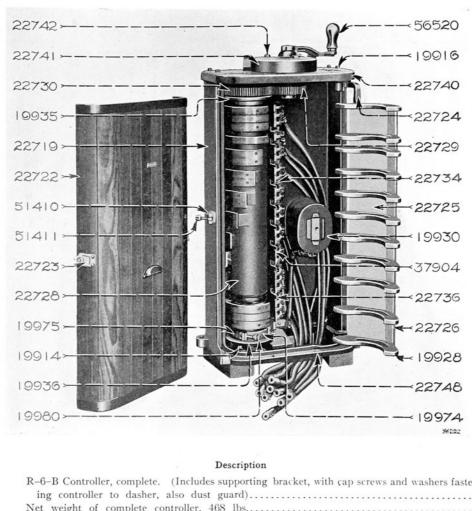
	R-6-A Controller, complete. (Includes supporting bracket, with cap screws and washers fasten- ing controller to dasher, also dust guard.)	
	Net weight of complete controller, 510 lbs	
38671	*Operating Handle, malleable iron\$1	4.50
17670	*Reversing Handle	3.65
22748	DUST GUARD, includes 5 screws (No. 12, 11/2" F. H., Cat. No. 10304)	1.00
22719	FRAME, fitted with bearing caps and cap screws for controlling and reversing cylinder shafts	
19914	Cap screw fastening bearing caps to frame $(\frac{7}{16}''-14, 1\frac{14}{4}''$ Hex. H. Slot) per 100	3.00
51410	Hinge joint for frame, with screws	.55

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Parts of R-6-A Controller-Concluded

Cat. No.	Description	List Price
37904	Reinforced contact finger, with spring	\$0.25
10264	Adjusting screw for contact finger (14-24, 1" R. H. Blued), per 1	
2 2213	Check nut for 10264 (14-24, Hex. Flat Brass), per 1	00 1.50
5889	Screw fastening finger to base (10-24, ⁷ / ₁₆ " R. H. Blued), per 1	
19683	Double washer for No. 5889 per 1	00 2.00
19972	Collector ring base	
15941	Screw fastening No. 19972 to wood base (No. 10, 11/ F. H.) per 1	
19648	Binding Screw for No. 19972 (14-24, §" R. H. Blued, Round Point), per 1	00 1.00
22 213	Check nut for binding screw (14-24, Hex. Flat Brass), per 1	00 1.50
19973	COLLECTOR RING, complete (includes parts indented below)	б.00
19974	Half ring, right-hand	
19975	Half ring, left-hand	3.00
19976	Tension pin $(\frac{5}{16}'' \times 1\frac{5}{8}'' R. H.)$	10
19977	Tension spring for No. 19976 (5 Turns .048" Steel wire)	03
9806	Washer for No. 19977 (5" x 5" x .062" Copper)	00 3.00
10110	Spring Cotter for No. 19976 ($\frac{5}{64}$ " x $\frac{1}{2}$ ") per 10	00 2.00
19978	Tension screw $(\frac{5}{16}''-18, 2\frac{1}{2}'' R. H.)$ per l	00.8.00
19979	Tension spring for No. 19978 (7 Turns .048" Steel wire)	
19980	Thumb nut for No. 19978 (1 / -18 Brass)	10
19981	Flexible connector, with two washers attached for halves of rings (13 thicknesses .005" Copp	er) .15
19982	Flexible connector, with one washer attached for collector ring and base (26 thicknesses .005" Co	op-
	per	20
14434	Screw fastening Nos. 19981, 19982 to ring (8-32, §" R. H. Blued) per 1	00 .50
19983	Screw fastening No. 19982 to collector base (14-24, ³ / ₄ Sq. H. Blued Sp'l) per 1	00 4.00
19984	Washer for No. 19983 ($\frac{9}{32}$ " x 1" x 1" x $\frac{1}{4}$ " thick Brass)	00 5.00
19985	REVERSING CONTACT BOARD, wired, complete	18.50
19986	Two-way connector for wires with two screws	
5889	Screw for No. 19986 (10-24, 7/16" R. H. Blued) per 1	
19987	Wood base	
19988	Screw fastening wood base to frame (3"-16, 12" R. H.) per 1	
9811	Washer for No. 19988 (3" x 3" x .062" Copper) per 1	00 2.00
19966	Threaded bushing used in connection with No. 19988 (3"-16 Sp'l)	
19989	Contact base	
1188	Screw fastening base to wood base (No. 10, 1" F. H.) per 1	
37749	Reinforced contact finger, with spring	
14434	Screw fastening finger to base (8-32, §" R. H. Blued) per l	
13804	Double washer for No. 14434 per 1	
19990	Shield, with brackets, between controlling and reversing contact boards	
14192	Screw fastening bracket to shield (No. 8, §" F. H.) per 1	
19804	Screw fastening bracket to frame (14-24, ⁷ / ₁₆ " R. H. Blued) per 1	00 .75

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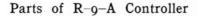
Parts of R-6-B Controller

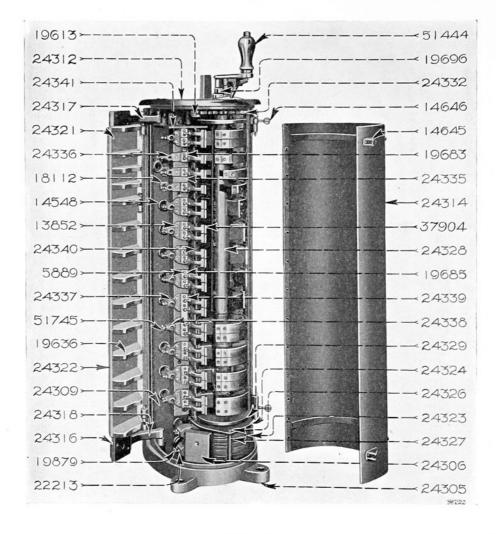
Cat. No.	Description	st Price
	R-6-B Controller, complete. (Includes supporting bracket, with cap screws and washers fasten- ing controller to dasher, also dust guard) Net weight of complete controller, 468 lbs	
56520	*Operating Handle	\$6.00
00710	Following are the interchangeable parts:	
22748	DUST GUARD, includes 5 screws (No. 12, 1 ¹ / ₂ " F. H., Cat. No. 10304)	
22719	FRAME, fitted with bearing caps and cap screws for controlling and reversing cylinder shafts	
19914	Cap screw fastening bearing caps to frame $(\frac{7}{16})^{-14}$, $1\frac{1}{4}$ Hex. H. Slot) per 100	3.00
51410	Hinge joint for frame, with screws	.55
9877	Screw fastening No. 51410 to frame (5/16"-18, 1" R. H.) per 100	
51411	Hinge bolt, with pin and nut fastening cover to frame	.30
22721	Wire guard	.30
1288	Screw fastening wire guard to frame (10-24, 3" F. H.) per 100	.50
22740	CAP for top of controller	
19916	Cap screw fastening No. 22740 to frame (7 "-14, 1" Hex. H., Iron Nickeled) per 100	3.00
22741	Cover for star wheel attachment	4.00
22742	Cap screw fastening No. 22741 to No. 22740 (5"-11, 13" Hex. H. Marine Finish)	.15
22743	Star wheel, with pin	1.50
	*Not included in complete controller; must be ordered separately.	

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Cat. No.

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С	at.	No.

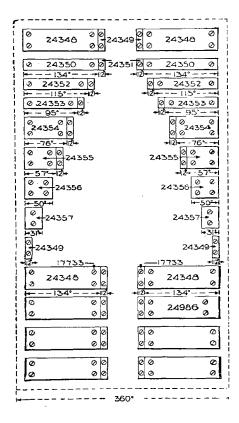
Description

	Net weight of complete controller, 365 lbs	
51444	*Operating Handle\$	14.50
	Following are the interchangeable parts:	
24305	FRAME, fitted with bearing, bearing support, spring post, and front and back linings	
24306	Pole piece stop and bearing	5.50
24307	Bearing support	5.50
24308	Screw fastening Nos. 24306, 24307, together (¹ / ₂ "-13, 1 ¹ / ₄ " F. H.)	.15
13843	Screw fastening No. 24307 to frame (§"-16,1" Hex. H. Slot)per 100	5.00
24309	Asbestos lining for front of frame $(42'' \times 11\frac{1}{2}'' \times \frac{1}{16}''$ thick)	.15
24310	Asbestos lining for tack of frame $(36\frac{1}{2}'' \times 11\frac{3}{4}'' \times \frac{1}{16}''$ thick)	.15
14646	Hinge bolt with pin and nut for fastening front cover	.45
24311	Hinge bolt with pin and nut for fastening back cover	.40
4030	Spring Cotter for Nos. 14646, 24311 $(\frac{3}{32}'' \times \frac{5}{8}'')$	2.00
24312	CAP for top of controller	
	*Not included in complete controller: must be ordered separately	

Parts of R Controllers 4493-9

Parts of R-9-A Controller-Continued

Cat. No.	Description	List Price
24313	Screw fastening cap to frame (1/-13, 11/ French H. Tob. Brz.)	\$0. 35
19696	WATER CAP AND POINTER, for cylinder shaft, with set screw	1.00
14410	Set screw for water cap $\left(\frac{5}{16}$ "-18, $\frac{21}{32}$ " Sp'l Blued)pe	r 100 5.00
24314	SHEET IRON COVER for front of frame	10 .00
14645	Slotted lug for cover, with rivets	10
24315	SHEET IRON COVER for back of frame	11.00



Cat. No.	List Price	Cat. No.	List Price
24348 24349 24350 24351 24352 24352 24353	\$1.22 .34 .79 .28 .72 .61	24354 24355 24356 24357 24986	\$0.75 .64 .56 .43 1.22
39479 17733	Complete set of segments, w Screw for segments, per 100	with screws.	31.86 3.00

Parts of R-9-A Controller Continued

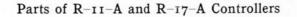
Cat. No.	Description	List	t Price
24316	HINGED POLE PIECE, complete, with hinge brackets		\$6.00
24317	Upper hinge bracket, with hinge pin		1.85
24318	Lower hinge bracket, with hinge pin		1.85
24319	Hinge pin for brackets $(2_{16}^{1}" \log, Sp'l)$.05
56788	Screw fastening hinge brackets to pole piece (16 "-18, 1" F. H.)		1.25
5150	Cap screw fastening pole piece to pole piece stop (1/2 13 11/2 Hex. II.)	.per 100 J	10 .00
16131	Lock washer for No. 5150		4.00
24320	ARC DEFLECTOR, complete	-	7.25
22774	Screw fastening arc deflector to pole piece (No. 10, 13" R. H. Blued		.50
13635	Insulating bushing used with No. 22774		.05
24321	Wide strip for arc deflector		2.75
24322	Narrow strip for arc deflector		1.10
19636	Division plate for arc deflector		.20
13852	Screw fastening strips to division plates No. 10, 3" F. H.)	per 100	.50
24323	MAGNET SPOOL wound, complete, with cable terminals and upper and lower flange	es 3	30.00
19879	Binding screw for magnet spool terminal (14 24, 11" R. H. Blued)	, per 100	1.50
22213	Check nut for No. 19879 (14-24, Hex. Flat Brass)	. per 100	1.50
24324	Fiber flange for magnet spool (upper)		.60
24325	Fiber flange for magnet spool (lower)		.55
24326	Screw fastening flange to frame (14-24, 55" R. H.)		.10
24327	Fiber sleeve for No. 24326 $(\frac{5}{16}'' \times \frac{1}{2}'' \times 4\zeta'' \log)$.15
24328	CONTROLLING CYLINDER, complete, with shaft, insulation disks, collar and star	wheel13	35 .00
39479	Complete set of copper contact segments with screws		
	Contact segments and screws listed on page 9		
24329	Insulation disk		.75
24330	Key $(\frac{1}{4}'' \times \frac{1}{4}'' \times 34 \tilde{\zeta}'')$ long		.08
24331	Collar for shaft, with pin		3.00
24332	Star wheel, with pin; must be fitted		1.10
19613	Check pawl, with roller for star wheel		.40
19739	Roller with pin		.10
56804	Pivot pin for pawl		.04
10365	Washer for pin $(\frac{7}{16}'' \times \frac{7}{8}'' \times .125'')$		3.50
16118	Spring Cotter for pin $\binom{1''}{8} x \frac{3''}{4}$	per 1000	2 .00
13632	Tension Spring for pawl (26 Turns .091" Steel wire)	•••••	.06
24333	Threaded post for spring $\binom{3^n}{6}$ 16, $1^{1^n}_{8}$ long)		.15
24334	CONTROLLING CONTACT BOARD, complete, with reinforced fingers	2	24 .00
24335	Wood base		.45
51652	Screw fastening wood base to frame (14 24, 13" R. H.)	per 100	2 .00
14426	Washer for No. 51652 $\binom{15}{64}$ x $\frac{1}{2}$ x $.062$ " Brass	per 100	1.00
24336	Single contact base		.60
24337	Double contact base		.80
24338	Double contact base, not adapted for wire connection		.80
13852	Screw fastening contact base to wood base (No. 10, 3" F. H.)	per 100	.50
51745	Binding screw for contact base (14-24, ³ / ₄ " R H. Blued)	per 100	1.00
22213	Check nut for No. 51745 (14-24, Hex. Flat Brass)	per 100	1.50
37904 10685	Contact finger, with spring		.25
19685	Adjusting screw for contact finger (14-24, $\frac{2}{8}$ " R. H. Blued)	per 100	.85
22213	Check nut for No. 19685 (14-24, Hex. Flat Brass)	per 100	1.50
5889 10682	Screw fastening finger to base (10 24, $\frac{7}{16}$ " R. H. Blued)	-	.50
19683 24330	Double washer for No. 5889	per 100	2.00
24339	Copper connection strip and washer plate for Nos. 24337, 24338		.10
24340 12852	Finger shield		3.00
13852	Screw fastening No. 24340 to wood base (No. 10, 7" F. H.)		.50
24341	Trolley shield		.30
13852	Screw fastening No. 24341 to wood base (No. 10, 3" F. H.)	per 100	.50

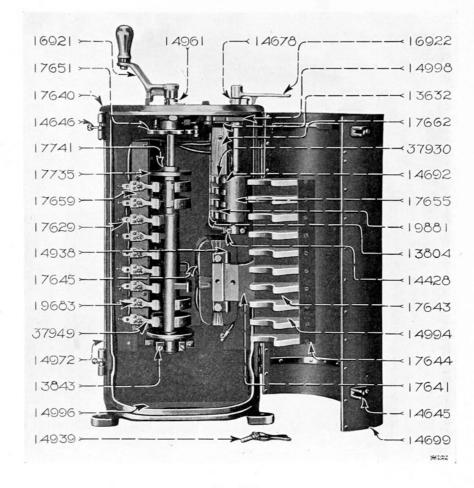
Parts of R Controllers 4493-11

Parts of R-9-A Controller Concluded

Cat. No.	Description Li	st Price
18112	Soft rubber bushing with $\frac{3}{4}''$ hole for cables	\$0.15
14548	Soft rubber bushing with 1/2 hole for cables	.08
24396	CONNECTION BOARD, complete, for back of frame, does not include cables	16.00
24397	Wood base	1.35
19669	Screw fastening wood base to frame (14 24, 1 ¹ / ₄ " R. H.) per 100	
14426	Washer for No. 19669 (17/1 x 1/2 x .062" Brass)	
24398	Fiber spacing block, between connection board and frame	
24399	Terminal with $\frac{1}{2}''$ hole for cable	
24511	Terminal, with $\frac{2}{3}$ hole for cable	
10264	Screw for fastening terminals to wood base (14-24, 1" R. H. Blued) per 100	
14426	Washer for No. 10264 (17 x 1 x .062" Brass)	
50428	Binding Screw for terminal (14-24, 1/2" R. H. Blued) per 100	

12-4493 Parts of R Controllers





Cat. No.

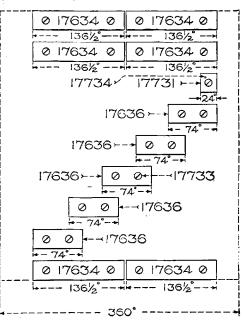
Description

	R-11-A Controller (rheostatic), formerly KR, complete. (Includes supporting bracket with cap screws and washers fastening controller to dasher, also wire guard and rubber gasket.)	
	R-17-A Controller (rheostatic), complete. (Includes supporting bracket with cap screws and washers fastening controller to dasher, also wire guard and rubber gasket.)	
	The R-17-A Controller differs from the R-11-A in that it has the resistance on the trolley side, con- sequently no shunt can be used	
	The interchangeable parts are identical with those of the R-11 with the exception of the controlling contact board, which includes a copper terminal.	
16921	*Operating Handle	\$4.15
16922	*Reversing Handle	
	The following are the interchangeable parts:	
14972	FRAME fitted with cylinder shaft bearing caps and screws for same	
13843	Cap screw fastening controlling shaft bearing caps to frame (3"-16, 1" Hex. H. Slot) per 100	5.00
14428	Cap screw fastening reversing shaft bearing caps to frame $(\frac{5}{16}''-18, \frac{11''}{8}''$ Hex. H. Slot) per 100	8.00
17640	Cap for controller	
1349	Screw fastening cap to frame $(14-20, \frac{9}{16}"$ F. H. Brass) per 100 *Not included in complete controller: must be ordered separately	1 .00

Parts of R Controllers 4493-13

Parts of R-11-A and R-17-A Controllers--Continued

Cat. No.	Description	List Price
10380	Thumb screw with washer fastening cap to controlling shaft bearing cap (14-20, 3" Sp'l)	\$0.10
14961	WATER CAP AND POINTER for controlling cylinder shaft, with set screw	45
14678	WATER CAP for reversing cylinder shaft, with set screw	75
13734	Set screw for water caps (14-20, $\frac{7}{16}$ " Sp'l Blued) per	100 5.00
14699	SHEET IRON COVER, complete	8.75
14645	Slotted lug for cover with rivets	10
14646	Hinge bolt with pin and nut	
14996	Fiber plate for base of controller	
13847	Screw fastening No. 14996 to base of controller (14-20, 3" F. H.) per	
17641	HINGED POLE PIECE.	
14938	Hinge joint for pole piece	
14937	Hinge pin for pole piece	
9887	Cap screw for hinge joint (1/1-13, 11/1 Hex. H.)	
14939	Cap screw wit' wrench attached for pole piece	
17642	ARC DEFLECTOR, complete	
13846	Screw fastening arc deflector to pole piece (No. 10, 11 R, H. Blued) per	
13635	Insulating bushing used with No. 13846	
17643	Wide strip for arc deflector	
17644	Narrow strip for arc deflector	
14994	Division plate for arc deflector	
13852	Screw fastening strips to division plates (No. 10, $\frac{7}{8}$ F. H.) per	



Cat. No.	Description	List Price
17634	Segment	\$0.35
17731	Segment	.11
17636	Segment	.23
39480	Complete set of segments, with screws	4.02
17734	Pin for segments, per 100	.50
17733	Screw for segments, per 100	3.00

Parts of R 11 A and R-17 A Controllers-Continued

Cat. No.	Description	List Price
17645	MAGNET SPOOL, wound, complete, with terminal	\$16.50
17637	Binding screw for terminal (14-20, 1/2" R. H. Round Point Blued) per 100	
14408	Check nut for No. 17637 (14 20 Hex. Flat Brass)per 100	
17646	CONTROLLING CYLINDER, complete, with shaft, insulation disks and star wheel	. 22.75
39480	Complete set of copper contact segments with screws	
	Contact screws and segments are listed on page 13.	
17647	Shaft	1.45
17648	Key for cylinder	
17735	Insulation di-k	
17741	Brass collar with pin for shaft	
17651	STAR WHEEL with pin, must be fitted	
14978	Check pawl with roller for controlling cylinder	
14623	Check pawl with roller for reversing cylinder	
14925	Roller with pin	
19615	Pin for roller $(\frac{5}{16}'' \times 1\frac{7}{32}'')$.	
14624	Pivot pin for pawl for reversing cylinder	
14979	Pivot pin for pawl for controlling cylinder	
10365	Washer for Nos. 14624. 14979 ($\frac{7}{16}'' \ge \frac{5}{16}'' \ge \frac{125''}{16}$)	
16118	Spring cotter for Nos. 14624, 14679 $(\frac{1}{8}'' \times \frac{3}{4}'')$	
13632	Spring for pawl (26 turns .091" Steel wire):	
14976	Pin for spring for reversing cylinder	
14980	Pin for spring for controlling cylinder.	
14648	Lock bolt with pin, used in connection with check pawl for reversing cylinder	
4030 17653	Spring cotter for No. 14648 $\left(\frac{3}{32}\pi \times \frac{5}{3}\pi\right)$	
17655	REVERSING CYLINDER, complete, with shaft and star wheel	
14691	Wood body	
13666	Brass collar with pin	
14098	Screw fastening collar to body (No. 10, 14" F. H. Brass) per 100	
14692	STAR WHEEL with pin, must be fitted	.40
14693	Long contact	
10194	Screw for contacts (No. 8, ⁷ / ₄ R. H. Brass) per 100	
17658	CONTROLLING CONTACT BOARD, complete, with reinforced fingers, for R-11 A control	1.00
1.000	ler	5.75
24370	CONTROLLING CONTACT BOARD, complete, with reinforced fingers, for R 17 A control-	
	ler	5.75
24371	Copper terminal for No. 24370	.15
17659	Wood base	
37949	Contact finger with spring	
17677	Adjusting screw for fingers (14 20, §" R. H. Blued) per 100	.50
14408	Check nut for No. 17677 (14 20 Hex. Flat Brass) per 100	1.50
17629	Base for contact finger	.25
5889	Screw fastening finger to base (10-24, $\frac{7}{16}''$ R. H. Blued) per 100	.50
19683	Washer plate for No. 5889 per 100	2.00
13848	Screw fastening contact base to wood base (No. 10, 3" F. H.)	.50
17663	Terminal binding screw for contact (14-20, §" R. H. Blued) Der 100	.75
14408	Check nut for No. 17663 (14 20, Hex. Flat Brass)per 100	1.50
12572	Screw fastening wood base to frame (14 20, 11" R. H.) per 100	1.00
14426	Washer for No. 12572 ($\frac{17}{64}$ " x $\frac{1}{2}$ " x .062" Brass)	1.00
17661	REVERSING CONTACT BOARD, complete, with reinforced fingers	2.35
17662	Wood base	.15
37930	Contact finger with spring	.16
19881	Base for finger	.30
14434	Screw fastening finger to base (8-32, ³ / ₈ " R. H. Blued) per 100	.50
13804	Brass washer plate for No. 14434 per 100	3.00

Parts of R 11-A and R 17 A Controllers Concluded

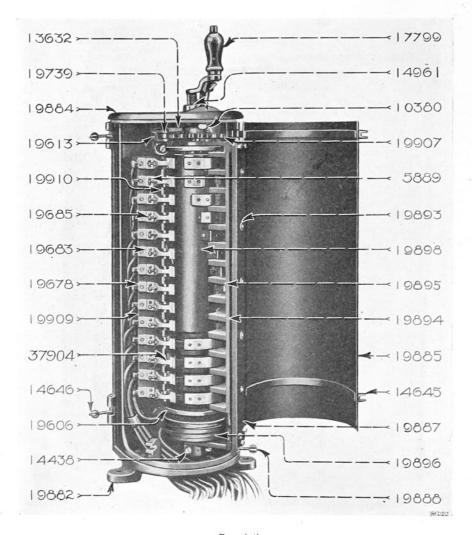
Cat. No.	Description Lis	t Price
1013	Screw fastening contact base to wood base (No.8, $\frac{3}{4}$ " F. H.)	\$0.40
1758	Screw fastening wood base to frame (14 20, 1 ¹ / ₄ " R. H.) per 100	1.00
14426	Washer for No. 1758 (17 x 1/2 x .062" Brass)	1.00
17663	Screw for ground wire (14 20, 5" R. II. Blued) per 100	.75
14408	Check nut for No. 17663 (14-20 Hex Flat Brass) per 100	1.50
14995	Sheet insulation between controlling contact cylinder and frame	.30
6081	Screw fastening No. 14995 to frame (10 24, 3" R. H. Blued per 100	.50
13845	Screw fastening No. 14995 to controlling contact board (No. 10, 1/ F. H per 100	.50
14647	WIRE GUARD	.55
17085	RUBBER GASKET	.06
14963	Bracket fastening controller to dasher	.45
439	Cap screw for bracket (1/2 13, 1" Hex. H.) per 100	8 .00
13850	Washer for No. 439 $\left(\frac{9}{16}'' \times 1\frac{1}{2}'' \times .025''\right)$ per 100	2 .00
17789	Dowel for feet of controller, with nut	.20
16325	Nut for No. 17789 (1" 13 Hex. Rough) per 100	3 .00

Parts of R-II-B Controller

16921 16922	 R-11-B Controller (Rheostatic), complete. (Includes supporting bracket, with cap screws and washers fastening controller to dasher, also wire guard and rubber gasket	4 .15 2 .35
	The following are the interchangeable pirts of the R 11 B controller, which differ from those of the	
	R-11 A.	
51714	FRAME fitted with cylinder shaft bearing caps and cap screws for same	
51699	CONNECTION BOARD, complete, for back of frame	17.50
51700	Wood base	1 .40
51701	Screw fastening wood base to frame (14 24, 15" R. H.) per 100	1.50
14426	Washer for No. 51701 (11" x 1" x .062" Brass	1 .00
51702	Two-way connector, with four binding screws	.45
51703	Binding screw for No. 51702 (12-24, 1/2" R. H. Blued per 100	.75
19646	Screw fastening connector to base (14 24, 1" R. H.) per 100	1 .00
14426	Washer for No. 19646 (17" x 2" x 062" Brass)	1 .00
51704	Insulating bushing for use with connection wires	.45

Parts of R-12-A Controller

	R-12-A Controller (Rheostatic), complete. (Includes supporting bracket, with cap screws and	
	washers fastening controller to dasher, also wire guard and rubber gasket.)	
	Net weight of complete controller, 170 lbs.	
16921	*Operating handle	4.15
16922	*Reversing handle	2.35
	Following are the interchangeable parts of the R 12 .4 controller, which differ from those of the R 11-	-A
14689	Reversing cylinder with shaft and star wheel, complete	
14690	Wood body	.45
24372	Reversing contact board, complete, with reinforced fingers	
17676	Wood base	.15
	*Not included in complete controller; must be ordered separately.	



Parts	of	R-	13	-A	Control	ler
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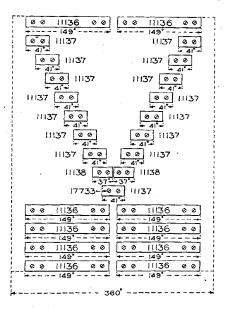
Cat. No.		t Price
	R-13-A Controller (formerly LR), complete. (Includes supporting bracket with cap screws and washers fastening controller to dasher, also wire guard and rubber gasket.)	
17799	*Operating and reversing handle	\$8.50
	Following are the interchangeable parts:	
19882	Frame fitted with cylinder shaft bearings and bearing caps, bracket for magnet spool, stop for pole piece and cap screws fastening parts in position	
19883	Cap screw fastening bearings to frame (1"-13, 1" Hex. H. Slot.) per 100	10.00
14438	Cap screw fastening bearing caps to bearings and fastening bracket for magnet spool and stop for	
	pole piece to frame (3"-16, 14" Hex. H. Slot.) per 100	5.00
19884	Cap for top of controller	
1349	Screw fastening No. 19884 to frame (14-20, 9/16" F.H. Brass) per 100	1.00
10380	Thumb screw with washer fastening No. 19884 to cylinder shaft bearing cap (14-20, 3" Sp'l)	.10
14961	Water cap and pointer for cylinder shaft, with set screw	.45
13734	Set screw for No. 14961 (14-20, 7/16" Sp'l Blued) per 100	5.00
19885	Sheet iron cover, complete	7.00
	* Not included in complete controller: must be ordered separately	

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Parts of R Controllers 4493-17

Parts of R-13-A Controller-Continued

Cat. No.	Description	List Price
14645	Slotted lug for cover, with rivets	. \$0.10
14646	Hinge bolt with pin and nut fastening cover to frame	
19886	Fiber plate for base of controller	
103	Screw fastening No. 19886 to base of controller (14-20, 3" R. H.) per 10	
19887	Hinged pole piece, complete, with lower supporting hinge	
14438	Cap screw fastening pole piece to hinge (3"-16, 11" Hex. H. Slot)per 10	
19888	Hinge bolt with nut fastening pole piece to stop	30
3	Screw fastening No. 19888 to pole piece (14-20, 1" R. H.) per 10	
19889	Retaining collar with pin fastening to cylinder shaft, for lower supporting hinge for pole piece	
19890	Retaining screw for No. 19889 (14-20, 21" Headless Sp'l)per 10	0 10 .00
19891	Arc deflector, complete	. 6.50
19892	Screw fastening No. 19891 to pole piece (No. 10, 14" R. H. Blued) per 10	
19893	Insulating bushing used with No. 19892	
19894	Strip	2.00
19895	Division plate	
13852	Screw fastening strip to division plates (No. 10, 3" F. H.) per 10	0 50



Cat. No.	List Price	Cat. No.	List Price
11136 11137	\$0 .55 .20	11138	\$0.18
39481 17733	Complete set of segments, wi Screw for segments, per 100.	ith screws.	11 .08 3 .00

Parts of R 13 A Controller Concluded

Cat. No.	Desemption	List Price
19896	MAGNET spool, wound, complete, with leads	
14438	Long cap screw fastening No. 19896 to bracket (3" 16, 11" Hex. II Slot per 10	
19897	Short cap screw fastening No. 19896 to bracket (§" 16, ½" Hex. H. Slot.) per 10	
19898	CYLINDER complete, with shaft, insulation disks and washers, upper supporting hinge for pol	e
	piece, collars and star wheel	75.00
39481	Complete set of copper contact segments with screws	-
	Contact segments and screas are listed on page 17	
19606	Insulation disk	
19899	Washer $(1'' \ge 2_1'' \ge \frac{3''}{8})$ thick H compound	
19900	Collar with pin, for shaft	65
19901	Cylinder hub, with key	. 1.25
19902	Bushing for cylinder hub	45
19903	Reversing contact block, with insulation	. 3.50
19904	Reversing contact block, with insulation and one short connection wire	. 3.50
19905	Reversing contact block, with insulation and one long connection wire	. 3.50
19906	Reversing contact block, with insulation and two connection wires	. 3.50
19907	Star wheel, with pin, must be fitted	
19613	Check pawl, with roller for No. 19907	40
19739	Roller, with pin	10
19616	Pivot pin for pawl	10
10365	Washer for No. 19616 $\binom{7}{16}'' \times \frac{5}{8}'' \times .125'' \dots$ per 10	0 3.50
16118	Spring cotter for No. 19616 (1 x 1 per 100	
13632	Spring for pawl (26 Turns .091" Steel wire	
19908	CONTACT BOARD, with reinforced fingers, complete, with finger shield and insulated wires	
19909	Wood base	
10265	Screw fastening wood base to frame (14 20, 13" R. H.)	0 1.50
14426	Washer for No. 10265 (17 x 17 x .062" Brass) per 10	0 1.00
19678	Contact base	
13852	Screw fastening No. 19678 to wood base (No. 10, 5" F. H	0 .50
37904	Contact finger, with spring	
19685	Adjusting screw for contact finger (14 24, 37 R. H. Blued) per 10	0 .85
22213	Check nut for adjusting screw 14 24 Hex. Flat Brass) per 10	0 1.50
5889	Screw fastening finger to base 10 24, $\frac{-}{10}$ " R. H. Blued) per 10	0 .50
19683	Double washer for No. 5889 per 10	0 2.00
19910	Finger shield	. 2.00
16282	Screw fastening finger shield to wood base (No. 10, 3" F. H.) per 10	
14647	WIRE GUARD	55
17085	RUBBER GASKET	06

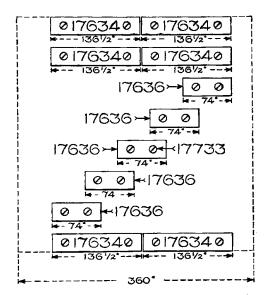
Parts of R-14-A Controller

	R 14 A (formerly MR) Rheostatic Controller, complete. (Includes supporting bracket, with cap screws and washers fastening controller to dasher)	
16921	*Operating handle	4.15
16922	*Reversing handle	2.35
	Following are the interchangeable parts.	
17630	FRAME fitted with bearing caps and cap screws for controlling and reversing cylinder shafts	
13843	Cap screw fastening controlling shaft bearing caps to frame (3" 16, 1", Hex. H. Slot.) per 100	5.00
14428	Cap screw fastening reversing shaft bearing caps to frame $\binom{16}{16}$ -18, $\binom{16}{1}$ Hex. H. Slot.) per 100	8 .00
17674	Cap for top of controller	
1349	Screw fastening No. 17674 to frame (14 20, $\frac{0}{16}$ " F. H. Brass	1.00
10380	Thumb screw with washer fastening No. 17674 to bearing cap for controlling cylinder shaft (14 20,	
	2″ Sp'l)	.10
14961	WATER CAP AND POINTER for controlling cylinder shaft, with set screw	.45
14678	WATER CAP for reversing cylinder shaft, with set screw	.75
	*Not included in complete controller; must be ordered separately.	

Parts of R Controllers 4493-19

Parts of R-14-A Controller-Continued

Cat. No.	Description	List Pric
13734	Set screw for Nos. 14961, 14678 (14–20, 7 / Sp'l Blued)	0 \$5 .0
17686	SHEET IRON COVER, complete	. 10.0
14645	Slotted lug for cover, with rivets	1
14646	Hinge bolt, with pin and nut fastening cover to frame	4
17687	HINGED POLE PIECE	. 2.6
17688	Hinge pin for pole piece	
17689	Hinge joint for pole piece	2
4099	Cap screw fastening hinge joint to magnet core (3"-16, 12" Hex. H.) per 10	
14939	Cap screw, with wrench attached fastening pole piece to magnet core (1"-13, 11" Hex. H. Sp'l)	.2
17690	ARC DEFLECTOR, complete	4.0
13846	Screw fastening arc deflector to pole piece (No. 10, 11" R. H. Blued) per 10	6. 0
13635	Insulating bushing, used with No. 13846.	
17691	Wide strip for arc deflector	. 1.0
17692	Narrow strip for arc deflector	
56756	Upper end division plate for arc deflector	
14994 .	Division plate for arc deflector, except upper end	2



Cat. No.	Description	List Price
17634 17636 39482	Segment	\$0 .35 .23 3 .91
17733	Screw for segments, per 100	3 .00

20-4493 Parts of R Controllers

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Parts of R-14-A Controller—Continued

Cat. No.	Description
13852	Screw fastening strip to division plates (No. 10, 🐉 F. H.)
17693	MAGNET SPOOL, wound, complete
17695	CONTROLLING CYLINDER, complete, with shaft, insulation disks, collar and star wheel
39482	Complete set of copper contact segments with screws
	Contrast comments and comments and listed on taxes 10
17735	Insulation disk
17696	Key
17741	Collar for shaft, with pin
17651	STAR WHEEL, with pin; must be fitted
14978	Check pawl, with roller, for controlling cylinder
14925	Roller, with pin
14979	Pivot pin for pawl
10365	Washer for pin $(\frac{1}{16}'' \times \frac{1}{8}'' \times .125'')$
16118	Spring cotter for pin $(\frac{1}{2}'' \times \frac{3}{2}')$ per 1000
13632	Tension spring for pawl (26 turns .091" Steel wire)
14980	Pin fastening spring to frame
14689	REVERSING CYLINDER, with shaft and star wheel, complete
14998	STAR WHEEL, with pin; must be fitted
14690	Wood body
14691	Brass collar, with pin fastening wood body to shaft $(\frac{3''}{4} \times 1\frac{3''}{4} \times \frac{1}{2}$ thick)
13666	Screw fastening collar to wood body (No. 10, 14" F. H. Brass) per 100
14692	Short contact
14693	Long contact
10194	Screw fastening contacts to wood body (No. 8, $\frac{2}{5}$ " R. H. Brass) per 100
14623	Check pawl, with roller, for reversing cylinder
14925	Roller, with pin
14624	Pivot pin, for pawl
10365	Washer for pin $(\frac{7}{16}'' \times \frac{7}{8}'' \times .125'')$ per 100
16118	Spring cotter for pin $(\frac{1}{8}'' \times \frac{3}{4}'')$ per 1000
13632	Tension spring for pawl (26 turns, .091" Steel wire)
38539	Pin fastening spring to frame
14648	Lock bolt, with pin (used in connection with check pawl for reversing cylinder)
4030	Spring cotter for pin $(\frac{3}{32}'' \times \frac{5}{3}'')$ per 1000
56706	Fiber partition between controlling and reversing cylinders with fiber top and side shields and
	fiber supporting blocks
6081	Screw fastening parts of partition together (10-24, $\frac{3}{8}''$ R. H. Blued) per 100
1188	Screw fastening top shield to controlling contact board (No. 10, 1" F. H.) per 100
5516	Screw fastening supporting block to frame (10-24, 7/8" R. H.) per 100
759	Washer for No. 5516 $(\frac{7}{32}'' \times \frac{1}{2}'' \times .055''$ Brass)
17697	CONTROLLING CONTACT BOARD, complete, with unreinforced fingers
17698	Wood base
12572	Solew lastening wood base to frame $(1 \pm 20, 12]$ N. II.)
14426 17690	Washer for No. 12572 (11/1 x 1/2 x .062" Brass)
17629	Contact base
13848	Screw fastening base to wood base (No. 10, ³ / ₄ " F. H.) per 100 Binding screw for contact base (14–20, ⁵ / ₈ " R. H. Blued) per 100
17663	Check nut for binding screws (14–20, * R. Flat Brass) per 100
14408 27046	CONTACT FINGER, with spring
37946	Adjusting screw for contact finger (14–20, $\frac{2}{3}$ " R. H. Blued) per 100
17077	Check nut for adjusting screw (14–20 Hex. Flat Brass) per 100
17677	Check nut for adjusting sciew (17-20 first file blass)
14408	Screen factoring finger to here $(11) - 24 = 27 R H Kine(1)$
14408 6081	Screw fastening finger to base (10-24, ³ / ₈ " R. H. Blued) per 100
14408 6081 19683	Double washer for No. 6081 per 100
14408 6081 19683 56707	Double washer for No. 6081
14408 6081 19683	Double washer for No. 6081 per 100

Parts of R Controllers 4493-21

Parts of R-14-A Controller—Concluded

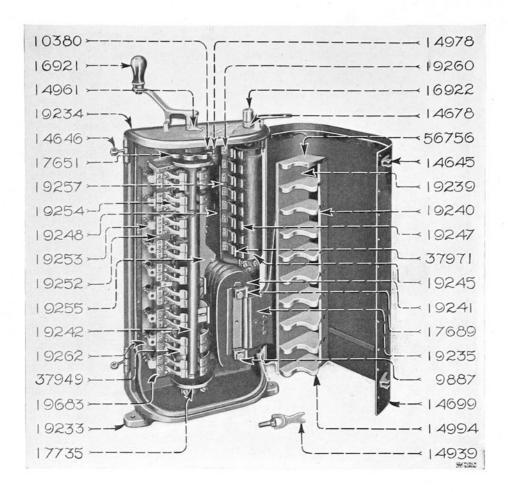
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Cat. No.	Description	ist Price
17699	Sheet insulation between controlling cylinder and frame	\$0.25
6081	Screw fastening No. 17699 to frame (10-24, 3" R. H. Blued) per 100	.5 0
13845	Screw fastening No. 17699 to controlling contact board No. 10, 1/ F. H.) per 100	
14448	REVERSING CONTACT BOARD, complete with unreinforced fingers	
17676	Wood base	.15
1758	Screw fastening wood base to frame (14-20, 1 ¹ / ₄ " R. H.) per 100	1.00
14426	Washer for No. 1758 (17/1 x 1/2 x .062" Brass) per 100	1.00
19881	Contact base	.30
17663	Binding screw for contact base (14-20, §" R. H. Blued) per 10	0 .75
14408	Check nut for binding screw (14-20 Hex. Flat Brass) per 100) 1.50
1013	Screw fastening base to wood base (No. 8, 3" F. H.) per 100) .40
37969	CONTACT FINGER, with spring	.12
5883	Screw fastening finger to base (8-32, ⁵ / ₁₆ " R. H. Blued) per 100	.30
13804	Double washer for No. 5883, per 100	3.00
56773	Fiber cleat for holding wire to frame	20
56774	Screw fastening cleat to frame (14-24, 1§" R. H.) per 100	

Parts of R-14-C Controller

	R-14-C Controller (Rheostatic), complete. (Includes supporting bracket with cap screws and	
	washers fastening controller to dasher.)	
16921	*Operating handle	4.15
16922	*Reversing handle	2.35
	Following are the interchangeable parts of the R-14-C controller, which differ from those of the R-14-A	
51705	Frame fitted wth cylinder shaft bearing caps, and cap screws for same	•
51706	Connection board, complete, for back of frame	4 .00
51707	Wood base	.40
19646	Screw fastening wood base and cover for connection board to frame (14-24, 1" R. H.) per 100	1.00
14426	Washer for No. 19646 (#4" x 1" x .062" Brass)	1.00
51708	Binding post	.25
51709	Screw fastening No. 51708 to wood base $(\frac{5}{16}''-18, \frac{3}{4}'' R. H. Brass)$ per 100	6.00
51710	Binding screw for No. 51708 (18-18, 3" R. H. Brass) per 100	2.50
51711	Thumb screw for No. 51708 (18-18, §" Brass)	.45
51712	Cover for connection board	1.00
	*Not included in complete controller; must be ordered separately.	

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Parts of	R-15-	A Co	ontrol	ler
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Cat. No.

Description

	R-15-A Controller (formerly NR), complete. (Includes supporting bracket with cap screws and washers fastening controller to dasher.)	
16921	*Operating handle	\$4.15
16922	*Reversing handle	2.35
	Following are the interchangeable parts:	
19233	FRAME fitted with bearing caps and cap screws for controlling and reversing cylinder shafts	
13843	Cap screw fastening controlling shaft bearing caps to frame (3"-16, 1" Hex. H Slot.) per 100	5.00
14428	Cap screw fastening reversing shaft bearing caps to frame $(\frac{5}{16}"-18, 1\frac{1}{8}"$ Hex. H. Slot.) per 100	8.00
19234	Cap for top of controller	
1349	Screw fastening cap to frame (14-20, 9/16" F. H. Brass) per 100	1.00
10380	Thumb screw with washer fastening cap to bearing cap for controlling cylinder shaft (14-20, 3" Sp'l)	.10
14961	WATER CAP AND POINTER for controlling cylinder shaft, with set screw	.45
14678	Water cap for reversing cylinder shaft, with set screw	.75
13734	Set screw for water caps (14-20, 7/16" Blued Sp'l) per 100	5.00
14699	SHEET IRON COVER, complete	8.75
14645	Slotted lug for cover, with rivets	.10
	*Not included in complete controller; must be ordered separately.	

ERRATA

To Accompany Bulletin No. 4493 Parts of R Controllers

Pages 39 and 42: the cuts on these two pages should be transposed.

Page 47: The price of Cat. No. 56772 should be 30 cents unstead of 26 cents.

Page 66: The price of Cat. No. 41020 should be \$12.00 instead of 15 cents.

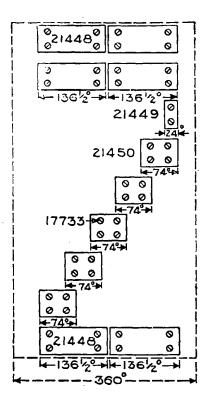
Parts of R Controllers 4493 23

Parts of R 15 A Controller Continued

Cat.	No.	Description	ist Price
14646		Hinge bolt with pin and nut fastening cover to frame.	\$0.45
19263	3	Steel cover for back of frame	4.85
928		Screw for No. 19263 10 24 1/ F. H per 100	1.25
19235		HINGED POLE PIECE	7.75
19236		Hinge pin for pole piece	.10
17689		Hinge joint for pole piece	.20
9887		Cap screw fastening hinge joint to magnet core (1" 13, 11" Hev. H per 100	8 .00
14930		Cap screw with wrench attached fastening pole piece to magnet core 4" 13, 13" Hev. H. Sp'l)	.20
19238		ARC DEFLECTOR, complete	8.75
19892		Screw fastening arc deflector to pole piece No. 10, 11" R. H. Blued per 100	
1963(Insulating bushing, used with No. 19892	.04
19239 19240		Wide strip for arc deflector	
56756		Narrow strip for arc deflector.	.85
14994		Upper end division plate for arc deflector	.25
13848		Division plate for arc deflector, except upper end.	.25
19241		Screw fastening strips to division plates No 10, ^{3"} F. H per 100 MAGNET SPOOL wound, complete	.50
19648		Terminal binding screw (14 24, ;" R. H. Blued, Round Point per 100	1.00
22213		Check nut for No. 19648 (14 24, $\frac{1}{8}''$ Hex. Flat Brass) per 100	1.50
19242		CONTROLLING CYLINDER complete with shaft, insulation disks, collar and star wheel	56 50
3948;	3	Complete set of copper contact segments with screws	50.50
		Contact segments and screws are listed on page 24.	
17733	5	Insulation disk	.55
17696	3	Key	
17741	í	Collar for shaft, with pin.	.30
17651	1	STAR WHEEL, with pin. Must be fitted	.85
14978	3	Check pawl with roller, for controlling cylinder	.30
14923	5	Roller, with pin	.10
14979		Pivot pin for pawl	.10
10365		Washer for pin $(\frac{7}{16} \times \frac{3}{8}'' \times .125'')$ per 100	3.50
16118	-	Spring cotter for pin $\binom{1}{8}$ x $\frac{3}{4}$ per 1000	2 .00
13632		Tension spring for pawl (26 Turns .091" Steel wire	.06
14980		Pin fastening spring to frame.	.05
19244		REVERSING CYLINDER, with shaft and star wheel, complete	
14998 19243		STAR WHEEL, with pin. Must be fitted.	.40
14691		Wood body Brass collar, with pin fastening wood body to shaft $(\frac{3''}{4} \times 1\frac{5''}{4} \times \frac{1}{2})$ thick	.80
13666		Screw fastening collar to wood body (No. 10, $1_4^{1''}$ F. H. Brass) per 100	.30 1.00
19246		Short contact	.15
19247		Long contact	.13
10143		Screw fastening contacts to wood body (No. 10, 3" R. H. Brass per 100	
14623		Check pawl, with roller, for reversing cylinder	.35
14925		Roller, with pin	.10
14624	Ŀ	Pivot pin, for pawl	.10
10365		Washer for pin $\binom{7}{16}x \frac{7}{8}x x.125''$ per 100	3.50
16118		Spring cotter for pin $\binom{1''}{8} x_{4}^{3''}$ per 1000	2.00
13632	2	Tension spring for pawl (26 Turns .091" Steel wire	.06
38539)	Pin fastening spring to frame	.05
14648	3	Lock bolt, with pin (used in connection with check pawl for reversing cylinder	.15
4030)	Spring cotter for pin $(\frac{3}{32}'' \times \frac{3}{2}'')$ per 1000	2 .00
19248	3	Fiber partition between controlling and reversing cylinders, with fiber top and side shields and	
		fiber supporting blocks	.55
6081		Screw fastening parts of partition together (10 24, 3" R. H Blued) per 100	
1188	3	Screw fastening top shield to controlling contact board (No. 10, 1" F. H per 100	.50

Parts of R-15-A Controller--Continued

Cat. No.	Description Lis	t Pric
5516	Screw fastening supporting block to frame (10-24, 3" R. H.) per 100	\$0.50
759	Washer for No. 5516 $(\frac{7}{32}'' \times \frac{1}{2}'' \times .055''$ Brass) per 100	
19249	CONTROLLING CONTACT BOARD, complete, with reinforced fingers	25 .0(
19252	Wood base	.3(
56774	Screw fastening wood base to frame (14-24, 1§" R. H.) per 100	2.00
14426	Washer for No. 56774 (11/1 x 1/2 x .062" Brass) per 100	1.00
19253	Contact base	.7(
1188	Screw fastening base to wood base (No. 10, 1" F. H.) per 100	.50
19648	Binding screw for contact base (14-24, §" R. H. Blued Round Point) per 100	1.00
22213	Check nut for binding screw (14-24, 3" Hex. Flat Brass) per 100	1.50



Cat. No.	List Price	Cat. No.	List Price
21448 21449	\$1.20 .38	21450	\$0.84
39483 17733	Complete set of segments, with sc Screw for segments, per 100	rews	\$13.16 3.00

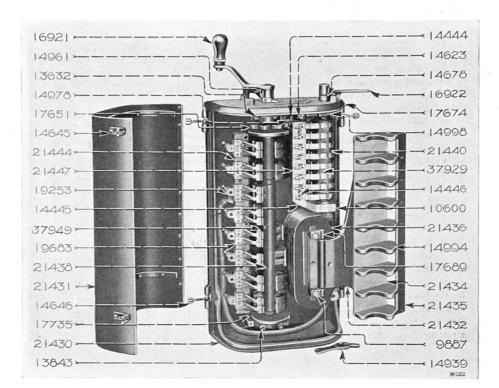
Parts of R Controllers 4493-25

Parts of R-15-A Controller-Concluded

Cat. No.	Description Lis	t Price
37949	CONTACT FINGER, with spring	\$0.29
17677	Adjusting screw for contact finger (14-20, 🐉 R. H. Blued) per 100	.50
14408	Check nut for adjusting screw (14-20 Hex. Flat Brass) per 100	1.50
5889	Screw fastening finger to base (10-24, ⁷ / ₁₆ " R. H. Blued) per 100	.50
19683	Double washer for No. 5889 per 100	2.00
19254	Finger shield with finger blocks	1.60
385	Screw fastening shield to blocks (10-24, §" F. H.) per 100	.60
10222	Screw fastening blocks to wood base (No. 7, 11" R. H.) per 100	.30
19255	Sheet insulation between controlling cylinder and frame	.25
6081	Screw fastening No. 19255 to frame (10-24, 3" R. H. Blued) per 100	.50
13845	Screw fastening No. 19255 to controlling contact board (No. 10, 1/2 F. H.) per 100	.50
19256	REVERSING CONTACT BOARD, complete, with reinforced fingers	
19257	Wood base	,15
19669	Screw fastening wood base to frame (14-24, 14" R. H.) per 100	1.00
14426	Washer for No. 19669 ($\frac{17}{64}$ " x $\frac{1}{2}$ " x .062 " Brass) per 100	1.00
19258	Contact base	.35
19259	Binding screw for contact base (5, 7, 18, 5" R. H. Blued Round Point) per 100	
19237	Check nut for binding screw $(\frac{5}{16}", 18, \frac{1}{8}"$ thick Hex. Flat Brass) per 100	.80
1188	Screw fastening base to wood base (No. 10, 1" F. H.) per 100	.50
37971	CONTACT FINGER, with spring	.22
6081	Screw fastening finger to base (10-24, §" R. H. Blued) per 100	.50
19260	Double washer for No. 6081 per 100	1.00
19261	Wire guard for reversing leads	1.60
19262	Wire guard for main leads	2.00
56743	Screw for Nos. 19261, 19262 (14-24, ½" F. H.) per 100	.60

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Parts of R-16-A Controller

Cat. No.

Description

	R-16-A Controller, complete. (Includes supporting bracket, with cap screws and washers fasten-	
16921	ing controller to dasher.)	\$4.15
16922	*Reversing handle	
10922	Following are the interchangeable parts:	2.00
21430	FRAME fitted with bearing caps and cap screws for controlling and reversing cylinder shafts	
13843	Short cap screw fastening controlling shaft bearing caps to frame (3"-16, 1" Hex. H. Slot.) per 100	5.00
14438	Long cap screw fastening controlling shaft bearing cap to frame (3"-16, 14" Hex. H. Slot.) per 100	5.00
14428	Short cap screw fastening reversing shaft bearing cap to frame (⁵ / ₁₆ "-18, 1 ¹ / ₃ " Hex. H. Slot.) per 100	8.00
10600	Long cap screw fastening reversing shaft bearing caps to frame $(\frac{5}{16}"-18, 1\frac{3}{8}"$ Hex. H. Slot.) per 100	6.00
17674	Cap for top of controller	
1349	Screw fastening cap to frame (14-20, ⁹ / ₁₆ " F. H. Brass) per 100	1.00
10380	Thumb screw with washer fastening cap to bearing cap for controlling cylinder shaft(14-20,3" Sp'l)	.10
14961	WATER CAP AND POINTER for controlling cylinder shaft, with set screw	.45
14678	Water cap for reversing cylinder shaft, with set screw	.75
13734	Set screw for water caps (14-20, ⁷ / ₁₆ " Blued, Sp'l) per 100	5.00
21431	SHEET IRON COVER, complete	10.00
14645	Slotted lug for cover, with rivets	.10
14646	Hinge bolt with pin and nut fastening cover to frame	.45
21432	HINGED POLE PIECE	7.50
19236	Hinge pin for pole piece	.10
	*Not included in complete controller; must be ordered separately.	

Parts of R 16-A Controller Continued

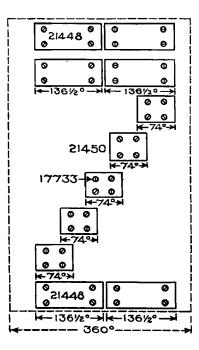
Parts of R Controllers 4493-27

Base Base Base Base Hinge joint for pole piere.Less DescriptionLess DescriptionS77Cap screw fastening hinge joint to magnet core $\frac{1}{2}$ [13 1] ^a [He., II.).per 100D06Cap screw kit write wrench attached fastening pole piece to magnet core ($\frac{1}{2}$ -13, 1] ^a [Hex. II. SpT)B33Arr. deflector, complete.per 100B300Insulating bashing, used with No. [15822]per 100B310Masulating bashing, used with No. [15822]per 100B321Start deflector.per 100B332MAGNET SPOOL, wound, complete with terminal.per 100B433MAGNET SPOOL, wound, complete with terminal.per 100C0Check nut for No. 21437 (14-20), ¹⁴ (K. Hit Brass).per 100B438CONTROLLING CYLINDER, complete, with shaft, insulation disk., collars and star wheel.Complete set of copper contact segments with screws.Contact segments with screws.Contact segments with screws.Contact segments with screws.Collar for shaft, with pinfor controlling cylinder.per 100B439Fitser for pin ($\frac{1}{2}^a \times \frac{1}{2}^a \times 125^a$).per 100B441Collar for pawl.for controlling cylinder.per 100B452Relever for pin ($\frac{1}{2}^a \times \frac{1}{2}^a \times 125^a$).per 100B453Spring cotter for pin ($\frac{1}{2}^a \times \frac{1}{2}^a \times 125^a$).per 100B454For pin ($\frac{1}{2}^a \times \frac{1}{2}^a \times 125^a$).per 100B454Spring cotter for pin ($\frac{1}{2}^a \times \frac{1}{2}^a \times 125^a$).per 100B454Spring cotter for pin ($\frac{1}{2}^a \times \frac{1}{2}^a \times$	C-4 N	1 and of 12 Controllors 4
887Cosp Strew fastening hing: joint to magnet core $\frac{1}{2}^{n}$ 13 $1\frac{1}{2}^{n}$ Hev. H.1,, per 100708Cap screw with wrench attached fastening pole piece to magnet core $\frac{1}{2}^{n}$.13, $\frac{1}{2}^{n}$ Hex. H. Spil)892Screw fastening are deflector to pole piece (No. 10, 1!" R. H. Blued), per 100803Insulating bushing, used with No. 19802.804Wide strip for are deflector.805Screw fastening strips to division plates (No. 10, $\frac{n}{2}^{n}$ F. H.).806Screw fastening strips to division plates (No. 10, $\frac{n}{2}^{n}$ F. H.).807CONTROLLING CYLLNDER, complete, with terminal.808Terminal binding screw (14 20, $\frac{n}{2}^{n}$ R. H. Blued, Round Point809CONTROLLING CYLLNDER, complete, with shaft, insulation disks, collars and star wheel.806Complete set of copper contact segments and screws.807Collar for shaft, with pin.808Key809Key801Spring outer for pin ($\frac{1}{2}^{n} \sqrt{\frac{n}{2}} x.125^{n}$).805Washer for pin ($\frac{1}{2}^{n} \sqrt{\frac{n}{2}} x.125^{n}$).806Star wheel, with pin, must be fitted.807Washer for pin ($\frac{1}{2}^{n} \sqrt{\frac{n}{2}} x.125^{n}$).808STAR WHEEL, with shaft and star wheel complete.809Star withe pin, in must be fitted.800Tension spring for pawl (26 Turns 0.014" Steel wire).801Brass collar, with pin, must be fitted.802HEXESING CYLINDER, with shaft and star wheel complete.803Star WHEEL, with shaft and star wheel complete.804Star WHEEL, with shaft and	Cat. No.	*
389Cap serve with whench attached fastening pole γ is 13 [17] (17] [17], [17] [18] [18].389Cap serve with wrench attached fastening pole γ is 13 [18] [18].381Arc deflector, complete.382Serve fastening ac deflector to pole piere (No. 10, 11" R. H. Eluci).383per doff ac deflector is a pole piere (No. 10, 11" R. H. Eluci).384Wide strip for arc deflector.385Narrow strip for arc deflector.386Serve fastening strips to division plates (No. 10, $\frac{1}{4}$ " F. H.).387Per function of the strip of arc deflector.388Serve fastening strips to division plates (No. 10, $\frac{1}{4}$ " F. H.).389Per function of the strip of arc deflector.380MAGNET SPOOL, wound, complete with terminal.381Traminal binding screw (14 20, $\frac{1}{4}$ M. H. Blued, Round Point.382Contract segments with screws.383Complete set of copper contact segments with screws.384Contact segments and screws are listed on page 46385Itaulation disk.386Key.387Chark wheel, with pin.387Privot pin for pawl.389Privot pin for pawl.389Relevent for pin ($\frac{1}{6}$ x ($\frac{1}{7}$ x ($\frac{1}{7}$ x 1.25").380Spring cotter for pin ($\frac{1}{6}$ x ($\frac{1}{7}$ x ($\frac{1}{7}$ x 1.25").381Relevent with pin.382Relevent with shaft and star wheel complete.383Spring otter for pin ($\frac{1}{6}$ x ($\frac{1}{7}$ x ($\frac{1}{7}$ x 1.25").384Privot pin for pawl.385Serve	17689	Hinge joint for pole piece
639 Cap screw with wrench attached fastening pole piece to magnet core $(4^{n-1}, 14^n)$ Hex. H. Sp1) 334 Arr deflector, complete 532 Screw fastening arc deflector 543 Wide strip for arc deflector. 544 Wide strip for arc deflector. 555 Narrow strip ior arc deflector. 566 Screw fastening strips to division plates (No. 10, $\frac{1}{4}^n$ F. H.). 567 Terminal binding screw (14 20, $\frac{1}{4}^n$ R. H. Blued, Round Point per 100 568 Screw fastening strips to division plates (No. 10, $\frac{1}{4}^n$ F. H.). per 100 569 CONTROLLING CYLINDER, complete, with haft, insulation disks, collars and star wheel. Complete set of copper contact segments with screws. 5785 Insulation disk. Contact segments and screws are listed on page 46 5786 Star wheel, with pin, must be fatted. Star wheel, with pin, must be fatted. 5797 Pirot pin for pawl. per 100 5718 Star wheel, with pin, must be fatted. per 100 579 Pirot pin for pawl. per 100 570 Pirot pin for pawl. per 100 5719 Pirot pin for pawl. per 100 576 Straw wheel, with pin, must	9887	Cap screw fastening hinge joint to magnet core 1" 13 11" Hex. H.)
Arr deflector, complete. per 100 Signed Server fastening arc deflector to pole piere (No. 10, 11" R. H. Blued). per 100 Insulating bushing, used with No. 19892. minimized server fastening arc deflector. Signed Server fastening strips to division plates (No. 10, 14" R. H. Blued). per 100 Mide strip for arc deflector. per 100 MAGNET SPOOL, wound, complete with terminal. per 100 Check nut for No. 21437 (14-20, 14" Bck. Flat Brass). per 100 Cletch nut for No. 21437 (14-20, 14" Bck. Flat Brass). per 100 CONTROLLING CYLINDER, complete, with shaft, insulation disks, collars and star wheel. Contact segments and screws are listed on page 46 Insulation disk. flat Collar for shaft, with pin. per 100 Signe otter for pin ($\frac{1}{4}x^* x^* x^* x^* x^* x^* x^* x^* x^* x^* $	4939	Cap screw with wrench attached fastening pole piece to magnet core $(\frac{4''-13}{12''}$ Hex. H. Sp'l)
Serew fastening are deflector to pole piere (No. 10, 1!" R. H. Blued).	1433	Arc deflector, complete
930Insulating bushing, used with No. 19892.134Wide strip for arc deflector.135Narrow strip for arc deflector.136Division plate for arc deflector.137Screw fastening strips to division plates (No. 10, $\frac{1}{2}$ F. H.).138MaGNET SPOOL, wound, complete with terminal137Terminal binding screw (14 20, $\frac{1}{2}$ K. H. Blued, Round Point.138per 100139CoNTROLLING CYLINDER, complete, with shaft, insulation disks, collars and star wheel.139Complete set of coper contact segments with screws.131Collar for shaft, with pin.132Star wheel, with pin, must be fitted.133Star wheel, with pin.134Check pawl, with roller, for controlling cylinder.135Raler, with pin.136Washer for pin ($\frac{1}{2}x^* x^* x.125^o$).136Washer for pin ($\frac{1}{2}x^* x^* x.125^o$).137Per 100138Spring cotter for pin ($\frac{1}{2}x^* x^* x.125^o$).139Pivot pin for pawl.139Pivot pin for pawl.139REVERSING CYLINDER, with shaft and star wheel complete.139Star WHEEL, with pin, must be fitted.139ReVERSING CYLINDER, with shaft and star wheel complete.139Star WHEEL, with pin, in with be fitted.140Wood body.151Bras collar, with pin fastening wood body (No. 10, 14" F. H. Brass).152Roller, with pin statening wood body (No. 10, 14" F. H. Brass).153Per 100154Stort contact. <t< td=""><td>9892</td><td>Screw fastening arc deflector to pole piece (No. 10, 11" R. H. Blued) per 16</td></t<>	9892	Screw fastening arc deflector to pole piece (No. 10, 11" R. H. Blued) per 16
134Wide strip for arc deflector.135Narrow strip for arc deflector.136Division plate for arc deflector.137Screw fastening strips to division plates (No. 10, $\frac{1}{2}$ " F. H.).138per 100139MAGNET SPOOL, wound, complete with terminal.139Terminal binding screw (14 20, $\frac{1}{2}$ " R. H. Blued, Round Point139Terminal binding screw (14 20, $\frac{1}{2}$ " Rex. Flat Brass).130CONTROLLING CYLINDER, complete, with shaft, insulation disks, collars and star wheel.131Complete set of copper contact segments with screws.132Contact segments and screws are listed on page 46133Insulation disk.134Star wheel, with pin135Star wheel, with pin136Star wheel, with noller, for controlling cylinder.137Check pawl, with roller, for controlling cylinder.1379Pivot pin for pawl.1379Pivot pin for pawl.1370Pixot pin for pawl.1371Pixot pin for pawl.1372Pixot pin for pawl.1373REVERSING CYLINDER, with shaft and star wheel complete.1384Rever Starting collar to wood body (No. 10, $\frac{1}{2}$ " x $\frac{1}{2}"$ x $\frac{1}{2}" x \frac{1}{2}" x \frac{1}{2}" x \frac{1}{2}"139Brass collar, with pin fastening wood body (No. 10, \frac{1}{4}" x L \frac{2}" x \frac{1}{2}" x \frac{1}{2}"139Bras collar, with pin fastening wood body (No. 10, \frac{1}{4}" x L \frac{2}" x \frac{1}{4}" x \frac{1}{4}" x \frac{1}{4}" x \frac{1}{4}" x \frac{1}{4}1$	9630	Insulating bushing, used with No. 19892
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994Division plate for arc deflector.852Server Mastening strips to division plates (No. 10, $\frac{1}{4}$ " F. H.).843MAGNET SPOOL, wound, complete with terminal.844Terminal binding screw (14 20, $\frac{1}{4}$ " R. H. Blued, Round Point845Terminal binding screw (14 20, $\frac{1}{4}$ " R. H. Blued, Round Point846Context segments on so 21437 (14-20, $\frac{1}{4}$ Mc. Flat Brass).847Control coppet contact segments with screws.848Contact segments and screws are listed on page 46849Tasulation disk.840Key.841Collar for shaft, with pin.845Roller, with pin, must be fitted.846Key.847Check paul, with roller, for controlling cylinder.848Roller, with pin.849Washer for pin ($\frac{1}{4}$ " χ_1^{*} x.125").840Privot pin for pawl.843Privot pin for pawl.844Prin fastening spring to frame.845ReVERSING CYLINDER, with shaft and star wheel complete.846Strak WHEEL, with pin, must be fitted.847Wood body.848Screw fastening collar to wood body (No. 10, 11" F. H. Brass).849Strew fastening collar to wood body (No. 10, 11" F. H. Brass).844Long contact.845Lock bolt, with pin ($\frac{1}{4}$ " χ_1^{**} x.125").846Strew fastening collar to wood body (No. 10, 11" F. H. Brass).847Privot pin for pawl.848Lock bolt, with pin ($\frac{1}{4}$ " χ_1^{**} x.125").849Lock bolt, with pin (1435	Narrow strip for arc deflector
S52Screw fastening strips to division plates (No. 10, $\frac{4^{o}}{v}$ F. H.).per 100436MAGNET SPOOL, wound, complete with terminal.per 100437Terminal binding screw (14 20, $\frac{1}{v}$ R. H. Blued, Round Pointper 100438CoNTROLLING CVLINDER, complete, with shaft, insulation disks, collars and star wheel.contrast segments and screws are listed on page 46439Insulation disk.file430Key.file431Collar for shaft, with pinfile432Collar for shaft, with pinfile433Collar for shaft, with pinfile434Collar for shaft, with pinfile435Key.file436Key.file437Collar for shaft, with pinfile438Collar for shaft, with pinfile439Pivot pin for pawl.file430Washer for pin ($\frac{1}{v} \times \frac{1}{v} \times 125^{o}$).per 100431Finsion spring for pawl (26 Turns .091" Steel wire).per 100432Tension spring for frame.file434Wood body.fileshaft and star wheel complete.437Star WHEEL, with pin; must be fitted.file438REVERSING CVLINDER, with shaft and star wheel complete.file440Wood body.filefile441Long contact.per 100442Long contact.per 100444Wood body.filefile445Long contact.per 100446Screw fast	4994	Division plate for arc deflector.
436MAGNET SPOOL, wound, complete with terminal	3852	Screw fastening strips to division plates (No 10 $\frac{10}{20}$ F H) per I
437 Terminal binding screw (14 20, $\frac{9}{4}$ " R. H. Blued, Round Point. per 100 438 CONTROLLING CVLINDER, complete, with shaft, insulation disks, collars and star wheel. Complete set of copper contact segments with screws. 438 Contact segments and screws are listed on page 46 439 Insulation disk. 536 Key. 547 Collar for shaft, with pin. 551 Star wheel, with pin. 552 Roller, with pin. 563 Star wheel, with pin. 574 Collar for shaft, with pin. 575 Roller, with pin. 576 Star wheel, with pin. 577 Pin for pawl. 578 Roller, with pin. 579 Point for pawl. 570 Pin fastening spring to frame. 571 Pin fastening spring to frame. 572 Roller, with pin fastening wood body to shaft ($\frac{19}{4}$ x 1 $\frac{9}{4}$ x 1 $\frac{10}{40}$) 573 Brass collar, with pin fastening wood body (No. 10, $1\frac{19}{4}$ r X 1 $\frac{9}{4}$ x 1 $\frac{10}{40}$) 574 WHEEL, with pin fastening wood body (No. 10, $1\frac{19}{4}$ r X 1 $\frac{9}{4}$ x 1 $\frac{10}{40}$) 574 Brass collar to wood body (No. 0, $\frac{1}{4}$ r X 1 $\frac{9}{4}$ x 1 $\frac{10}{40}$)	1436	MAGNET SPOOL wound complete with terminal
108Check nut for No. 21437 (14-20, $1''$ Hex. Flat Brass).per 100109CONTROLLING CYLINDER, complete, with shaft, insulation disks, collars and star wheel.100Complete set of copper contact segments with screws.101Contact segments and screws are listed on page 46102Insulation disk.103Key.104Collar for shaft, with pin105Star wheel, with roller, for controlling cylinder.107Roller, with pin108Star wheel, with roller, for controlling cylinder.109Privot pin for pawl.109Privot pin for pawl.101Spring cotter for pin ($f_{x}^{*} \times 1^{*} \times 125''$).102Period Spring cotter for pin ($f_{x}^{*} \times 1^{*} \times 125''$).103Period Spring for pawl (26 Turns .091" Steel wire).104Pin fastening spring to frame.105REVERSING CYLINDER, with shaft and star wheel complete.106Strak WHEEL, with pin; must be fitted.107Short contact.108Short contact.109Short contact.104Screw fastening collar to wood body (No. 10, 11'' F. H. Brass).105Spring cotter for pin ($f_{x}^{*} \chi^{*} \times .125''$).108Strew fastening contact to wood body (No. 8, $\xi'' R. H. Brass).109Spring cotter for pin (f_{x}^{*} \chi^{*} \times .125'').101Short contact.102Check pawl, with roller. for reversing cylinder.108Strew fastening contact to wood body (No. 8, \xi'' R. H. Brass).109Spring cotter for pin (f_{x}^{*} \chi^{*$	1437	Terminal binding screw (11 20 3" R H Blued Round Point part of the screw (11 20 3" R H Blued Round Point
438CONTROLLING CYLINDER, complete, with shaft, insulation disks, collars and star wheel. Complete set of copper contact segments with screws. Contact segments and screws are listed on page 46437Insulation disk. Total collar for shaft, with pin. Collar for shaft, with pin. Coller, with pin. Coller, with pin. Coller, with pin. Coller, with pin.438Check pawl, with roller, for controlling cylinder. Roller, with pin. Coller for pin ($\frac{1}{17} \times \frac{1}{4}^n \times .125^n$). per 100 Contact base for pin ($\frac{1}{17} \times \frac{1}{4}^n \times .125^n$). per 100436Washer for pin ($\frac{1}{17} \times \frac{1}{4}^n \times .125^n$). per 100437Pin fastening spring to frawl. Collar for pin ($\frac{1}{14}^n \times \frac{1}{4}^n \times .001^n$ Steel wire). Pin fastening spring to frame. STAR WHEEL, with pin; must be fitted. Wood body. Straw WHEEL, with pin; must be fitted. Straw fastening collar to wood body (No. 10, $1\frac{1}{4}^n F$ H. Brass). Screw fastening contact to wood body (No. 10, $1\frac{1}{4}^n F$ H. Brass). Der 100 Coller, with pin fastening cylinder. Per 100 Spring cotter for pin ($\frac{1}{4}^n \times \frac{1}{4}^n \times .001^n $ Steel wire). Per 100 Coller, with pin cuestion contact. Pin fastening for pawl (26 Turns .091'' Steel wire). Per 100 Contact base.438Pivot pin for pawl. Contact to wood body (No. 8, $\frac{1}{4}^n R$ H. Brass). Per 100 Spring cotter for pin ($\frac{1}{4}^n \times \frac{1}{4}^n \times .002^n$ Steel wire).439Check pawl, with roller. for reversing cylinder. Prind steining spring to frame. Prind steining spring to frame. Prind for pawl. Prind for pawl. Prind for pawl. Prind for pawl. Prind for pawl. Prind for pawl. <b< td=""><td>4408</td><td>Check nut for No. 21437 (11-20) // Hay Elet Brees)</td></b<>	4408	Check nut for No. 21437 (11-20) // Hay Elet Brees)
484Complete set of copper contact segments with start, instantion disk, contaits and start wheel. Contact segments and screws are listed on page 46675Insulation disk. Key	1438	CONTROLING CVINDED complete with cheft in valuing di le college and the when
Contact segments and screws are listed on page 46735Insulation disk.741Collar for shaft, with pin741Collar for shaft, with pin751Star wheel, with pin, must be futed.762Roller, with pin.763Check pawl, with roller, for controlling cylinder.764Roller, with pin.775Roller, with pin.776Pivot pin for pawl.777Pivot pin for pawl.778Pivot pin for pawl.779Pivot pin for pawl.770Pin fastening spring to rane.771Pirot pin fastening spring to frame.772Pirot pin fastening collar.773Pirot pin fastening collar.774Wood body.775Pin fastening collar.776Piras collar, with pin fastening wood body to shaft ($\frac{1}{2}$ x $\frac{1}{2}^{\alpha}$ x $\frac{1}{2}^{\alpha}$ thick).773Serew fastening collar to wood body (No. 10, $1\frac{1}{4}^{\alpha}$ F. H. Brass).774Pivot pin for pawl.775Roller, with pin.776Pirot pin for pawl.777Pivot pin for pawl.778Poleck pawl, with roller. for reversing cylinder.779Pivot pin for pawl.771Pivot pin for pawl.772Pivot pin for pawl.773Pivot pin for pawl.774Pivot pin for pawl.774Pivot pin for pawl.775Pin fastening spring to frame.776Pin fastening spring to frame.777Pin fastening spring to frame.<	9484	Complete set of comparison of the comparison with some start mission disks, collars and star wheel.
735Insulation disk.696Key.697Collar for shaft, with pin.651Star wheel, with pin, must be fitted.651Star wheel, with pin.651Star wheel, with pin.657Roller, with pin.658Roller, with pin.659Pivot pin for pawl.659Pivot pin for pawl.650Spring cotter for pin $(\frac{1}{2}^{w} x \frac{1}{2}^{w})$.651Star wheel, with yin.652Pin fastening spring to frame.653Pin fastening spring to frame.654STAR WHEEL, with pin; must be fitted.656Screw fastening collar to wood body (No. 10, 1_4^{w} F. H. Brass).656Screw fastening collar to wood body (No. 8, $\frac{1}{4}^{w}$ R. H. Brass).657Pin for pawl.668Screw fastening contacts to wood body (No. 8, $\frac{1}{4}^{w}$ R. H. Brass).679Pivot pin for pawl.670Short contact.671Spring cotter for pin $(\frac{1}{4}^{w} x \frac{1}{4}^{w})$.672Roller, with pin.673Roller, with pin.674Check pawl, with roller. for reversing cylinder.674Spring cotter for pin $(\frac{1}{4}^{w} x \frac{1}{4}^{w})$.674Spring cotter for pin $(\frac{1}{4}^{w} x \frac{1}{4}^{w})$.674Spring cotter for pin $(\frac{1}{4}^{w} x \frac{1}{4}^{w})$.675Roller, with pin.676Screw fastening spring to rame.677Pin fastening spring to frame.678Lock bolt, with pin (used in connection with check pawl far reversing cylinder<	0101	
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651Star wheel, with pin, must be fitted.778Check pawl, with roller, for controlling cylinder.797Pivot pin for pawl.797Pivot pin for pawl.708Spring cotter for pin $(\frac{1}{4}^w \times \frac{1}{4}^w)$.709Pivot pin for pawl.701Pixot pin for pawl.702Pixot pin for pawl.703Pixot pin for pawl.704Pixot pin for pawl.705Pin fastening spring to frame.706Pin fastening spring to frame.707Pixot pin fastening spring to frame.708REVERSING CYLINDER, with shaft and star wheel complete.709Pixot pin fastening collar to wood body to shaft $(\frac{1}{4}^w x 1\frac{1}{4}^w x \frac{1}{4}^w$ thick).709Brass collar, with pin fastening wood body to shaft $(\frac{1}{4}^w x 1\frac{1}{4}^w x \frac{1}{4}^w$ thick).709Screw fastening contacts to wood body (No. 10, $1\frac{1}{4}^w$ F. H. Brass).710Pivot pin for pawl.711Screw fastening contacts to wood body (No. 8, $\frac{1}{4}^w$ R. H. Brass).712Pivot pin for pawl.714Screw fastening contacts to wood body (No. 8, $\frac{1}{4}^w$ R. H. Brass).715Pivot pin for pawl.726Roller, with pin.727Pivot pin for pawl.728Washer for pin $(\frac{1}{4}^w x \frac{1}{4}^w 1.25^w)$.729Pivot pin for pawl.730Spring cotter for pin $(\frac{1}{4}^w x \frac{1}{4}^w 1.25^w)$.731Pin fastening spring to frame.732Pin fastening spring to frame.733Pin fastening spring to frame. <td< td=""><td></td><td>Coller for al. 6 and 5</td></td<>		Coller for al. 6 and 5
978Check pawl, with roller, for controlling cylinder.979Pivot pin for pawl.979Pivot pin for pawl.979Pivot pin for pawl.970Spring cotter for pin $(\frac{1}{3}'' \times \frac{1}{2}'')$.971Per 1000972Tension spring for pawl (26 Turns .091" Steel wire).973Pin fastening spring to frame.974Pin fastening spring to frame.975Pin fastening spring to frame.976Pin fastening cylinder.977Pin fastening cylinder.978STAR WHEEL, with pin; must be fitted.979Wood body971Brass collar, with pin fastening wood body to shaft $(\frac{3}{7}'' x \frac{1}{9}'' thick)$.972Screw fastening collar to wood body (No. 10, $1\frac{1}{4}'' F$ H. Brass).974Screw fastening contacts to wood body (No. 8, $\frac{1}{7}''' R$ H. Brass).975Roller, with pin.976Pin fastening contacts to wood body (No. 8, $\frac{1}{7}''' R$ H. Brass).977Pin fastening contact to wood body (No. 8, $\frac{1}{7}''' R$ H. Brass).978Pivot pin for pawl.979Pivot pin for pawl.979Pivot pin for pawl.970Check pawl, with roller. for reversing cylinder.971Roller, with pin.972Roller, with pin.973Pivot pin for pawl.974Spring cotter for pin $(\frac{1}{3}''' \times \frac{1}{2}'')$.975Pin fastening spring to frame.976Pin fastening spring to frame.977Pin fastening spring to frame.978Lock bolt, wit		Collar for shaft, with pin
P25Roller, with pin979Pivot pin for pawl979Pivot pin for pawl970Pivot pin for pawl971Pirot pin ($\frac{1}{4}^{''} \times \frac{1}{4}^{''}$)972Persion spring for pawl (26 Turns .091" Steel wire).973Pin fastening spring to frame.974Pin fastening spring to frame.975STAR WHEEL, with pin; must be fitted.976STAR WHEEL, with pin; must be fitted.978Stark WHEEL, with pin; must be fitted.979Screw fastening collar to wood body to shaft ($\frac{1}{4}^{''} \times 1\frac{5}{4}^{''} \times \frac{1}{4}^{''}$ thick).979Screw fastening contacts to wood body (No. 10, $1\frac{1}{4}^{''}$ F. H. Brass).974Screw fastening contacts to wood body (No. 8, $\frac{7}{4}^{''}$ R. H. Brass).975Roller, with pin976Pivot pin for pawl.977Spring cotter for pin ($\frac{1}{4}^{''} \times \frac{1}{4}^{''} \times .125^{''}$).978Pivot pin for pawl.979Pivot pin for pawl.979Spring cotter for pin ($\frac{1}{4}^{''} \times \frac{1}{4}^{''} \times .125^{''}$).979Pin fastening spring to frame.974Pivot pin for pawl.975Pin fastening spring to frame.976Pin fastening spring to frame.977Pin fastening spring to frame.978Lock bolt, with pin (used in connection with check pawl far reversing cylinder979Pin fastening spring to frame.974Ya' X 2062" Brass).975Screw fastening wood base to frame (14 24, $1\frac{14}{4}$ R. H.).976Pin fas		Star wheel, with pin, must be fitted.
979Pivot pin for pawl		Check pawl, with roller, for controlling cylinder
365Washer for pin $(\frac{1}{4}^w \times \frac{1}{4}^w \times 125^w)$.per 100118Spring cotter for pin $(\frac{1}{4}^w \times \frac{1}{4}^w)$.per 1000365Tension spring for pawl (26 Turns .001" Steel wire).per 1000366Tension spring to frame.368367REVERSING CYLINDER, with shaft and star wheel complete.369368STAR WHEEL, with pin; must be fitted.366369STAR WHEEL, with pin fastening wood body to shaft $(\frac{1}{4}^w \times \frac{1}{3}^w \times \frac{1}{3}^w t \frac{1}{2}^w t \frac{1}{2$		Roller, with pin
118Spring cotter for pin $(\frac{1}{2}^m \times \frac{1}{2}^m)$.per 1000632Tension spring for pawl (26 Turns .0911" Steel wire).pin fastening spring to frame.439REVERSING CYLINDER, with shaft and star wheel complete.698STAR WHEEL, with pin; must be fitted.699Brass collar, with pin fastening wood body to shaft ($\frac{3}{4}^m \times \frac{1}{2}^m \times \frac{1}{2}^m$ thick).661Brass collar, with pin fastening wood body to shaft ($\frac{3}{4}^m \times \frac{1}{2}^m \times \frac{1}{2}^m$ thick).676Screw fastening collar to wood body (No. 10, 1 $\frac{1}{4}^m$ F. H. Brass).677Pivot ontact.678Long contact.679Roller, with pin.674Screw fastening contacts to wood body (No. 8, $\frac{1}{4}^m$ R. H. Brass).674Pivot pin for pawl.675Roller, with pin.676Spring cotter for pin ($\frac{1}{4}^m \times \frac{1}{4}^m \times .125^m$).677Pin fastening spring to frame.678Lock bolt, with pin (used in connection with check pawl far reversing cylinder674Screw fastening wood base to frame (14 24, $1\frac{1}{4}^m$ R. H.).674Screw fastening wood base to frame (14 24, $\frac{1}{4}^m$ R. H.).674Screw fastening base to wood base (No. 10, $\frac{1}{4}^m$ F. H.).674Screw fastening base to wood base (No. 10, $\frac{1}{4}^m$ R. H. Blued).675Binding screw for contact base (14 24 $\frac{3}{4}^m$ R. H. Blued).676Screw fastening base to wood base (No. 10, $\frac{1}{4}^m$ F. H.).677Screw fastening base to wood base (No. 10, $\frac{1}{4}^m$ R. H. Blued).678Binding screw for contact base (14 24 $\frac{3}{4}^m$ R.		Pivot pin for pawl
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976Pin fastening spring to frame.439REVERSING CYLINDER, with shaft and star wheel complete.908STAR WHEEL, with pin; must be fitted.440Wood body.4501Brass collar, with pin fastening wood body to shaft $(\frac{3}{4}'' x \frac{1}{4}''' x \frac{1}{4}''' thick)$.666Screw fastening collar to wood body (No. 10, $1\frac{1}{4}'' F. H. Brass$).677per 100778Screw fastening contacts to wood body (No. 8, $\frac{1}{4}'' R. H. Brass$).779per 100780Screw fastening contacts to wood body (No. 8, $\frac{1}{4}'' R. H. Brass$).781per 100782Roller, with pin.783Pivot pin for pawl.784Pivot pin for pawl.785Washer for pin ($\frac{1}{4}'' x \frac{9}{4}'' x .125'')$.786Pin fastening spring to frame.787Pin fastening spring to frame.788Lock bolt, with pin (used in connection with check pawl far reversing cylinder784Wood base.784Wood base.784Screw fastening wood base to frame (14 24, $\frac{1}{4}'' R. H.)$.784Screw fastening wood base to frame (14 24, $\frac{1}{4}'' R. H.)$.784Screw fastening base to wood base (No. 10, $\frac{3}{4}'' F. H.$).785Binding screw for No. 56740 ($\frac{3}{4}''' x \frac{3}{4}''' x .062''' Brass$).786Screw fastening base to wood base (No. 10, $\frac{3}{4}'' F. H.$).787Binding screw for contact base (14 24 $\frac{3}{4}''' R. H. Blued$).788Screw fastening base to wood base (No. 10, $\frac{3}{4}'' F. H.$).789Binding screw for contact base (1		Spring cotter for pin $(\frac{1}{2}'' \times \frac{3}{2}'')$ per 100
439REVERSING CYLINDER, with shaft and star wheel complete.908STAR WHEEL, with pin; must be fitted.440Wood body.651Brass collar, with pin fastening wood body to shaft $(\frac{3''}{4}x \frac{1}{4}^{''}x \frac{1}{4}^{''})$ thick).666Screw fastening collar to wood body (No. 10, $1\frac{1}{4}^{''}$ F. H. Brass).671Short contact.672Long contact.673Screw fastening contacts to wood body (No. 8, $\frac{7}{4}^{''}$ R. H. Brass).674Screw fastening contacts to wood body (No. 8, $\frac{7}{4}^{''}$ R. H. Brass).674Pivot pin for pawl.675Roller, with pin.676Pivot pin for pawl.677Pin fastening spring to frame.678Lock bolt, with pin (used in connection with check pawl far reversing cylinder).678Lock bolt, with pin (used in connection with check pawl far reversing cylinder).6740Screw fastening wood base to frame (14 24, $1\frac{14}{4}^{''}$ R. H.).6740Screw fastening base to wood base (No. 10, $\frac{14}{4}^{''}$ F. H.).6741Screw fastening base to wood base (No. 10, $\frac{14}{4}^{''}$ R. H. Blued).6742Binding screw for contact base (14 24, $\frac{14}{4}^{''}$ R. H. Blued).6743Screw fastening base to wood base (No. 10, $\frac{14}{4}^{''}$ F. H.).6744Screw fastening base to wood base (No. 10, $\frac{14}{4}^{''}$ R. H. Blued).6745Binding screw for contact base (14 24, $\frac{14}{4}^{''}$ R. H. Blued).6749Contact base.6740Check nut for binding screw (14 24, $\frac{14}{4}^{''}$ Hev. Flat Brass).6749Contact base, (No. 10, $\frac{14}$	3632	
998STAR WHEEL, with pin; must be fitted.440Wood body661Brass collar, with pin fastening wood body to shaft $(\frac{3''}{4} x \frac{1}{2}'' x \frac{1}{2}'' thick)$.666Screw fastening collar to wood body (No. 10, $1\frac{1}{4}''$ F. H. Brass).671Long contact.672Long contact.673Check pawl, with roller. for reversing cylinder.674Pivot pin for pawl.675Roller, with pin.676per 100677Spring cotter for pin ($\frac{1}{16}'' x \frac{7}{4}'' x .125'')$.678Washer for pin ($\frac{1}{16}'' x \frac{7}{4}'' x .125'')$.679Pin fastening spring to frame670Spring cotter for pin ($\frac{1}{3}'' x \frac{7}{4}'')$.671Pin fastening spring to frame672Lock bolt, with pin (used in connection with check pawl far reversing cylinder6743CONTROLLING CONTACT BOARD, complete, with reinforced fingers.6744Screw fastening wood base to frame (14 24, $1\frac{1}{4}'' R. H.)$.6745Screw fastening base to wood base (No. 10, $\frac{1}{4}'' F. H.)$.6746Screw fastening base to wood base (No. 10, $\frac{1}{4}'' R. H. Blued$).6745Binding screw for contact base (14 24, $\frac{3}{4}'' R. H. Blued$).6749CONTACT FINGER, reinforced, with spring.6749CONTACT FINGER, reinforced, with spring.	4976	Pin fastening spring to frame
440Wood bodyperiod base to find the field of the spring to find the spring to spring to spring to spring the spring to spring the spring to spring to spring to spring to spring to spring to spring the spring to spring the	1439	
661Brass collar, with pin fastening wood body to shaft $(\frac{3''}{4} x 1\frac{3''}{5} x \frac{1}{2}'' thick)$.666Screw fastening collar to wood body (No. 10, $1\frac{1}{4}''$ F. H. Brass)	4998	STAR WHEEL, with pin; must be fitted
661Brass collar, with pin fastening wood body to shaft $(\frac{3''}{4}, x 1\frac{5''}{8}, x \frac{1}{2''})$ thick).666Screw fastening collar to wood body (No. 10, $1\frac{1}{4''}$ F. H. Brass).per 100641Short contact.142142Long contact.144650Screw fastening contacts to wood body (No. 8, $\frac{7}{4''}$ R. H. Brass).per 100632Check pawl, with roller. for reversing cylinder.per 100633Check pawl, with roller. for reversing cylinder.per 100634Pivot pin for pawl.per 100635Washer for pin $(\frac{7}{4''} x \frac{7}{4''} x .125'')$.per 100636Washer for pin $(\frac{1}{4''} x \frac{7}{4''})$.per 1000637Tension spring for pawl (26 Turns .091'' Steel wire).per 1000638Lock bolt, with pin (used in connection with check pawl far reversing cylinderper 1000644CONTROLLING CONTACT BOARD, complete, with reinforced fingers.per 1000644Wood base.per 1000645Screw fastening wood base to frame (14 24, $1\frac{1}{2''}$ R. H.).per 1000646Washer for No. 56740 ($\frac{14}{4''} x \frac{1}{2''} x .062''' Brass)$.per 100647Screw fastening base to wood base (No. 10, $\frac{3''}{4''}$ F. H.).per 100648Screw fastening base to wood base (No. 10, $\frac{3''}{4''}$ R. H.)per 100649CONTACT FINGER, reinforced, with spring.per 100	1440	Wood body
441Short contact.142Long contact.194Screw fastening contacts to wood body (No. 8, ζ'' R. H. Brass).195Roller, with roller. for reversing cylinder.196Roller, with pin.197Pivot pin for pawl.198Spring cotter for pin ($\frac{1}{16}'' \times \frac{5}{8}'' \times .125''$).199Pivot pin for pawl.199Spring cotter for pin ($\frac{1}{34}'' \times \frac{5}{8}'' \times .125''$).190Spring cotter for pin ($\frac{1}{34}'' \times \frac{5}{8}'' \times .125''$).191Spring cotter for pin ($\frac{1}{34}'' \times \frac{5}{8}'''$).196Pin fastening spring to frame197Pin fastening spring to frame198Lock bolt, with pin (used in connection with check pawl far reversing cylinder199Spring cotter for pin ($\frac{4}{32}'' \times \frac{5}{3}''')$.190CONTROLLING CONTACT BOARD, complete, with reinforced fingers.194Wood base.194Screw fastening wood base to frame (14 24, $1\frac{1}{2}''' R. H.)$.195Contact base.196Washer for No. 56740 ($\frac{14}{14}'' \times \frac{12}{2}'' \times 0.02''' Brass)$.197Per 100198Screw fastening base to wood base (No. 10, $\frac{14}{16}'' F. H.$).198Screw fastening base to wood base (No. 10, $\frac{3}{4}''' F. H.$).199Contact base.199ContACT FINGER, reinforced, with spring.	4691	
442Long contact194Screw fastening contacts to wood body (No. 8, ζ'' R. H. Brass)	3666	Screw fastening collar to wood body (No. 10, 11" F. H. Brass) per 10
194Screw fastening contacts to wood body (No. 8, ζ'' R. H. Brass)	1441	Short contact
194Screw fastening contacts to wood body (No. 8, ζ'' R. H. Brass)	1442	
323Check pawl, with roller. for reversing cylinder.324Roller, with pin.325Roller, with pin.326Pivot pin for pawl.326Washer for pin $(\frac{1}{16}'' x \frac{3}{8}'' x .125'')$.327per 100328Spring cotter for pin $(\frac{1}{3}'' x \frac{3}{4}'')$.329Tension spring for pawl (26 Turns .091'' Steel wire).320Pin fastening spring to frame.321Lock bolt, with pin (used in connection with check pawl far reversing cylinder).323Spring cotter for pin $(\frac{4}{32}'' x \frac{5}{3}'')$.324CONTROLLING CONTACT BOARD, complete, with reinforced fingers.325Screw fastening wood base to frame (14 24, $1\frac{1}{2}''$ R. H.)326Per 1000327Contact base.328Screw fastening base to wood base (No. 10, $\frac{3}{4}''$ F. H.)329Per 100331Binding screw for contact base (14 24 $\frac{3}{4}''$ R. H. Blued)332per 100333Contact base, per 100344Screw fastening base to wood base (No. 10, $\frac{3}{4}''$ F. H.)345Screw fastening base to wood base (No. 10, $\frac{3}{4}''$ F. H.)348Screw for contact base (14 24 $\frac{3}{4}'''$ R. H. Blued)349Contact base, per 100341Contact base, per 100342Contact for pin (15 binding screw (14 24, $\frac{1}{4}''''''''''''''''''''''''''''''''''$	0194	
925Roller, with pin	1623	
Bive pin for pawl.Bit Washer for pin $(\frac{1}{16} x \frac{2}{8} x \cdot 125'')$.Bit pin for pawl.Bit pin for pin $(\frac{1}{3} x \frac{2}{3} x \frac{2}{3})$.Bit pin for pin ($\frac{1}{3} x \frac{2}{3} x \frac{2}{3})$.Bit pin fastening spring to frame.Bit pin fastening spring to frame.Bit pin for pin ($\frac{1}{32} x \frac{2}{3} x \frac{2}{3})$.Bit pin for pin ($\frac{1}{32} x \frac{2}{3} x \frac{2}{3$	4925	
365Washer for pin $(\frac{7}{6}'' \times \frac{7}{8}'' \times 125'')$	4624	
118Spring cotter for pin $(\frac{1}{8}" x \frac{1}{4}")$	0365	
532Tension spring for pawl (26 Turns .091" Steel wire).976Pin fastening spring to frame.648Lock bolt, with pin (used in connection with check pawl far reversing cylinder	6118	
976Pin fastening spring to frame548Lock bolt, with pin (used in connection with check pawl far reversing cylinder530Spring cotter for pin $(\frac{4}{32}'' \times \frac{5}{3}'')$ 530CONTROLLING CONTACT BOARD, complete, with reinforced tingers544Wood base544Wood base545Screw fastening wood base to frame (14 24, $1\frac{1}{2}''$ R. H.)546Per 100547Screw fastening base to frame (14 24, $1\frac{1}{2}''$ R. H.)548Screw fastening base to wood base (No. 10, $\frac{3}{4}''$ F. H.)548Screw fastening base to wood base (No. 10, $\frac{3}{4}''$ F. H.)548Screw fastening base to wood base (14 24 $\frac{3}{4}''$ R. H. Blued)549CONTACT FINGER, reinforced, with spring.	3632	
548Lock bolt, with pin (used in connection with check pawl far reversing cylinder	4976	
D30Spring cotter for pin $(\frac{3}{32}" \times \frac{5}{2}")$	4648	
443CONTROLLING CONTACT BOARD, complete, with reinforced fingers.444Wood base.740Screw fastening wood base to frame (14 24, $1\frac{1}{2}"$ R. H.)	4030	
444Wood base		
740Screw fastening wood base to frame (14 24, $1\frac{1}{2}$ " R. H.)		
426Washer for No. 56740 ($_{64}^{17}$ x $_{2}^{17}$ x .062" Brass)		
253Contact base848Screw fastening base to wood base (No. 10, 3" F. H.) per 100745Binding screw for contact base (14 24 3" R. H. Blued) per 100213Check nut for binding screw (14 24, $\frac{1}{8}"$ Hex. Flat Brass) per 100949CONTACT FINGER, reinforced, with spring		
848Screw fastening base to wood base (No. 10, 3" F. H.) per 100745Binding screw for contact base (14 24 3" R. H. Blued) per 100213Check nut for binding screw (14 24, $\frac{1}{8}"$ Hex. Flat Brass) per 100949CONTACT FINGER, reinforced, with spring		
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213Check nut for binding screw (14 24, $\frac{1}{6}''$ Hex. Flat Brass) per 100949CONTACT FINGER, reinforced, with spring	3848	• • • • • • •
949 CONTACT FINGER, reinforced, with spring	1745	5
	2213	•
Adjusting screw for contact finger (14 20, 3" R. H. Blued) per 100	7949	
	7677	Adjusting screw for contact finger (14 20, $\frac{7}{6}$ " R. H. Blued) per 10

28-4493 Parts of R Controllers

Parts of R-16-A Controller-Continued

Cat. No.	Description Lis	t Price
14408	Check nut for adjusting screw (14-20, 1/2" Hex. Flat Brass) per 100	\$1.50
5889	Screw fastening finger to base (10-24, $\frac{7}{16}$ " R. H. Blued) per 100	.50
19683	Double washer for No. 5889 per 100	2.00
21445	Sheet insulation between controlling cylinder and frame	.20
6081	Screw fastening No. 21445 to frame (10-24, §" R. H. Blued) per 100	.50
13845	Screw fastening No. 21445 to controlling contact board (No. 10, 1/2" F. H.) per 100	.50
14441	INNER REVERSING CONTACT BOARD, complete, with two connection wires with clips.	
	These clips are used in place of two of the washers Cat. No. 13804 when the wires are connected	
	to board	5.00
14686	Wood base	.15
1758	Screw fastening wood base to frame (14-20, 14" R. H.) per 100	1 .00
14426	Washer for No. 1758 (174 x 1/2 x 1/2 x 1/2 Brass)	1.00
14687	Contact base	.25
1013	Screw fastening base to wood base (No. 8, 3" F. H.) per 100	.40
17663	Binding screw for contact base (14-20, $\frac{5}{3}$ " R. H. Blued, Round Point) per 100	.75
14408	Check nut for binding screw (14-20, $\frac{1}{2}''$ Hex. Flat Brass) per 100	1.50
37930	CONTACT FINGER, reinforced, with spring	.16
14434	Screw fastening finger to base (8-32, 3" R. H Blued) per 100	.50
13804	Double washer for No. 14434 per 100	3.00



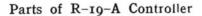
Cat. No	Description	List Price
21448 21450	Segment	\$1.20 .84
39 484 1 77 33	Complete set of segments, with screws Screw for segments, per 100	12 .72 3 .00

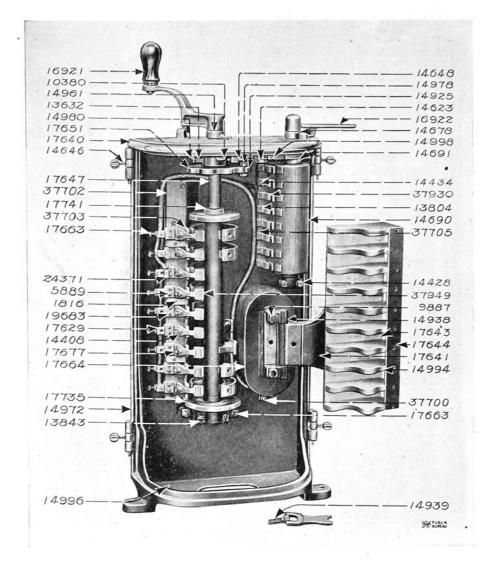
Parts of R Controllers 4493-29

Parts of R-16-A Controller-Concluded

Cat. No.	Description Lis	st Price
21446	OUTER REVERSING CONTACT BOARD, complete	\$4 .00
21447	Wood base	.25
14444	Upper bracket for contact board	.35
14445	Lower bracket for contact board	.35
19878	Screw fastening No. 21446 to upper bracket (14-24, §" R. H.) per 100	1.00
19879	Screw fastening No. 21446 to lower bracket (14-24, 11" R. H. Blued) per 100	1.50
14426	Washer for Nos. 19878, 19879 (17 x 1/2" x .062" Brass) per 100	1.00
14446	Contact base	.20
19648	Binding screw for contact base (14-24, §" R. H. Blued, Round Point) per 100	1.00
22213	Check nut for binding screw (14-24, ¹ / ₈ " Hex. Flat Brass) per 100	1.50
10214	Screw fastening base to wood base (No. 8, ½" F. H.) per 100	.25
37929	CONTACT FINGER, reinforced, with spring	.16
14434	Screw fastening finger to base (8-32, §" R. H. Blued) per 100	.50
13804	Double washer for No. 14434 per 100	3 .00

30-4493 Parts of R Controllers





Cat No

Description

List Price

10

Cat. no.		
	R-19-A Controller (rheostatic), complete. (Includes supporting bracket with cap screws and washers for fastening controller to dasher, also wire guard and rubber gasket.)	
16921	*Operating handle	
16922	*Reversing handle	
	Following are the interchangeable parts of the R-19-A Controller, which differ from those of the R-17-	Α.
17664	MAGNET SPOOL wound, complete, with terminal	37.50
37700	Binding screw for terminal 14-24, 1/2" R. H. Round Point, Blued) per 100	.75
26353	Check nut for No. 37700 (14-24, Hex. Cham. one side Brass) per 100	2.00
14689	REVERSING CYLINDER, complete, with shaft and star wheel	4.65
14690	Wood body	.45
37701	CONTROLLING CONTACT BOARD, complete, with contact bases	8.25
0.000	*Not included in complete controller, must be ordered separately.	

Parts of R Controllers 4493-31

Parts of R-19 A Controller Concluded

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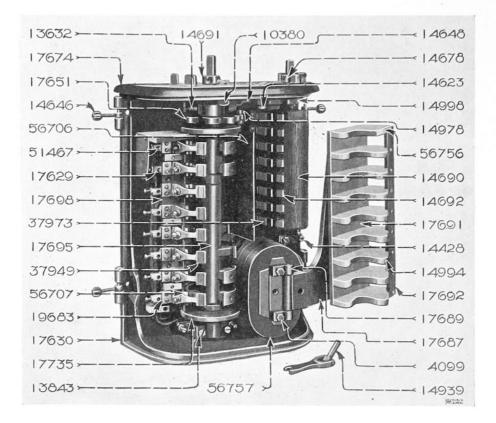
Cat. No.	Description	st Price
37702	Wood base	\$0.35
37703	Finger shield with supporting blocks and screws	.75
928	Screw fastening shield to supporting block (10 24, 1/2" F. H.) per 100	1.25
1816	Screw fastening supporting block to board (No. 8, 1" R. H.) per 100	1.00
37704	REVERSING CONTACT BOARD, complete, with contact bases	5.00
37705	Wood base	.15

Parts of R 21-A Controller

	R-21-A Controller, complete. (Includes supporting bracket, with cap screws and washers fasten-	
	ing controller to dasher; also wire guard and rubber gaskct.)	
17799	*Operating and reversing handle	8 .50
	The R 21-A controller differs from the R-13-A in that it has heavier carrying capacity.	
	Following are the interchangeable parts of the R 21 A controller, which differ from those of the R 13 A	
56878	Magnet Spool, wound, complete	19.00
56879	Contact board with reinforced fingers, complete, with finger shield and insulated wires	28.00
37904	Contact finger, with spring	.25
5889	Screw fastening finger to base (10 24, 16" R. H. Blued) per 100	.50
19805	Contact base for soldered connections	.35
39133	Contact base for binding screw connections	.75
	*Not included in complete controller; must be ordered separately	

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32-4493 Parts of R Controllers



Parts of R-22-A Controller.

Cat. No.

Description

List Price

	R-22-A Controller, complete. (Includes supporting bracket with cap screws and washers fasten- ing controller to dasher.)	
16921	*Operating handle	\$4.15
16922	*Reversing handle	2.35
	Following are the interchangeable parts of the R-22-A Controller which differ from those of the R-14-A Controller:	
56757	MAGNET SPOOL, wound, complete	14.00
51465	CONTROLLING CONTACT BOARD, complete, with reinforced fingers	6.50
51467	Contact base, with large hole for two wires	.25
37949	Contact finger, with spring	.29
5889	Screw fastening finger to base (10-24, 76" R. H. Blued) per 100	.50
51466	REVERSING CONTACT BOARD, complete, with reinforced fingers	4.75
37973	Contact finger, with spring	.16
14434	Screw fastening finger to base (8-32, 3" R. H. Blued) per 100	.50
56708	Fiber cleat for holding wire to frame	.20
56709	Screw fastening fiber cleat to frame (14-24, 2" R. H. Blued) per 100 *Not included in complete controller; must be ordered separately.	2 .00

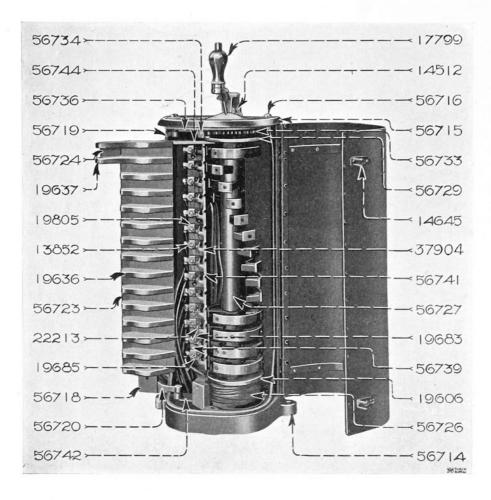
Parts of R Controllers 4493 33

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Parts of R-22 C Controller

Cat. No.	Description L	ist Price
	R 22 C Controller, complete. (Includes supporting bracket with cap screws and washers fasten ing controller to dasher.)	
16921	*Operating handle	
16922	*Reversing handle	
	The R 22 C controller differs from the R 22 A in that it has a connection board on back of frame	
	Following are the interch ingeable parts of the R-22 C controller, which differ from those of the R 22 1	
51705	Frame fitted with cylinder shaft bearing caps and cap screws for same	
51706	Connection board, complete, for back of frame	4.00
51707	Wood base	.40
19646	Screw fastening wood base and cover for connection board to frame (14-24, 1" R. H.) per 100	1.00
14426	Washer for No. 19646 (17 x 1/2 x .062" Brass) per 100	1.00
51708	Binding post	.25
51709	Screw fastening No. 51708 to wood base (⁵ / ₁₆ " 18, ³ / ₁ " R. H. Brass er 100	6.00
51710	Binding screw for No. 51708 (18 18, 3" R. H. Brass per 100	
51711	Thumb screw for No. 51708 (18 18, 5" Brass)	
51712	Cover for connection board	1.00
	*Not included in complete controller; must be ordered separately.	

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Parts of R-27-A	A Controller
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Cat. No.

Description

List Price

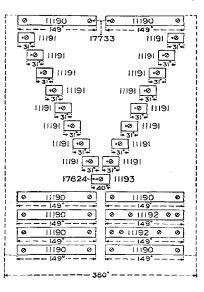
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	R-27-A Controller, complete. (Includes supporting bracket, with cap screws and washers fasten-	
	ing controller to dasher.)	
17799	*Operating and reversing handle	\$8.50
56714	FRAME, complete	
14646	Hinge bolt with pin and nut for frame	.45
56715	Cap for top of controller	
56716	Screw fastening cap to frame (3"-16, 1" R. H. Brass) per 100	8.00
14512	WATER CAP AND POINTER for cylinder shaft, with set screw	1.25
14410	Set screw for water cap $\left(\frac{5}{16}''-18, \frac{21}{32}''$ Sp'l Blued $\right)$ per 100	5.00
56717	SHEET IRON COVER, complete	9.75
14645	Slotted lug for cover, with rivets	.10
56718	HINGED POLE PIECE, complete, with hinges	3.50
56719	Upper hinge, with screws	.85
56720	Lower hinge, with rivets	.75
51745	Screw fastening No. 56719 to pole piece (14-24, 3" R. H. Blued) per 100	1.00
	*Not included in complete controller; must be ordered separately.	

Parts of R Controllers 4493-35

Parts of R-27-A Controller-Continued

Cat. No.	Description	st Price
56721	Thumb screw fastening pole piece to frame $(\frac{3}{8}''-16, \frac{1}{16}''$ Brass Sp'l)	\$0 .25
56722	ARC DEFLECTOR, complete	
56723	Large strip	
56724	Small strip	
19637	Large division plate	
19636	Small division plate	.20
19929	Screw fastening strips to division plates (No. 8, 3" F. H.) per 100	1.00
19892	Screw fastening arc deflector to pole piece (No. 10, 11/ R. H. Blued) per 100	
19630	Insulating bushing used with No. 19892.	.04
56726	MAGNET SPOOL, wound complete, with terminals	19.00
19648	Binding screw for terminals (14-24, §" R. H. Blued, Round Point) per 100	
22213	Check nut for No. 19648 (14-24, Hex. Flat Brass) per 100	1.50
11096	Screw fastening No. 56726 to frame (14-24, §" R. H. Blued) per 100	.65
56727	CONTROLLING CYLINDER, complete, with shaft, insulation disks, bushings, collar and star wheel	55 .00
39485	Complete set of copper contact segments with screws	
	Contact segments and screws are listed below.	
56728	Shaft	3.50
17742	Key for cylinder and shaft	.20
56729	Insulation disk (upper)	.45



Cat. No.	List Price	Cat. No.	List Price
11190	\$0.52	11192	\$0 .72
11191	.17	11193	.24
39485	Complete set of segments, wi	ith screws	10 .00
17624	Pin for segments, per 100		1 .25
17733	Screw for segments, per 100.		3 .00

36-4493 Parts of R Controllers

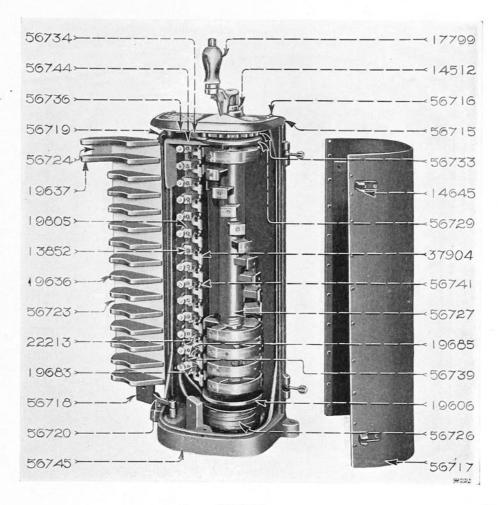
Parts of R 27 A Controller—Continued

Cat. No.	Description	st Price
56553	Insulation disk (lower)	\$0.40
56730	End bushing	.30
56731	Inner bushing	.25
56732	Collar, with pin, for shuft	.50
56733	Star wheel, with pin; must be fitted.	5.50
56734	Check pawl, with roller, for star wheel	1.25
19739	Roller, with pin	.10
56735	Pivot pin for pawl	.06
21392	Washer for pin $\binom{1}{32''} x_{\frac{1}{4}}^{\frac{1}{4}''} x .062''$.50
-4030	Spring cotter for pin $\binom{32'' \times 5''}{32}$ per 1000	
56736	Spring for pawl (17 Turns .091" Steel wire)	.05
56737	Pin for spring	.04
56738	CONTACT BOARD, complete, with finger shield and No. 4 insulated wires, with reinforced fingers	22 .00
56739	Wood base	.55
56740	Screw fastening wood base to frame (14 24, 11/2" R. H.) per 100	2 .00
14426	Washer for screw (14 x 1/2 x 0.02" Brass)	1.00
37904	Contact finger, with spring	.25
19685	Adjusting screw for finger (14 24, 3" R. H. Blued) per 100	.85
22213	Check nut for adjusting screw (14-24, Hex. Flat Brass) per 100	1.50
5889	Screw fastening finger to base (10 24, $\frac{7}{16}$ " R. H. Blued) per 100	.50
19683	Double washer for No. 5889	2 .00
19805	Contact base	.35
13852	Screw fastening base to wood base (No. 10, 3" F. H.) per 100	.50
56741	Finger shield	2 .65
13848	Screw fastening shield to wood base (No. 10, 3" F. H.) per 100	.50
56742	Fiber plate for base of controller	.50
56743	Screw fastening plate in position (14 24, 2" F. H.) per 100	.60
56744	Trolley shield, complete	.55
13848	Screw for trolley shield (No. 10, 2" F. H.) per 100	.50
56710	Two-way connector for cables, with two screws No. 5889	.15

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Parts of R Controllers 4493-37



Parts of R-27-D Controller

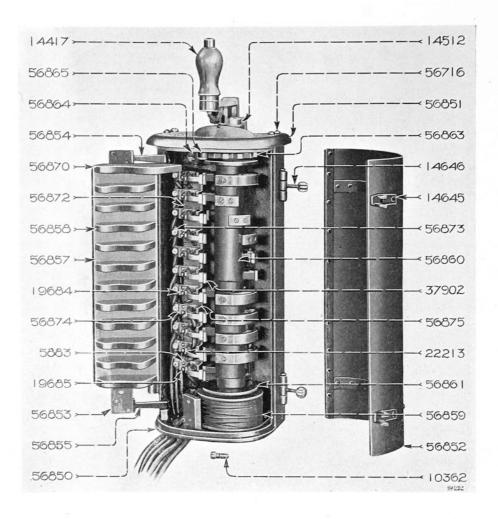
Cat. No.

Description

List Price

	R-27-D Controller, complete. (Includes supporting bracket, with cap screws and washers fasten- ing controller to dasher.)	
17799	*Operating and reversing handle The R-27-D controller differs from the R-27-A in that it has a connection board on the back to which the outside leads are attached.	\$8.50
	Following are the interchangeable parts which differ from those of the $R-27-A$:	
56745	Frame, complete	
56746	Connection board, complete, for back of frame	12.50
56747	Wood base with spacing blocks	1.45
56748	Screw fastening wood base to frame (14-24, 1116" R. H.) per 100	2.00
14426	Washer for No. 56748 (17/164" x 1/2" x .062" Brass) per 100	1.00
51702	Two-way connector with four binding screws	.45
51703	Binding screw for No. 51702 (12-24, 1/2 R. H. Blued) per 100	.75
19646	Screw fastening connector to base (14-24, 1" R. H.) per 100	1.00
14426	Washer for No. 19646 (17/1 x 1/2 x .062" Brass) per 100	1.00
14548	Soft rubber bushing for use with cables	.08
	*Not included in complete controller; must be ordered separately.	

38-4493 Parts of R Controllers



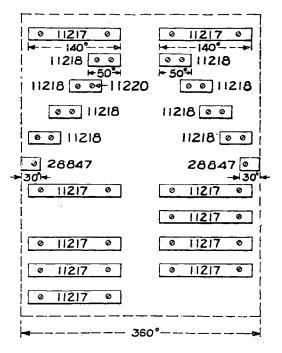
Parts	of	R-28-A	Control	ler
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	t Price
R-28-A Controller, Complète	
*Operating handle	
*Operating hand-wheel	13.75
*Operating wheel, rope drive	23.00
Following are the interchangeable parts:	
FRAME, complete	
Hinge bolt, with pin and nut fastening cover to frame	.45
Cap for top of controller	
Screw fastening cap to frame (3"-16, 1" R. H. Brass) per 100	8.00
Water cap and pointer, with set screw	1.25
Set screw for No. 14512 (⁵ / ₁₆ "-18, ³ / ₄ " Sp'l Blued) per 100	5.00
SHEET IRON COVER. complete	6.00
Slotted lug for cover, with rivets	.10
*Not included in complete controller; must be ordered separately	
	R-28-A Controller, Complete

Parts of R Controllers 4493-39

Parts of R-28-A Controller-Continued

Cat. No.	Description	ist Price
56853	HINGED POLE PIECE, complete, with hinge brackets	\$2.25
56854	Upper hinge bracket, with pin	
56855	Lower hinge bracket, with pin and rivets	
50428	Screw fastening No. 56854 to pole piece (14-24, 1/2" R. H. Blued) per 100	.75
10362	Cap screw fastening pole piece to frame (3/-16, 3/ Hex. H. Slot.) per 100	
56856	ARC DEFLECTOR, complete	3.75
56857	Strip for arc deflector	1.10
56858	Division plate for arc deflector	.20
56870	Upper end plate for arc deflector	.30
13852	Screw fastening strip to division plate (No. 10, §" F. H.) per 100	.50
13846	Screw fastening arc deflector to pole piece (No. 10, 11/2" R. H. Blued,) per 100	.60
13635	Insulating bushing used with No. 13846	.05
56859	Magnet spool, wound, complete. with terminals	12 .00
19880	Binding screw for terminals (14-24, §" R. H. Round Point Blued) per 100	
22213	Check nut for binding screw (14-24, Hex. Flat Brass) per 100) 1.50
50428	Screw fastening magnet spool to frame (14-24, 1/2" R. H. Blued) per 100	.75
56860	CONTROLLING CYLINDER, complete, with shaft, insulation disks, collar and star wheel	



Cat. No.	List Price	Cat. No.	List Price
11217 11218	\$0.29 .15	28847	\$0 .18
39486 17733	Complete set of segments, v Screw for segments, per 100	vith screws	5 .60 3 .00

40-4493 Parts of R Controllers

Parts of R-28-A Controller-Concluded

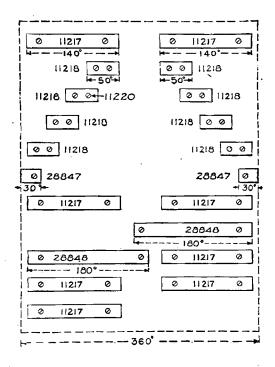
Cat. No.	Description	List Price
39486	Complete set of copper contact segments with screws	••
	Contact segments and screws are listed on page 39.	
56861	Insulation disk	\$0.30
56862	Collar for shaft, with pin	40
568 6 3	Star wheel, with pin; must be fitted	1.75
56864	Check pawl, with roller	
56865	Roller, with pin	10
56868	Pivot pin for check pawl	10
21392	Washer for pivot pin (12" x 3" x .062")	00 .50
4030	Spring cotter for pivot pin (32" x 3") per 10	
56869	Tension spring for check pawl (24 Turns .090" Steel wire)	04
56867	Pin for tension spring	
56871	CONTROLLING CONTACT BOARD, complete, with unreinforced fingers	7.00
56872	Wood base	
56740	Screw fastening wood base to frame (14-24, 1½" R. H.) per 1	00 2.00
14426	Washer for No. 56740 ($\frac{17}{64} \times \frac{17}{2} \times .062''$ Brass) per l	
56873	Contact base	25
13848	Screw fastening base to wood base (No. 10, 3" F. H.) per 1	0 0 .50
37902	Contact finger, with spring	
5883	Screw fastening finger to base (8-32, 5 " R. H. Blued) per 1	
19684	Brass washer plate for No. 5883	00 1.00
56874	Brass washer plate and connector for No. 5883	00 2.75
19685	Adjusting screw for contact finger (14-24, 3" R. H. Blued) per 1	
22213	Check nut for adjusting screw (14-24, Hex. Flat Brass) per 1	00 1.50
56875	Finger shield	1.80
14192	Screw fastening No. 56875 to board (No. 8, §" F. H.) per H	00 .50
56710	Two-way connector for cables, with two screws No. 5889	
5889	Screw for No. 56710 (10-24 $\frac{7}{16}$ " R. H. Blued) per 16	00 .5 0
56876	Wire guard	15
50428	Screw fastening wire guard to frame (14-24, ½" R. H. Blued) per I	00 .75

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Parts of R Controllers 4493-41

Parts of R-28-B Controller

Cat. No.	Description	List Price
11371	R-28-B Controller, complete	\$8.00
56877 39487	 The R-28-B controller differs from the R-28-A in that it has short circuiting contacts added to the cylinder at the off position. Following are the interchangeable parts of the R-28-B controller which differ from the R-28-A: Controlling cylinder, complete, with shaft, insulation disk, collar and star wheel	27 .00



Cat. No.	List Price	Cat No.	List Price
11217	\$0.29	28847	\$0 .18
11218	.15	28848	.37
39487	Complete set of segments, w	ith screws	6.05
11220	Screw for segments, per 100		3.75

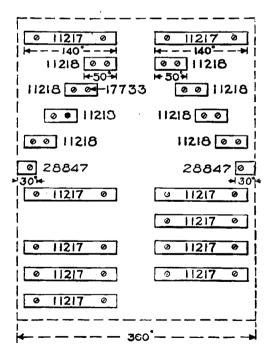
42-4493 Parts of R Controllers

Parts of R-28-D Controller

Cat. No.	Description	List Price
	R-28-D Controller, complete	
11371	*Operating handle, with set screw	\$8.00
	The R-28-D is a marine controller, and differs from the R-28-A in that the parts liable	to
	corrosion are made of non-corrosive metal where possible.	
	Following are the interchangeable parts of the R-28-D controller which differ from those of the R-28	3 - A.
56884	FRAME, complete	
56885	Hinge bolt with pin and nut, fastening cover to frame	
56886	Water cap and pointer, with set screw	1.15
56887	Set screw for water cap $(\frac{5}{16}"-18, \frac{3}{4}"$ Sp'l Brass) per	
56888	HINGED POLE PIECE, complete, with hinge brackets	2.25
10204	Screw fastening upper hinge bracket to pole piece (14-24, 1/2 R. H. Brass) per	
56889	Cap screw fastening pole piece to frame (3"-16, 3" Hex. H. Slot. Brass)per	
56890	ARC DEFLECTOR, complete	
469	Screw fastening arc deflector strips to division plates (No. 10, 3" F. H. Brass) per	100 1.50
56891	Screw fastening arc deflector to pole piece (No. 10, 1%" R H. Brass) per	
56892	MAGNET SPOOL, wound, complete, with terminals	
5689 3	Binding screw for terminals (14-24, §" R. H. Round Point Brass) per	100 2.00
10204	Screw fastening magnet spool to frame (14-24, 1/2" R. H. Brass) per	
56894	CONTROLLING CYLINDER, complete, with shaft, insulation disks, collar and star wheel	26.50
39488	Complete set of copper contact segments with screws.	
	Contact segments and screws are listed below.	

Contact segments and screws are listed below.

*Not included in complete controller; must be ordered separately.



Cat. No.	List Price	Cat. No.	List Price
11217 11218	\$0.29 .15	28847	\$0.18
39488 11220	Complete set of segments, with Screw for segments, per 100	n screws	5.89 3.75

Parts of R Controllers 4493-43

Parts of R-28-D Controller-Concluded

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Cat. No.

Description

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	•	List Price
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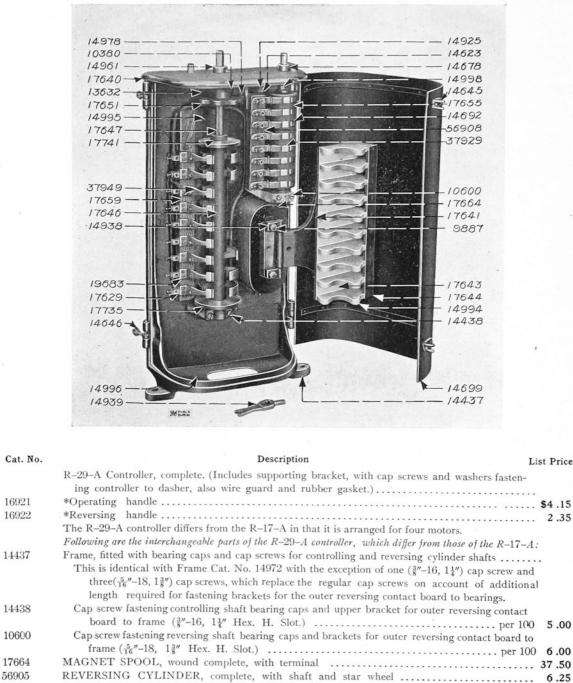
56895	Check pawl, with roller	\$0 75
56896	Roller with pin	
56897	Pivot pin for check pawl	.08
9997	Washer for pivot pin (137" x 3" x .062" Brass)	1.00
56898	Spring cotter for pivot pin (3" x \$" Brass)	
56899	Tension spring for check pawl (26 Turns .0.00" Steel wire, Copper-plated)	.06
56900	Pin for tension spring	.04
56201	CONTROLLING CONTACT BOARD, complete, with unreinforced fingers	
56902	Screw fastening wood base to frame (14-24, 11/2" R. H. Brass) per 100	4.00
9650	Screw fastening contact bare to wood ba e (No. 10, 3" F. H. Brass) per 100	
5531	Screw fastening contact finger to base (8-32, 16" R. H. Brass) per 100	
10437	Screw fastening finger shield to board (No. 8, §" F. H. Brass) per 100	
56903	Two-way connector for cables, with two screws, No. 5521	.15
10204	Screw fastening wire guard to frame (14-24, 1/2" R. H. Brass) per 100	

Parts of R-28-E Controller

	R-28-E Controller, complete	
11371	*Operating handle, with set screw	8.00
	The $R-28-E$ controller differs from the $R-28-D$ in the lettering of the cap plate only.	
	Following is the only interchangeable part of the $R-28-E$ controller which differs from the $R-28-D$:	
56904	Cap for top of controller	
	*Not included in complete controller; must be ordered separately	

44-4493 Parts of R Controllers

Parts of R-29-A Controller



*Not included in complete controller; must be ordered separately.

Parts of R Controllers 4493 45

Parts of R 29- A Controller Concluded

Cat. No.	Description	ist Price
37930	Contact finger with spring	\$0.16
56907	Outer Reversing Contact Board, complete, with reinforced fingers	3.00
56908	Wood base	.15
14444	Upper bracket for contact board	
14445	Lower bracket for contact board	
19878	Screw fastening No. 56907 to upper bracket (14 24, 3" R. H.) per 100	1.00
19691	Screw fastening No. 56907 to lower bracket (14 24, 11" R. H.) per 100	1.00
14426	Washer for Nos. 19878, 19691 ($\frac{11}{64}$ " x $\frac{1}{2}$ " x .062" Brass	1.00
37929	Contact finger, with spring	.16
5883	Screw fastening finger to base (8 32, $\frac{1}{16}$ " R. H. Blued) per 100	.30
13804	Brass washer plate for No. 5883, per 100	3.00
14446	Contact base and binding post, drilled through for connection wire	
14 117	Contact base and binding post except those drilled for connection wire	.20
13845	Short screw fastening No. 14446 to wood base (No. 10, 1/2 F. H.) per 100	.50
1013	Long screw fastening No. 14446 and screw fastening No. 14447 to wood base No. 8, 3" F. H.)	
		40
19880	Binding screw for Nos. 14446, 14447, (14 24, 5" R. H. Round Point Blued per 100	.50
22213	Check nut for No. 19880 14 24, Hex. Flat Brass) per 100	1.50

Parts of R 32 A Controller

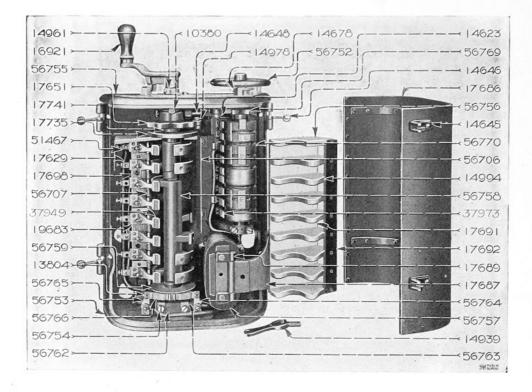
	R 32 A Controller, complete. (Includes supporting bracket, with cap screws and washers fasten	
	ing controller to dasher.	
17799	*Operating and reversing handle	8.50
	Following are the interchanguable parts of the R 32 A controller which differ from those of the R 27 1:	
56749	MAGNET SPOOL, wound complete, with terminal	21.00
56750	CONTACT BOARD, complete, with finger shield and No. 2 insulated wires, with reinforced fin-	
	gers	
37904	Contact finger, with spring	.25
3889	Screw fastening finger to base (10 24, "b" R. H Blued) per 100	
56751	Two way connector for cables with two screws No 5889	

Parts of R-32 B Controller

	R 32 B Controller, complete. Includes supporting bracket with cap screws and washers fasten-	
	ing controller to dasher.	
17799	*Operating and reversing handle	8.50
	The R 32-B controller differs from the R 32 A in that it has a connection board on back of frame.	
	Following are the interchangeable parts of the R 32 B controller, which differ from those of the R 32 A:	
56880	Frame, <omplete< td=""><td></td></omplete<>	
56881	Connection board, complete, for back of frame	12.50
	Note. This connection board differs from connection board Cat. No. 56746 for the R 27 D control-	
	ler, in that the two way connector has larger hole for cable.	
56747	Wood base with spacing blocks	1.45
56748	Screw fastening wood base to frame (14 24, 1_{16}^{117} R. H.)	2 .00
14426	Washer for No. 56748 (17" x 1" x .062" Brass)	1 .00
56882	Two-way connector, with four binding screws	1.10
51703	Binding screws for No. 56882 12-24, 1" R. H. Blued) per 100	.75
19646	Screw fastening connector to base 14 24, 1" R. H.) per 100	1 .00
14426	Washer for No. 19646 (1" x 1" x .062" Brass) per 100	1 .00
14548	Soft rubber bushings for use with cables	.08
	*Not included in complete controller; must be ordered separately.	

46-4493 Parts of R Controllers

Parts of R-37-A Controller



Cat. No.

Description

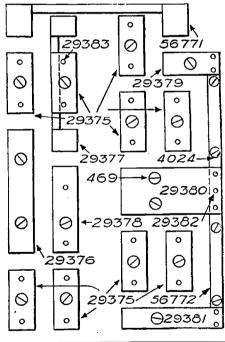
List Price

	R-37-A Controller, complete. (Includes supporting bracket, with cap screws and washers fasten- ing controller to dasher.)
16921	*Operating handle \$4.15
36699	*Reversing handle 3.00
56752	*Reversing hand-wheel 4.75
	Following are the interchangeable parts of the R-37-A controller which differ from those of the R-22-A:
56753	Frame fitted with bearing caps and cap screws for controlling and reversing cylinder shafts
	This differs from frame Cat. No. 17630 for R-22 controller in that the cap screws for the lower con- trolling cylinder bearing cap are longer, in order to fasten the equalizing attachment in position.
56754	Cap screw for lower bearing cap for controlling cylinder (3"-16, 21" Hex. H. Slot.) per 100 10.00
56755	CAP for top of controller
56758	CONTROLLING CYLINDER, complete, with shaft insulation disks, collar and star wheel 20.00 This differs from controlling cylinder Cat. No. 17695 for R-22-A controller in that the lower insu- lation disk is special for the R-37-A equalizing attachment
56759	Contact segments and screws are listed on page 19.
56760	Insulation disk (lower) with contact segment for equalizing attachment
5599	Contact segment for disk
17675	Screw fastening segment to disk (10-24, ¹ / ₂ " F. H. Brass) per 100 1.00
	Safety stop nut with pin
56761	EQUALIZING ATTACHMENT, complete, with insulated wires and reinforced fingers (Copper
50700	wire, No. 6 B. & S., requiring approximately 4 feet)
56762	Fiber block with two washer plates

Parts of R Controllers 4493-47

Parts of R-37-A Controller-Continued

Cat. No.	Description	Lis	t Price
56763	Washer plate for block	100	\$0.05
56764	Contact base, complete, with binding screw and nut, for contact finger (right-hand)		.35
56765	Contact base, complete, with binding screw and nut, for contact finger (left-hand)	· .	.15
385	Screw fastening base to fiber block (10-24, §" F. H.) per	100	.60
56766	Reinforced contact finger, with spring		.16
14434	Screw fastening finger to base (8-32, 3" R. H. Blued) per		.50
13804	Double washer for No. 14434 per		3.00
19880	Binding screw (14-24 §" R, H. Round Point Blued) per	100	.50
22213	Check nut for binding screw (14-24, Hex.Flat Brass) per	100	1.50
56767	Terminal for wires	• • • •	.10
56768	REVERSING CYLINDER, complete, with shaft and star wheel	• • • •	20.00
39489	Complete set of copper contact segments with ground contact, connection strip and scre	ws	
	Contact segments and screws are listed below.		
56769	Star wheel, with pin; must be fitted		.50
56770	Wood body	• • • •	.40
56771	Ground contact, with rivets	• • • •	1.50



Cat. No.	List Price	Cat. No.	List Price.
29375 29376 29377 29378 29379	\$0.54 .58 .30 .56 .56	29380 29381 56771 56772	\$0.76 .58 1.50 .26
39489 469 4024 29382 29383	Complete set of segments, wit Screw for segments, per 100 Screw for segments (Brass), p Copper rivet for segments per Pin for segments, per 100	h screws er 100 r 100	10.39 1.50 2.00 .25 .50

48-4493 Parts of R Controllers

Parts of R-37-A Controllers-Concluded

Cat. No.	Description Lis	st Price
56772	Connecting strip for contact segments	\$0 .30
4024	Screw fastening strip to wood body (No. 10, §" F. H. Brass) per 100	2.00
56775	REVERSING CONTACT BOARD, complete, with reinforced fingers	6.25
56776	Wood base	.70
56777	Insulation strip under No. 56776	.05
56778	Fiber cleat for holding wire to frame	.20
19669	Screw fastening cleat to frame (14-24, 1 ¹ / ₄ " R. H.) per 100	1.00

Parts of R-37-B Controller

	R-37-B Controller, complete. (Includes supporting bracket with cap screws and washers fasten-	
	ing controller to dasher.)	
16921	*Operating handle	4.15
56752	*Reversing hand-wheel	4.75
	The $R-37-B$ controller is the same as the $R-37-A$ except that the magnet spool has a different winding.	
	Following is the only interchangeable part of the R-37-B controller, which differs from the R-37-A:	
56828	Magnet spool, wound, complete I	4 .00

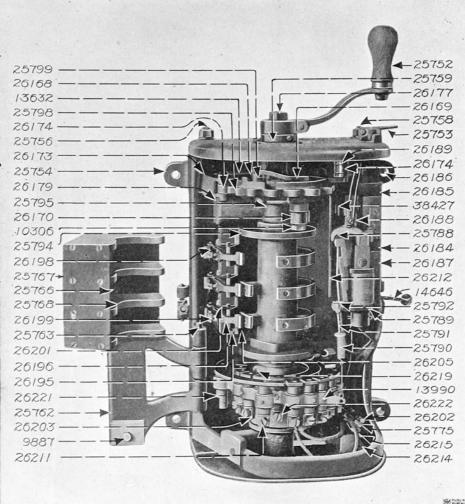
Parts of R-37-F Controller

16921 56752	 R-37-F Controller, complete. (Includes supporting bracket with cap screws and washers fastening controller to dasher.) *Operating handle	
	ently located. Following are the interchangeable parts of the R-37-F controller which differ from the R-37-B:	
24987	SHEET IRON COVER, complete	10.75
24988	Long hinge bolt, with pin and nut, for fastening cover to frame	1.00

Parts of R-38-A Controller

	R-38-A Controller, complete. (Includes supporting bracket with cap screws and washers fasten	
	ing controller to dasher.)	
16921	*Operating handle	4.15
56752	*Reversing hand-wheel	4.75
	The R- 38 -A controller differs from the R-37-A only in the capacity of the wiring and contact fingers	
	Following are the interchangeable parts of the R-38-A controller, which differ from those of the R-37-A	
56780	MAGNET SPOOL, wound, complete	15.00
17697	CONTROLLING CONTACT BOARD, complete, with unreinforced fingers	
37946	Contact finger, with spring	.20
	Note.—The contact base with large hole for wire is omitted from Cat. No. 17697.	
56781	REVERSING CONTACT BOARD, complete, with unreinforced fingers	5.85
37969	Contact finger, with spring	
	*Not included in complete controller. Must be ordered separately.	

Parts of R-43-A Controller



Cat. No.

Description

List Price

	R-43-A Controller. (Includes operating and reversing handles.)	
	Following are the interchangeale parts of the R-43-A Controller	
25752	Operating handle, with clamping screw	\$3.50
25753	Reversing handle, with set screw	.70
13354	Clamping screw for No. 25752 (3"-16, 14" Hex. H. Blued) per 100	8.00
25760	Set screw for No. 25753 (4"-20, 76" Sp'l. Blued) per 100	5.00
25754	FRAME, complete, with lining. Includes bearing for lower end of controlling cylinder shaft	
14646	Hinge bolt with pin and nut for fastening cover to frame	.45
25755	CAP, for top of controller	
25756	Long stud fastening cap to frame and fastening check pawl for controlling cylinder(1/2 13, 43/2 Sp'l.)	.20
25757	Washer for stud $\left(\frac{7}{16}'' \times \frac{11}{16}'' \times \frac{1}{16}''$ thick) per 100	1.00
15519	Spring cotter for stud (3 ² / ₃ " x 3 ³)	2.00
25758	Short stud fastening cap to frame (1"-13, 25" Sp'l.)	.20

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50-4493 Parts of R Controllers

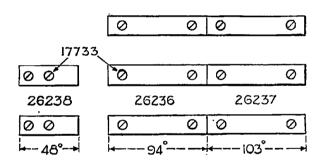
Parts of R 43-A Controller Continued

Cat. No.	Description	ist Price
11870	Nut for studs (1/2" 13, Hex. Fin. Std.)	\$0.16
5890	Screw fastening cap to bearing for no voltage release magnet (18-18, 3 F.H. Blued) per 100	2.00
25759	Pointer for controlling cylinder shaft with set screw	.70
25760	Set screw for No. 25759 (1/2 20. 10" Sp'l. Blued) per 100	5.00
25761	SHEET IRON COVER, complete	
14645	Slotted lug, for cover, with rivet	.10
25762	HINGED POLE PIECE	2.25
25763	Hinge pin, with spring cotter for pole piece (3/2 x 71/2 Sp'l.)	
15519	Spring cotter for pin $\left(\frac{3}{32}'' \times \frac{3}{4}''\right)$ per 1000	
9887	Cap screw fastening pole piece to frame (1/ 13, 11/ Hex. If Std.) per 100	
25764	ARC DEFLECTOR, complete	5.75
22774	Screw fastening arc deflector to pole piece (No. 10, 13" R. H. Blued) per 100	.50
25765	Insulating bushing used with No. 22774	.10
25766	Wide strip for arc deflector	.55
25767	Narrow strip for arc deflector	
25768	Division plate for arc deflector.	.60
13852	Screw fastening strips to division plates (No. 10, ⁷ / ₄ F. H.)	
25769	*BLOW OUT MAGNET, wound complete, (2 3.75 Amp.) includes terminals and leads. Spec	
20100	F-25989	5.00
25770	*BLOW-OUT MAGNET, wound complete, (3.75-7.5 Amp.) includes terminals and leads. Spec.	
25771	F-25987	
25772	F-25984 *BLOW OUT MAGNET, wound complete, (15 30 Amp.) includes terminals and leads. Spec.	
25773	F-25978 *BLOW-OUT MAGNET, wound complete, (30-55 Amp.) includes terminals and leads. Spec.	
25774	F25981 *BLOW-OUT MAGNET, wound complete, (55 80 Amp.) includes terminals and leads. Spec.	7 .00
	F–25982	7.50
25775	Copper terminal	.30
25776	*NO VOLTAGE RELEASE MAGNET, (115 volts) wound complete on bearing for controlling cylinder star wheel. Includes terminals and leads. Spec. F 25979	11.50
25777	*NO VOLTAGE RELEASE MAGNET, (230 volts) wound complete on bearing for controlling cylinder star wheel. Includes terminals and leads. Spec. F 25976	
25778	*NO VOLTAGE RELEASE MAGNET, (500 volts) wound complete on bearing for controlling cylinder star wheel. Includes terminals and leads. Spec. F-25986	
25779	Brass terminal for long lead	
25780	Brass terminal for short lead	.08
25781	Fiber cleat for fastening leads to cap plate. Includes two halves with two screws. No. 2592	
2592	Screw for No. 25781 (10 24, $\frac{3}{4}$ " R. H. Blued) per 100	
25782	*Overload Magnet, (2 3.75 Amp.) wound, complete. Includes contact base, contact spring, fiber	
20102	insulation, stud with pins, terminals No. 25775 and leads. Spec. F 25990	
25783	*Overload Magnet, (3.75 7.5 Amp.) wound, complete. Includes contact base, contact spring, fiber	
25784	insulation stud with pins, terminals No. 25775 and leads. Spec F 25988 *Overload Magnet, (7.5 15 Amp.) wound, complete. Includes contact base, contact spring, fiber	
05705	insulation, stud with pins, terminals No. 25775 and leads. Spec. F 25985	
25785	*Overload Magnet, (15 30 Amp.) wound, complete. Includes contact base, contact spring, fiber	
07-02	insulation, stud with pins, terminals No. 25775 and leads. Spec. F-25977	
25786	*Overload Magnet, (30 55 Amp.) wound, complete. Includes contact base, contact spring, fiber	
	insulation, stud with pins, terminals No. 25775 and leads. Spec. F-25980	
25787	*Overload Magnet, (55 80 Amp.) wound, complete. Includes contact base, contact spring, fiber insulation. stud with pins, terminals No. 25775 and leads. Spec. F 25983	
25788	Phos. Bronze contact spring	
6081	Screw fastening spring to contact base $(10-42, \frac{3}{2}"$ R. H. Blued) per 100 *Winding specification number stamped on each coil	.50
	•	

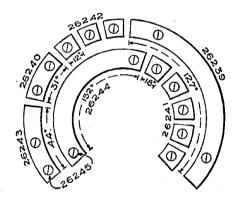
Parts of R Controllers 4493-51

Parts of R-43-A Controller-Continued

Cat. No.	Description	ist Price
13804	Double washer for No. 6081 per 10	0 \$3.00
6068	Binding screw for contact base and no-voltage magnet lead (10-24, ½" R. H. Blued) per 10	50
25789	Armature, complete, with hinge pin, copper contact, terminal No. 25775 and leads	.65
25790	Adjusting spring for armature, includes hook (26 turns, .0508" steel wire)	15
25791	Adjusting screw for No. 25790 (8-32, 23" Sp'l.) per 100	10.00
25792	Thumbnut for No. 25791 (8-32 Sp'l.)	20
25793	CONTROLLING CYLINDER, complete, with shaft, insulation disks and collar	32.50
39490	Complete set of copper contact segments, with screws.	-
	Contact segments and screws are listed below.	
25794	Insulation disk, upper	.30
25795	Releasing arm for cylinder with set screw	
25760	Set screw for No. 25795 (4"-20, 76" Sp'l.)) per 100	5.00
25796	Catch for No. 25795	
15212	Cap screw fastening catch to arm (3-16, 3" Hex. H.) per 100	
25797	Washer for No. 15212 (³ / ₈ x ¹¹ / ₁₆ x ³ / ₃₂ ") per 100	1.00
25798	Star wheel for controlling cylinder, includes spring for armature and spring stop	
25799	Spring for star wheel and armature (7 turns, .0414" steel wire)	.10
26168	Spring stop	
26169	Armature for star wheel, with stud	.85



CYLINDER DEVELOPMENT FOR R-43-A, R-45-A AND R-47-A CONTROLLERS.



RHEOSTAT SEGMENTS FOR R-43-A CONTROLLER,

Cat. No.	List Price	Cat. No.	·List Price
26236 26237 26238 26239 26240	\$0 .30 .30 .29 .79 .43	26241 26242 26243 26244	\$0 .28 .28 .49 .71
39490 39491 17733 26245	Complete set of Rheostat cyl Screw for segments, per 100.	ylinder segments, with screws inder segments, with screws	2 86 5 94 3 .00 8 .00

52-4493 Parts of R Controllers

Parts of R-43-A Controller-Continued

Cat. No.	Description	ist Price
26170	Catch for No. 26169	\$0.40
26171	Key for armature and catch $(\frac{1}{4}'' \times \frac{3}{10}'' \times \frac{1}{4}'')$	
10306	Nut fastening armature in position (718"-14 Hex. Brass) per 100	
26172	Lock washer for nut $\left(\frac{1}{5}\frac{5}{2}'' \times 1'' \times \frac{1}{32}''$ thick copper Sp'l.) per 100	
26173	Check pawl, with roller, for star wheel for controlling cylinder	
26174	Roller with pin	
13632	Tension spring for pawl, (26 turns, .091" steel wire)	
26175	Pin fastening spring to dash pot	
26176	Adjusting spring for controlling cylinder (64 turns, .144" steel wire)	
26177	Spring adjuster with pin	
26178	Adjusting pin for No. 26177 $(\frac{1}{4}" \times 1\frac{1}{4}")$.	
26179	DASH POT, complete, with plunger	
26180	Plunger	
26181	Spring for plunger (26 ¹ / ₂ turns, .0508" steel wire)	
308	Cap screw fastening dash pot to frame ($\frac{3^{\prime\prime}}{10}$ -16, 1" Hex. H. Std.)	
26182	Lock washer for No. 308 (² / ₈ Std.)	
26183	REVERSING CYLINDER, complete, with shaft, collars and star wheel	
26184	Wood body	
26185	_ •	
26186	Brass collar for body, with pin	
26187	Star wheel, with pin	
26188	Short contact	
1013	Long contact	
26189	Screw fastening contacts to wood body (No. 8, $\frac{3}{4}$ " F. H.) per 100 Check peud with collection and for standard for several factors.	
26174	Check pawl, with roller for star wheel for reversing cylinder	
26190	Roller with pin	
26191	Pivot pin for pawl	
15519	Washer for pin $(\frac{7}{16}'' \times \frac{5}{3}'' \times .062'')$ Brass)	
26 192	Spring cotter for pin $\left(\frac{3}{32}'' \times \frac{3}{4}''\right)$	
26192 26193	Tension spring for pawl (26½ turns, .0808" steel wire)	.05
26193 26194	Pin fastening spring to frame.	
20194	CONTROLLING CONTACT BOARD, complete, with reinforced contact fingers, includes finger	
26195	shield	
	Wood base	
19669	Screw fastening wood base to frame $(14-24, 14'' R. H.)$ per 100	
10147 26196	Washer for No. 19669 $(\frac{1}{4}'' \times \frac{1}{2}'' \times .062'')$ per 100	
26197	Contact finger, with shunt, locking spring and hinge	
26197	. Contact finger, with shunt, locking spring and rivets	
26198 26199	Locking spring	
26199 26200	Adjusting screw for finger (14–24, 1 ¹ / ₄ Sq. H. Slot.) per 100	
4030	Hinge pin for finger hinge $(\frac{5}{6}'' \times \frac{15}{6}'' \text{ Sp'l.})$	
26201	Spring cotter for No. 26200 $\left(\frac{3}{32}'' \times \frac{5}{8}''\right)$ per 1000	
	Contact base	
13852 26202	Screw fastening base to wood base (No. 10, $\frac{1}{8}$ " F. H.) per 100	
	Cap screw fastening finger to contact base $(\frac{5}{16}n-18, \frac{5}{8}n$ Hex. H. Slot.) per 100	8.00
26203 26204	Lock washer for No. 26202 $(\frac{11}{32}" \times \frac{3}{4}" \times \frac{3}{32}" \times \frac{1}{32}"$ thick copper Sp'l.) per 106	3.00
26204 26205	Compression spring for contact finger (9 turns .057" steel wire)	
26205	Finger shield	.55
13852	Screw fastening shield to wood base (No. 10, §" F. H.)	
26206	REVERSING CONTACT BOARD, complete with reinforced fingers, includes shield for cylinders	
26207	Wood base	
19669	Screw fastening wood base to frame (14-24, 1 ¹ / ₂ " R. H.) per 100	
10147	Washer for No. 19669 (¼" x ½" x .062") per 100) 1.00

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Parts of R-43-A Controller-Concluded

Cat. No.	Description	List Price
38427	Contact finger with spring	\$0.75
26208	Cap screw fastening finger to contact base (14-24, ½" Hex. H. Slot.) per 10	0 5.00
26209	Washer for No. 26208 $(\frac{17}{64}" \times \frac{1}{2}" \times \frac{5}{8}" \times \frac{1}{32}"$ thick copper) per 10	0 2.00
26210	Contact base	.40
1188	Long screw fastening base to wood base (No. 10, 1" F. H.) per 10	0 .50
13848	Short screw fastening base to wood base (No. 10, 3" F. H.) per 10	0 .50
25775	Copper terminal for contact base	30
26211	Cap screw fastening terminal to contact base (16"-18, 1" Hex. H. Slot.)	0 3.00
26203	Lock washer for No. 26211 $(\frac{11}{32}" \times \frac{3}{4}" \times \frac{3}{32}"$ thick copper) per 10	
26212	Shield for cylinder	55
1185	Screw fastening shield to reversing contact board (No. 8, §" R. H.) per 10	0.35
26213	CONNECTION BOARD, complete for Blow-out Magnet. Includes terminals and terminal block	s 2.25
26214	Wood base	60
19669	Screw fastening wood base to frame (14-24, 14" R. H.) per 10	0 1.00
10147	Washer for No. 19669 (¹ / ₄ " x ¹ / ₂ " x .062")	0 1.00
25775	Copper terminal	.30
26215	Terminal block	.25
13848	Screw fastening block to wood base (No. 10, 3" F. H.) per 10	
26202	Screw fastening terminal to block (⁵ / ₁₆ "-18, ³ / ₂ " Hex. H. Slot.) per 10	
26203	Lock washer for No. 26202 $(\frac{11}{32}'' \times \frac{3}{4}'' \times .031''$ copper)	0 3.00
26217	RHEOSTAT, complete	
39491	Complete set of copper contact segments, with screws	
	Contact segments and screws listed on page 51	-
26218	Spider with clamping screw	6.50
26219	Clamping screw for spider (1"-13. 15" Hex. II. Brass)	
26220	Key for spider $(1\frac{1}{4}'' \times \frac{3}{16}'' \times \frac{3}{16}'')$	05
26221	Contact post, complete, for outer circle	
26222	Contact post, complete, for inner circle	. 1.00
13990	Set screw for contact posts (14-24, 3" pointed headless) per 10	
25775	Copper terminal for contact posts	30
26211	Cap screw fastening terminal to post (5/16"-18, 1/2" Hex. H. Slot.) per 10	
26203	Lock washer for No. 26221 (11/32" x 3" x 3" x .031" copper) per 10	
26223	CONTACT SHOE, complete, in holder	
26224	Contact shoe, with shunt	50
26225	Shoe holder, with rivet	65
26226	Compression spring for shoe (5 turns, .035" steel wire)	
308	Cap screw fastening shoe holder in position (3"-16, 1" Hex. H.) per 10	
26182	Lock washer for No. 308 (§" Std.) per 10	
	· ·	

Parts of R-45-A Controller

8 .50
8.00
1.90
.65

54-4493 Parts of R Controllers

Cat. No.

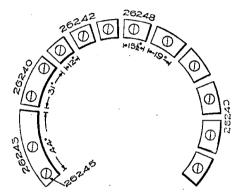
Parts of R-45-A and R-47-A Controllers-Concluded

Parts of R-47-A Controller

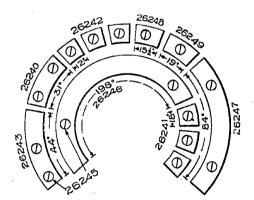
Description

List Price

	R-47-A CONTROLLER. (Includes operating and reversing handles.) Following are the interchangeable parts of the R-47-A Controller which differ from those of the R-43-A.	:
26227	CAP for top of controller	
26228	RHEOSTAT, complete\$	38.50
39493	Complete set of copper contact segments, with screws	
	Contact segments and screws for controlling cylinder are listed on page 51, for Rheostat see below	
26229		8.00



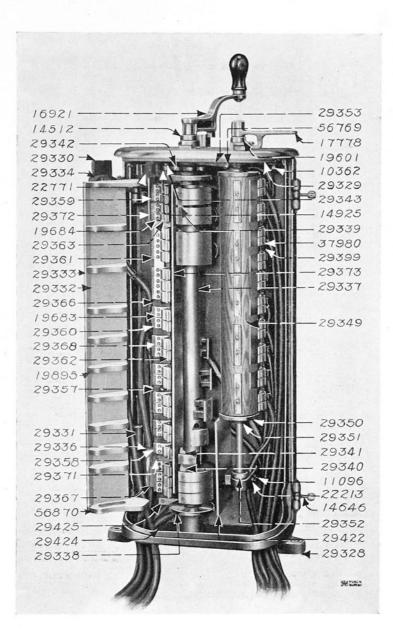
RHEOSTAT SEGMENTS FOR R-45-A CONTROLLER



RHEOSTAT SEGMENTS FOR R-47-A CONTROLLER

Cat. No.	List Price	Cat. No.	List Price
26240	\$0.43	26246	\$0.79
26241	.28	26247	.71
26242	.28	26248	.34
26243	.49	26249	.38
39492	Complete set of rheostat cyl	inder segments with screws	5.04
39493	Complete set of rheostat cylin	ider segments, with screws for	5.04
	the P 47 A controller		6.10
	ine K-ar-A controller		

Parts of R Controllers 4493-55



Parts of R-55-A Controller

Cat. No.

Description

List Price

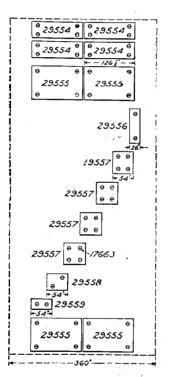
	R-55-A Controller, complete. (Includes supporting bracket with cap screws and washers for fa- tening controller to dasher.)	S-
16921	*Operating handle	\$4.15
17778	*Reversing handle	2.40
	Following are the interchangeable parts:	
	*Not included in complete controller, must be ordered separately.	

56-4493 Parts of R Controllers

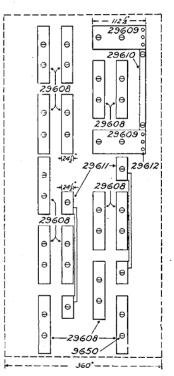
Parts of R-55-A Controller-Continued

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Cat. No.	Description	Lis	st Price
29328	Frame, complete		
14646	Hinge bolt with pin and nut for fastening cover to frame		\$0.45
11096	Binding screw for ground connection (14-24, §" R. H. Blued)		
22213	Check nut for No. 11096 (14-24, Hex. Flat. Brass)		
29329	Cap for top of controller		
322	Screw fastening No. 29329 to frame (3"-16, 1" F. H.)	per 100	2 .00
10362	Cap screw fastening No. 29329 to frame (3"-16, 3" Hex. H. Slot.)	per 100	7.00
14512	WATER CAP AND POINTER for controlling cylinder shaft with set screw		1.25
19601	Water cap for reversing cylinder shaft with set screw		1.00
14410	Set screw for Nos. 14512, 19601 (5 -18, 32" Sp'l. Blued)	per 100	5.00
29427	SHEET IRON COVER, complete		14.00
14645	Slotted lug for cover with rivets		.10
29330	Hinged pole piece		8.75



OPERATING CYLINDER.



REVERSING CYLINDER.

Cat. No.	List Price.	Cat. No.	List Price.	Cat. No.	List Price.	Cat. No.	List Price.
29554 29555 29556	\$.84 1.28 .54	29557 29558 29559	\$.62 .54 .46	29608 29609 29610	\$1.00 1.35 1.35	29611	\$2.28
37690 17663	1	et of segments, with screws egments, per 100	12.75 .75	37691 9650 29612	Complete set of segments, with screws and rivets Screw for Segments, per 100 Copper rivets, per 100		20.92 1.50 .40

Parts. of R Controllers 4493-57

Parts of R-55-A Controller-Continued

Cat. No.	Description	
		ist Price
29331	Hinge for pole piece	\$0.75
51726	Screw fastening hinge to pole piece (⁵ / ₁₆ "-18, ⁵ / ₈ " F. H.) per 100	· 5 .00 ف
22771	Spring catch complete, with two screws, for pole piece	.30
22772	Screw for No. 22771 (10-24, 3" F. H.) per 100	.65
29335	ARC DEFLECTOR, complete	9 .00'
13846	Screw fastening arc deflector to pole piece (No. 10. 1 ¹ / ₈ " R. H. Blued) per 100	
13635	Insulating bushing used with No. 13846.	.05
29332	Wide strip for arc deflector	2.75
29333	Narrow strip for are deflector	
56870 19895	Large division plate	.30
	Small division plate	
13848	Screw fastening strips to division plate (No. 10, ³ / ₄ " F. H.)	.5
29334 10029	MAGNET SPOOL, wound complete, with leads and connector	35.00
19932	Two-way connector for lead	.45
11096	Binding screw for No. 19932 (14-24, §" R. H. Blued) per 100	.65
29336	Fiber insulation sleeve for lead	.10
29337 37690	CONTROLLING CYLINDER, complete, with shaft, insulation disks, shields, collar and star whee	67.00
91090	Complete set of copper contact segments with screwsper se Contact segments and screws for same are listed on page 56.	12.75
29338	Insulation disk	
29339	Insulation block for cylinder, large	
29340	Insulation block for cylinder, medium.	
29341	Insulation block for cylinder, small	1.15
25541 861	Screw fastening blocks to cylinder (8–32, §" F. H.)	•
17741	Collar for shaft with pin	
29342	STAR WHEEL with pin must be fitted	.30
20343	Check pawl with roller for controlling cylinder.	1.35 .40
14925	Roller with pin	
29344	Pivot pin for pawl (³ / ["] -16, thread Sp'l.)	
29345	Washer for pin $(\frac{7}{16}'' \times 1'' \times .062'')$	4.00
16118	Spring cotter for pin $(\frac{1}{8}'' \times \frac{3}{4}'')$	2.00
29346	Tension spring for pawl (31 turns, .091" steel wire)	.06
29347	Pin fastening spring to cap plate (14-24, thread Sp'l.)	
29348	REVERSING CYLINDER, complete, with shaft, insulation disks, collar and star wheel	52.00
37691	Complete set of copper contact segments with screws, and rivetsper set	20.92
	Contact segments and screws for same are listed on page 56.	
29349	Wood body	1.50
29350	Insulation disk	.45
29351	Collar with pin for shaft and wood body	
29352	Collar with pin for shaft and bearing	.20
471	Screw fastening No. 29351 to wood body (No. 8, 14" F. H.) per 100	.25
56769	Star wheel with pin; must be fitted	.50
29353	Interlock pawl with pin for spring	
29354	Pin for pawl spring	
29355	Pivot pin for pawl	
29345	Washer for pin $(\frac{7}{16}'' \times 1'' \times .062'')$ per 100	4.00
16118	Spring cotter for pin $(\frac{1}{2}'' \times \frac{3}{4}'')$	
29346	Tension spring for pawl (31 turns, .091" steel wire)	
37731	Pin fastening spring to cap plate (14-24, thread Sp'l.)	
29356	CONTROLLING CONTACT BOARD, complete, includes finger shield and shield for upper	
	end of board	37.00
29357	Wood hase	
56740	Screw fastening wood base to frame (14-24, 1 ¹ / ₂ " R. H.) per 100	
14426	Washer for No. 56740 $(\frac{17}{64}" \times \frac{1}{2}" \times .062"$ Brass) per 100	
29358	Contact base, small, for two screws	.35

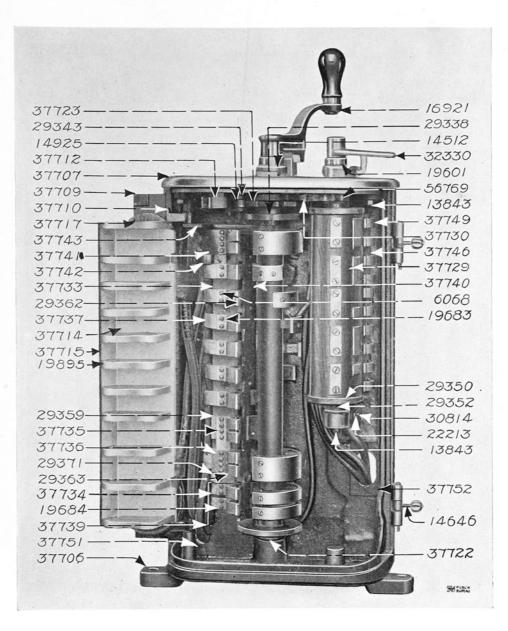
58-4493 Parts of R Controllers

Parts of R-55-A Controller-Concluded

Cat. No.	Description	ist Pric _e
29359	Contact base, large, for two screws	\$0.45
29360	Contact base for three screws	.55
29361	Contact base for four screws	75
1188	Screw fastening contact base to wood base (No. 10, 1" F. H.) per 100	.50
29362	Wide contact finger with spring	40
29363	Narrow contact finger with spring	.34
6068	Screw fastening wide finger to base (10-24, 1/2 R. H. Blued)per 100	.50
23691	Screw fastening narrow finger to base (8-32, 1/2 R. H. Blued) per 100	.50
19683	Double washer for No. 6068 per 100	2.00
19684	Double washer for No. 23691 per 100	1.00
29366	Copper connection strip for wide contact fingers	30
29367	Copper terminal for three fingers, front of board	.25
29368	Copper terminal for two fingers, front of board	15
29369	Copper terminal for three fingers, side of board	.25
29370	Copper terminal for one and two fingers, side of board	
29371	Fiber block between fingers	.15
56825	Screw fastening block to wood base (No. 8, 3" R. H. Blued) per 100	.60
29372	Fiber shield for upper end of board	15
1013	Screw fastening shield to wood base (No. 8, 3" F. H.) per 100	.40
29373	Finger shield	.45
10296	Screw fastening finger shield to board (No. 10, 14" R. H.) per 100	.50
29374	Fiber shield for connection cables to contact board	.30
19645	Screw fastening No. 29374 to contact board (No. 8, 2" R. H.) per 100	.40
29398	REVERSING CONTACT BOARD, complete, with reinforced fingers	16.50
29399	Wood base	
51652	Screw fastening wood base to frame (14-24, 13" R. H.) per 106	2.00
14426	Washer for No. 51652 (11 x 1 x .062" Brass) per 100	1.00
29420	Contact base	.75
10214	Screw fastening base to wood base (No. 8, 3" F. H.) per 100	
37980	Contact finger with spring	
14434	Screw fastening finger to base (8-32, §" R. H. Blued) per 100	
29421	Double washer for No. 14434 per 100	
29422	Insulation shield between cylinders includes supporting block	
11096	Screw fastening shield to supporting block (14-24, §" R. H. Blued) per 100	
14426	Washer for No. 11096 (17/1 x 1/2" x .062" Brass) per 100	
29423	Screw fastening supporting block to frame (14-24, 14" F. H.) per 100	
29424	Wire guard	
18	Screw fastening wire guard to frame(10-24, 1/2" R. H.) per 100	
29425	Fiber cleat for holding wires to frame	
29426	Screw fastening cleat to frame (10-32, 1 ¹ / ₄ " F. H.)per 100	
14963	Bracket fastening controller to dasher	
439	Cap screw fastening bracket to controller (1/2"-13, 1" Hex. H.) per 100	
37753	Washer for No. 439 (96" x 2" x .062") per 100	4.00

Parts of R Controllers_4493-59



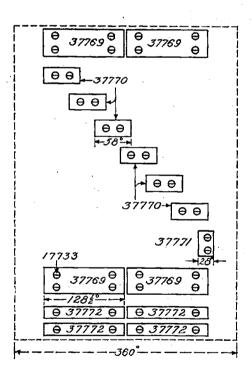


Cat. No.	Description	List Price
	R-60-A Controller (rheostatic) complete, includes supporting bracket with cap screws and wash for fastening controller in position.	ers
16921	*Operating handle	
32330	*Reversing handle	. 3.25
	Following are the interchangeable parts:	
37706	Frame, complete, fitted with bearing and cap screws for reversing cylinder shaft *Not included in complete controller; must be ordered separately.	

60-4493 Parts of R Controllers

Parts of R-60-A Controller-Continued

Cat. No.	Description	ist Price
13843	Cap screw fastening bearing to frame (2"-16, 1" Hex. H. Slot.) per 100	\$5.00
30814	Binding screw for ground connection (14-24, 3" R. H. Round Point Blued) per 100	1.00
22213	Check nut for No. 30814 (14-24, Hex. Flat Brass) per 100	1.50
14646	Hinge bolt with pin and nut for fastening cover to frame	.45
37707	Cap for top of controller	
322	Screw fastening No. 37707 to frame (§"-16, 1" F. H.) per 100	2.00
13843	Cap screw fastening No. 37707 to frame (3"-16, 1" Hex. H. Slot.) per 100	5.00
14512	WATER CAP AND POINTER with set screw, for controlling cylinder shaft	1.25
19601	Water cap with set screw for reversing cylinder shaft	1.00
14410	Set screw for Nos. 14512, 19601 (5"-18, 32" Blued Sp'l.) per 100	
37708	SHEET IRON COVER, complete	9.50
14645	Slotted lug for cover, with rivet	.10
37709	Hinged Pole Piece, complete, with hinge brackets	8.00
37710	Hinge bracket	.75
37711	Screw fastening hinge bracket to pole piece. (15"-18, 1" F. H.) per 100	1.25
37712	Spring catch, complete, with two screws, for pole piece	.20



Cat. No.	List Price.	Cat. No.	List Price.
37769	\$0 .65	37771	\$0 .26
37770	.24	37772	.32
37719	Complete set of seg	6.72	
17733	Screw for Segment	3.00	

Parts of R Controllers 4493-61

Parts of-R-60-A-Controller-Continued

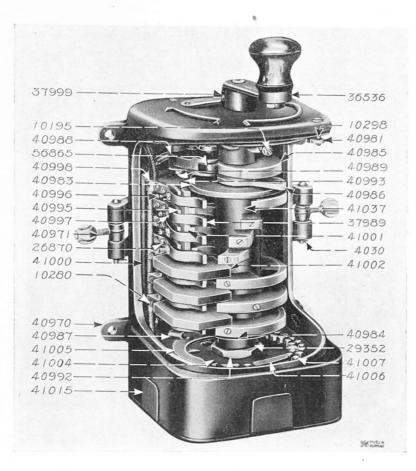
Cat. No.	Description	List Pric
306	Screw for No. 37712 (10-24, ³ / ₄ " F. H.) per 1)0 \$3 .0 0
37713	Arc Deflector, complete	7.00
13846	Screw fastening arc deflector to pole piece (No. 10, 11" R. H. Blued) per l	.60
13635	Insulating bushing used with No. 13848	05
37714	Wide strip for arc deflector	. 2.25
37715	Narrow strip for arc deflector	1.00
19895	Division plate for arc deflector	
13848	Screw fastening strips to division plate (No.10, ³ / ₄ " F. H.)	
	Site in alterning strips to division plate (No.10, 7 F. 11).	
37716	Fiber insulating between wide strip for arc deflector and pole piece	22 00
37717	BLOW-OUT COIL, wound, complete, with leads and connector	. 23.00
56713	Two-way connector for lead	00
-50428	Binding screw for No. 56713 (14-24, ½" R. H. Blued) per 10	0.75
37718	CONTROLLING CYLINDER, complete, with shaft, insulation disks, shields, collar and st	ar
	wheel	. 46.00
37719	Complete set of copper contact segments, with screws per s	et 6.72
	Contact segments and screws for same are listed on page 60	
29338	Insulation disk	
.37720	Insulation block for cylinder, large	80
37721	Insulation block for cylinder, medium	
29341	Insulation block for cylinder, small	
861	Screw fastening blocks to cylinder (8–32, §" F. H.)	
37722	Collar for shaft, with pin	
37723	STAR WHEEL, with pin, must be fitted	
29343	Check pawl with roller for controlling cylinder	
14925	Roller with pin	10
,		-
29344	Pivot pin for pawl $(\frac{3}{2}''-16 \text{ thread Sp'l.})$	
29345	Washer for pin $(\frac{7}{16}'' \times 1'' \times .062'')$	0 2.00
15519	Spring cotter for pin $\left(\frac{3}{32}'' \times \frac{3}{4}''\right)$ per 100	
-33778	Tension spring for pawl (20 turn, .091" steel wire)	05
29347	Pin fastening spring to cap plate (14-24 thread Sp'l.)	10
.37724	REVERSING CYLINDER, complete, with shaft insulation disks, collar and star wheel	. 33.00
37725	Complete set of copper contact segments with screwper s	
37726	Contact segment for four screws	
37727	Large contact segment for two screws	1.10
.37728	Small contact segment for two screws	40
13848	Screw fastening segments to wood body (No. 10, 3" F. H.) per 10	00 .50
.37729	Wood body	1.00
29350	Insulation disk	45
13848	Screw fastening No. 29350 to wood body (No. 10, 3" F. H.) per 10	.50
29352	Collar with pin	20
56769	Star wheel with pin. must be fitted	50
.37730	Interlock pawl with pin for spring	. 1.90
29354	Pin for pawl spring	06
29355	Pivot pin for pawl	15
29345	Washer for pin $(\frac{7}{16}" \times 1" \times .062")$	0 4.00
	Spring cotter for pin $\left(\frac{16}{32}'' \times \frac{3}{4}''\right)$	0 2.00
15519	Tension spring for pawl (20 turns, $.091''$ steel wire)	05
.33778	Pin fastening spring to cap plate (14-24, thread Sp'l.)	10
37731	CONTROLLING CONTACT BOARD, complete, with contact bases, without fingers	19.50
.37732	UNIKOLLING CONTACT DOARD, complete, with contact bases, without highs	19.50
37733	Wood base	1 1 00
19669	Screw fastening wood base to frame (14–24, 1 ¹ / ₄ " R. H)	0 1.00
14426	Washer for No. 19669 (17 x 1/2 x .062" Brass)	0 1.00
37734	Contact base, small, for one finger	. 30
:29358	Contact base, large, for one finger	. 35

62-4493 Parts of R Controllers

Parts of R 60 A Controller Concluded

Cat.No.	Description Li	st Price
29359	Contact base, for two fingers	\$0.45
1188	Screw fastening contact base to wood base (No. 10, 1" F. H.) per 100	.50
29362	Wide operating contact finger, with spring	.40
29363	Narrow operating contact finger, with spring	.34
6068	Screw fastening finger to base (10 24, 1/ R. H. Blued) per 100	.50
19683	Large double washer for No. 6068 per 100	2 .00
19684	Small double washer for No. 6068 per 100	
37735	Copper connection strip for four fingers	.25
37736	Copper terminal for two fingers, front of board	.15
37737	Copper terminal for one finger, front of board	.10
37738	Copper terminal for one finger, side of board	.10
29371	Fiber block between fingers	.15
56825	Screw fastening block to wood base No. 8, 3" R. H. Blued) per 100	.60
37739	Fiber shield for lower end of contact board	.12
56825	Screw fastening shield to board (No. 8, 3" R. H. Blued) per 100	.60
37740	Finger shield, with spacing blocks	1.15
10296	Screw fastening finger shield to contact board (No. 10, 14" R. H.) per 100	.50
37741	Fiber shield for blow-out coil leads to contact board	.15
6081	Screw fastening No. 37741 to frame (10-24, 3" R H. Blued) per 100	.50
37742	Fiber clamp for blow out coil leads to contact board	.20
1187	Screw fastening No. 37742 to contact board (No. 10, 5" R. H.) per 100	1.00
37743	Trolley shield	.45
51400	Screw fastening trolley shield to contact block (No. 10, 7" R. H. Blued) per 100	.75
37744	Insulation strip under contact board	.30
37745	REVERSING CONTACT BOARD, complete with contact bases, without fingers	8.00
37746	Wood base	.75
19691	Screw fastening wood base to frame (14 24, 1 ¹ / ₈ " R. H.) per 100	1.00
14426	Washer for No. 19691 $\binom{17}{64}$ x $\frac{17}{2}$ x .062" Brass)	1.00
37747	Contact has with $\frac{5}{16}''$ hole for connection wire	.40
37748	Contact hase with $\frac{11}{32}''$ hole for connection wire.	.40
13848	Screw fastening base to wood base (No. 10, ² / ₄ " F. H.) per 100	.50
37749	Reinforced reversing contact finger, with spring	.16
23691	Screw fastening finger to base (8 32, ¹ / ₂ R. H. Blued per 100	.50
13804	Double washer for No. 23691 per 100	3.00
37751	Wire guard for controlling contact board	.15
37752	Wire guard for reversing contact board	.15
10076	Screw fastening wire guard to frame (10 32, ³ / ₈ " F. H.) per 100	.50
14963	Bracket fastening controller to dasher	.45
439	Cap screw fastening bracket to controller $(\frac{1}{2}$ 13, 1" Hex. H.) per 100 Weaker for No. 420 ($\frac{1}{2}$ x 11" x 062")	8 .00 4 .00
37753	Washer for No. 439 $\binom{9}{16}$ x $1\frac{17}{2}$ x .062") per 109	4.00

Parts of R Controllers 4493-63



Parts of R-75-A Controller

Cat. No.

Description

List Price

	R75A Controller, complete, with operating handle	
	Following are the interchangeable parts	
36536	Operating handle, malleable iron with set screw	\$3.00
37999		
40970	FRAME, complete, includes spring and pawl posts and lining	
40971	Hinge bolt with pin and nut for fastening cover to frame	.35
4030	Spring cotter for No. 40971 (32" x 5")	2.00
38002	SHEET IRON COVER, complete	5.00
14645		.10
40972	RESISTANCE COIL, complete for R-75-A, 2HP, 125 volt controller	6.25
40973	Resistance coil, complete, for R-75-A, 5 HP, 125 volt controller	6.50
40974	Resistance coil, complete, for R-75-A. 2 HP, 250 volt controller	5.25
40975	Resistance coil, complete, for R-75-A, 5 HP, 250 volt controller	5.25
40976	Resistance coil, complete, for R-75-A, 2 HP, 500 volt controller	11.50
40977	Resistance coil, complete, for R-75-A, 5 HP, 500 volt controller	9.00
40978	물질을 즐길 수 있는 것을 물러 여러 집에 가지 않는 것을 다 나라는 것이 한 것이다. 그는 것이 같아 집에 가지 않는 것을 것 같아. 이 것을 것 같은 것 같아. 것이 같아. 것은 것이 같아. 같이 같이 같이 같이 같아. 같이 같이 같아. 같이 같이 같아.	2.00
0 979	Binding post, complete, for Nos. 40973, 40974, 40975, 40976, 40977per 100	2.00

64-4493 Parts of R Controllers

Parts of R-75-A Controller-Continued

Cat. No.	Description	ist P
	-	
10195 40980	Binding screw for Nos. 40978, 40979 (10-32, $\frac{5}{16}$ " R H. Brass) per 100	
	Mica insulation for resistance coil	
40981	Supporting strip for resistance coil	
10298	Screw fastening No. 40981 to frame $(14-24, \frac{5}{6}"$ F. H.)	
41037	CONTROLLING CYLINDER, complete, with shaft, insulation disks, collar, star wheel, cylin	
	der stop and field controlling dial contact	
40982	Complete set of copper contact segments with screws and pins	•
	Contact segments and screws for same are listed on page 65	
40983	Insulation disk, upper	
40984	Insulation disk, lower	
29352	Collar for shaft, with pin	
40985	Star wheel with pin; must be fitted	
40986	Cylinder stop	
14246	Screw fastening No. 40986 to star wheel (10-32, §" F. H.) per 10	
40987	Field controlling dial contact	
10297	Screw fastening No. 40987 to cylinder (10-32, §" R. H. Blued) per 100	
40988	Check pawl with roller for star wheel	
56865	Roller with pin	
40989	Pivot pin for pawl	
21392	Washer for pin $(\frac{132''}{32} \times \frac{37''}{2} \times .060')$	
4030	Spring cotter for pin $\left(\frac{3}{32}'' \times \frac{5}{3}''\right)$ per 100	
40990	Tension spring for pawl (30 turns, $.102''$ black steel wire, $\frac{9}{16}''$ outside diameter, closed)	
33779	Pin fastening spring to frame	•
40991	Bearing for cylinder shaft	
40992	Adjusting nut for bearing (14"-18, 3" thick, Hex. Brass Cham. both sides)	
40993	CONTROLLING CONTACT BLOCK, complete, with contact bases only	5
40994	Screw fastening No. 40993 to frame (10-32, 1 ¹ / ₄ " R. H.) per 100	
38890	Washer for No. 40994 (137 x 132" x .044") per 100)
37989	Unreinforced contact finger, with spring	
40995	Finger stop	
26870	Screw fastening Nos. 37989, 40995 to contact block (10-24, §" R. H. Blued) per 100)
40996	Adjusting screw for contact finger (8-32, 3" R. H. Blued) per 100)
40997	Check nut for No. 40996 (8-32, 1/2" thick Hex. Cham. both sides. Blued) per 100	
40998	Copper terminal for front of board	
40999	Copper terminal for back of board	
41000	Insulation strip under contact block	
41001	Finger shield	
41002	Fiber barrier for fingers	
10280	Screw fastening No. 41002 to contact block (No. 8, 14" F. H. Blued) per 100)
41003	FIELD CONTROLLING DIAL, complete.	14
41004	Slate base	
41005	Contact segment, large	1
41006	Contact segment, small	
41007	Contact post	
41008	Connection stud for Nos. 41006, 41007	
41009	Long connection screw for No. 41005 (8-32, 11" F. H. Brass) per 100) 1
41010	Short connection screw for No. 41005 (8-32, 1 ¹ / ₄ " F. H. Brass) per 100) 1
41011	Nut for Nos. 41008, 41009 (8-32, ¹ / ₈ " thick, Hex. Cham. both sides) per 100) 1
41012	Lock washer for No. 41011 (13 x 3 x .050" Ph. Brz.) per 100) -
695	Screw fastening Nos. 41005, 41006 to base $(8-32, \frac{1}{2}"$ R. H.) per 100)
33796	Washer for No. 695 $(\frac{3}{16}'' \times \frac{3}{8}'' \times .030''$ Brass)	,)
41013	Large binding post with binding screws)
41014	Small binding post with binding screws	
708	Binding screw for Nos. 41013, 41014 (8-32, §" R. H. Brass) per 100	
51633	Screw fastening No. 41013 to base $(14-24, \frac{3}{2}" R. H.)$	

ADDENDUM

To Accompany Bulletin No. 4493

PARTS OF R CONTROLLERS

 Page 72: To the list of interchangeable parts of the R 86-B controller should be added the following:

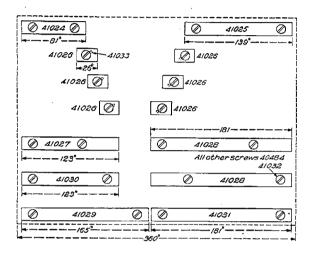
 Cat. No.
 List Price

 56828
 Magnet Spool, wound, complete, each...
 \$14.00

Parts of R Controllers 4493-65

Parts of R-75-A Controller-Concluded

Cat. No.	Description	•	Lis	t Price
. 14426	Washer for No. 51633 $(\frac{17}{64}" \times \frac{1}{2}" \times .062"$ Brass)		per 100	\$1.00
22780	Lock washer for No. 51633 (17 x 1/2 x .062" Ph. Brz.)			
13506	Screw fastening field controlling dial to frame (3"-16, 14" R. H.)		per 100	1.00
21392	Washer for No. 13506 $(\frac{13}{32}'' \times \frac{3}{4}'' \times .062'')$		per 100	.50
41015	Cover for base of frame			2.00
23691	Screw fastening No. 41015 to frame (8-32, ½" R. H. Blued)		per 100	.50

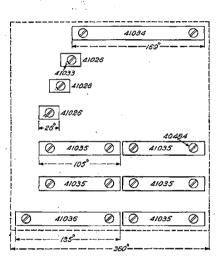


Cai. No.	List Price	Cat. No.	List Price
41024	\$0.28	41028	\$0.40
41025	.35	41029	.38
41026	.18	41030	.34
41027	.34	41031	.40
40982	Complete set of segments	with screws and pins	4.57
40484	Screw for segments, per	100	3.00
41032	Screw for segments, per	100	3.00
41033	Pin for segments, per 10	- C	.50

66-4493 Parts of R Controllers

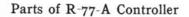
Parts of R-76-A Controller

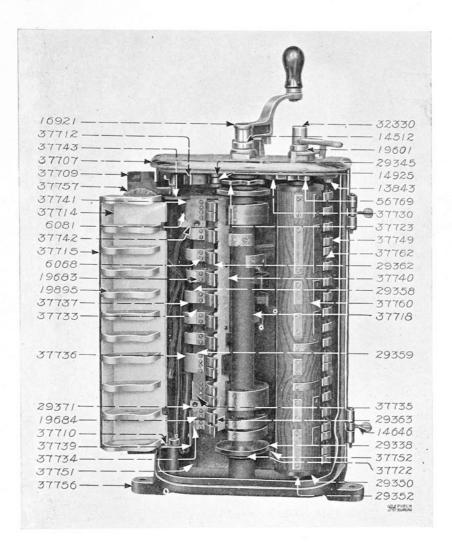
Cat. No.	. Description List Pric	е .
	R-76A Controller, complete, with operating handle	
	Following are the interchangeable parts of the R-76-A Controller which differ from those of the R-75-A:	
41016	FRAME, complete, includes spring and pawl posts and lining	
41017	CONTROLLING CYLINDER, complete, with shaft, insulation disks, collar, star wheel, cylinder	
	stop and field controlling dial contact)
41018	Complete set of copper contact segments with screws and pins	
	Contact segments and screws for same are listed below	
41019	Cylinder stop)
41020	FIELD CONTROLLING DIAL, complete	\$
41021	Slate base	
41022	Contact segment, large	-
41023	Contact segment, small	



Cai. No.	List Price .	Cat. No.	List Price
41026	\$0.18	41035	\$0.32
41034	.40	41036	.35
41018	Complete set of segments,	-	3.33
41033	Pin for segments, per 100		.50
40484	Screw for segments, per		3.00

Parts of R Controllers 4493-67





Cat. No.

Description

List Price

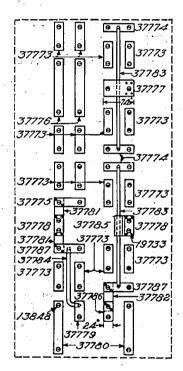
	R-77-A CONTROLLER (rheostatic) complete, includes supporting bracket with cap screws	
	and washers for fastening controller in position.	
16921	*Operating handle	\$4.15
32330	*Reversing handle	3.25
	Following are the interchangeable parts of the R-77-A Controller which differ from those of the R-60-A:	
37756	FRAME, complete	
37757	BLOW-OUT COIL, wound, complete, with leads and connector	19.50
56711	Two-way connector for lead	.25
6068	Binding screw for No. 56711 (10-24, 1/2" R. H. Blued) per 100	.50
37758	REVERSING CYLINDER, complete, with shaft, insulation disks, collar and star wheel	46.00
37759	Complete set of copper contact segments with connectors, screws and pins	
	Contact segments and screws for same are listed on page 68.	
	에는 것이라 한 것에서 바람이 있는 것이 가지 않는 것이다. 이 것이 가지 않는 것이다. 가지 않는 것이라 가지 않는 것이라 가지 않는 것이라. 것이라 있는 것이라 있는 것이다.	

*Not included in complete controller; must be ordered separately.

68-4493 Parts of R Controllers

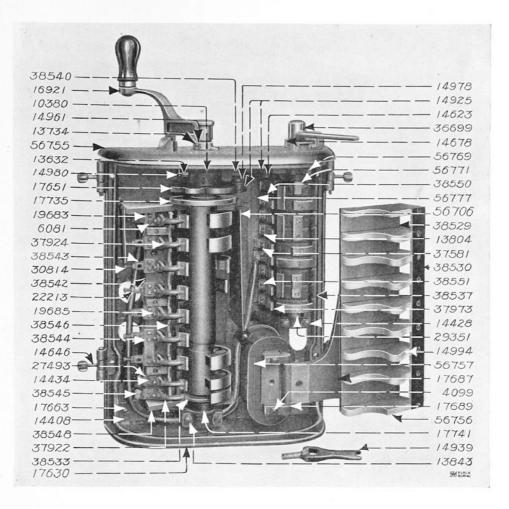
Parts of R-77-A Controller-Concluded

Cat. No.	Description	List Price
37760	Wood body	\$1.45
37761	REVERSING CONTACT BOARD, complete, with contact bases, without fingers	16.00
37762	Wood base	1.25
19646	Screw fastening wood base to frame (14-24, 1" R. H.) per	
37763	Contact base with $\frac{7}{32}$ hole for connection wire	40
37764	Contact base with $\frac{5}{16}$ " hole for connection wire	40
37765	Contact base with $\frac{5}{16}$ " hole for connection wire, drilled for grounding screw	45
37766	Contact base not drilled for connection wire	
37767	Grounding screw for No. 37765 (14-24, 13/ F. H.) per	
37768	Connector for two fingers per	100 1.00
33815	Double washer for screw fastening finger to base per	100 .70



Cat. No.	List Price.	Cat. No.	List Price.
37773 37774 37775 37776 37777 37778 37778 37779 37780	\$0.69 .68 .68 .75 .76 .66 .66 .73	37781 37782 37783 37784 37785 37785 37786 37786 37787	\$0.71 .65 .17 .13 .71 .66 .68
37759 13848 19733	Complete set of Segme Screw for Segments, p Pin for Segments, per.	screws and pins	\$24.44 .50 .20

Parts of R-86-A Controller



Cat. No.

Description

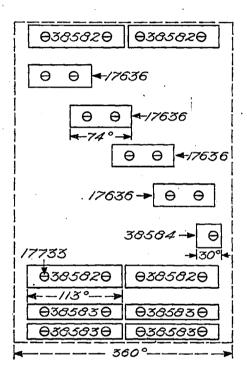
List Price

	R-86-A Controller, complete, includes supporting bracket, with cap screws and washers for fasten-	
	ing controller to dasher.	
16921	*Operating handle	\$4.15
36699	*Reversing handle	3.00
56752	*Reversing hand-wheel	4.75
	Following are the interchangeable parts:	
17630	FRAME, fitted with bearing caps and cap screws for controlling and reversing cylinder shafts	
13843	Cap screw fastening controlling shaft bearing cap to frame (3"-16, 1" Hex. H. Slot.) per 100	5.00
14428	Cap screw fastening reversing shaft bearing cap to frame, $(\frac{5}{16}''-18, 1\frac{1}{5}''$ Hex. H. Slot.). per 100	8.00
17663	Binding screw for ground connection (14-20, §" R. H. Blued) per 100	.75
14408	Check nut for No. 17663 (14-20, Hex. Flat Brass)	1.50
14646	Hinge bolt with pin and nut for fastening cover to frame	.45
56755	Cap for top of controller	
10379	Screw fastening No. 56755 to frame (14-20, 2" F. H. Brass) per 100	2.00
	*Not included in complete controller, must be ordered separately.	

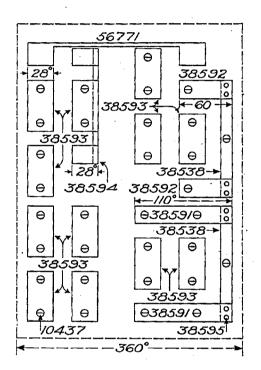
72-4493 Parts of R Controllers

Parts of R-86-B Controller

Cat. No.	Description	List Price
	R-86-B Controller, complete, includes supporting bracket, with cap screws and washers for fas- ing controller to dasher	sten-
16921	*Operating handle	
36699 56752	*Reversing handle	



CONTROLLING CYLINDER



REVERSING CYLINDER

I	Cat. No.	List Price	e	Cat: No.	List Price	Cat. No.	List Price
	17636 38582 38583 38584	\$0.23 .66 .60 .48	-	38538 38591 38592 38593	\$0.25 .38 .34 .33	38594 56771	\$0.60 1.50
38532Complete set of segments, with screws17733Screw for segments, per 100		7.20 3.00	38536 10437 38595	Complete set o with screw Screw for segn Copper rivets,	vs and rivets nents, per 100	7.15 1.00 .40	

	Following are the interchangeable parts of the R-86-B Controller which differ from those of the R-86-A:	
38552	CONTROLLING CONTACT BOARD, complete, with contact bases, without fingers \$6	.00
38553	Tanua anatast has	.25
33802	Unreinforced operating contact finger, with spring 1" wide	.20
37914	Unreinforced operating contact finger, with spring $\frac{3}{4}''$ wide	.18
37969	Unreinforced reversing contact finger, with spring	.12
	*Not included in complete controller; must be ordered separately.	

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General Electric Company Schenectady, N.Y.

MAIN LAMP SALES OFFICES, HARRISON, NEW JERSEY

March, 1907

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EDISON "GEM" HIGH EFFICIENCY INCANDESCENT UNITS With Bowl Holophanes

Edison GEM Incandescent Units, through their large use and wide application, have established themselves as the most effective and desirable electric lighting devices available. These Units are, as is well known, a

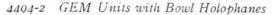
various sizes and give a powerful illumination of high brilliancy and of agreeable color and softness.

To the two forms of Holophane reflectors, the Concentrating and Distributing,



Fig. I-VIEW IN DEPARTMENT STORE Illuminated by GEM Units Fitted with Bowl Holophane Reflectors

simple combination of high efficiency GEM filament lamps of high candle-power with scientifically designed reflectors of the Holophane type. They therefore possess all the simplicity of the ordinary incandescent lamp and are inexpensive in first cost as well as in operation and renewal. They are made in heretofore employed with these units, **a** new line of Holophanes has been added. These new reflectors, known as the form "B" or Bowl Holophanes, from their resemblance to an inverted bowl, will greatly increase the effectiveness and range of application of the Incandescent Units by



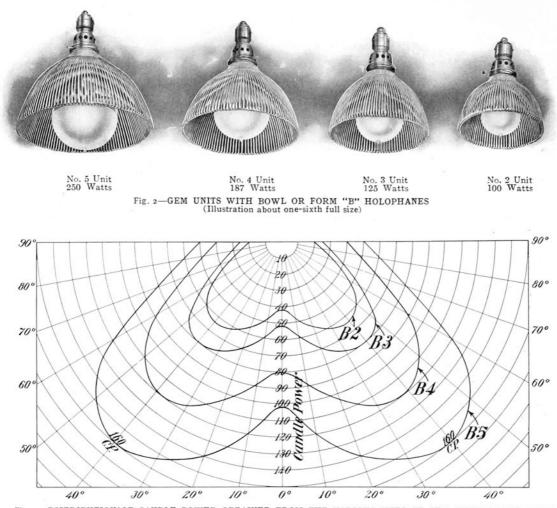


Fig. 3-DISTRIBUTION_OF CANDLE POWER OBTAINED FROM THE VARIOUS SIZES OF GEM UNITS FITTED WITH BOWL HOLOPHANES

the excellent character of light distribution secured.

As may be seen from the candle-power distribution curves (Fig. 3) the Bowl Holophanes secure an ideal form of light distribution by throwing the light down and spreading it out. The large volume of light given at the relatively useless angles of 10 to 20 degrees below horizontal (by the Distributing Reflector) is brought down and spread out at the more useful angles of 45 to 60 degrees from horizontal. Higher values and a wider area of uniform light distribution is thus obtained *beneath* the lamp than is given by any other form of reflector or electric lamp available for uniform lighting Incandescent Units with Bowl Holophanes can be placed for uniform lighting a distance apart equal to twice their height above the plane of illumination.

The bowl form of Holophane presents a graceful appearance in that it follows the lines of the lamp more closely than other forms of reflectors. The lamp is well hooded with the Bowl Holophane, which softens the light and eliminates glare, so that clear lamps can be satisfactorily used. All things considered, the Bowl Holophane should be the preferred reflector for general illumination.

GEM Units with Bowl Holophanes 4494-3

SIZES AND PRICES

The regular GEM Incandescent Units are made in the four sizes shown in the following table. The bulbs of the lamps are regularly supplied "Bowl" frosted (i.e., frosted on the lower end of the bulb or bowl of lamp). For use with the form "B" Holophane, clear bulb lamps are recommended, and must be specified if desired, as otherwise bowl frosted lamps will be sent.

GEM INCANDESCENT UNITS AND BOWL HOLOPHANES TABLE OF SIZES AND PRICES

											List Price	
Type No. of Lamp		Total Watts per Lamp	Size of Lamp Bulb Maximum Diameter	No. Lamps in Stand. Package	Type No. Form "B" Holophane Reflector	Diameter of Reflector	Distributed Candle Pr. in down- ward di- rection		ent Lamp n Base	Bowl Holoph'nes (Stnd. Pkg.		
				·				-		Plain	Frosted	Quantity 10)
											[
No. 2			•	100	3-1/8"	100	B-2	$6\frac{1}{2}$	60	\$0.35	\$0.38	\$0.60
No. 3	•			125	$3 - \frac{3''}{4}$	50	B-3	$7\frac{1}{2}$	75	.45	$.48\frac{1}{2}$.80
No. 4		•		187 -	$4-\frac{3}{8}''$	30	B-4	· 9	110	.65	.69	1.10
No. 5	•	•		250	5″	20	B5	10 1	150	.80	.85	1.40

LABEL RATING OF GEM LAMPS

The style of label employed for GEM Lamps is as here shown. These labels are



printed for all the voltages from 100 to 130 and for the various sizes of lamps.

As shown in the cut of label, only the total wattage of lamp and the volts are printed. Candle-power values are not given,

as these values vary with the different forms of reflectors. (See Candle-Power distribution curves.) The voltage markings are arranged to show three voltages in steps two volts apart, and this provides a ready method of varying the efficiency and life of lamps to suit different conditions. The values at each of the three voltages are shown in the following table.

Lamps should, of course, be ordered at the "Top" or first voltage (VI) whenever possible, so as to secure the full lighting value and maximum efficiency and brilliancy.

Voltage of Circuit	Percent. Total Watts	Percent. of C. P. Values (See Fig. 3)	Eff. in watts per candle (mean Hori- zontal C. P.)	Useful Life in Hours		
Same as "Top" or 1st Voltage (V1), Same as "Middle" or 2nd Voltage (V2). Same as "Bottom" or 3rd Voltage (V3).		•	100% 95% 90%	100% 90% 80%	2.5 2.65 2.8	500 700 1,000

TABLE OF VALUES AT 1st, 2nd and 3rd VOLTAGES

4494-4 GEM Units with Bowl Holophanes

ILLUMINATING VALUES FOR GEM UNITS WITH FORM "B" HOLOPHANES

To obtain uniform illumination between lamps as well as beneath them, it is found that with the "B" reflector the distance between lamps should approximate about twice the height of the lamp above the plane in which uniform illumination is

desired. This gives a simple rule for the installation of these lighting units. The intensity of illumination upon any plane will of course vary with the height of the lamp above it.

The height of a lamp is the distance from

the lamp to the plane in which the light is utilized, and it should be remembered that the illumination is not required on the floor, but usually from $2\frac{1}{2}$ to 3 feet above the floor, as this is the height of the average table or desk.

The following table gives complete illumination data for "Bowl" Holophanes and GEM Units.

ILLUMINATION	DATA	FOR	"GEM"	INCANI	DESCENT	UNITS	WITH	THE	NEW
	"1	BOWI	" HOLO	PHANE	REFLEC	TORS		•	

(No allowance for reflection from walls or ceiling) (Distances in feet.)

		No. 2 ndescent 100 Watt		No. 3 Incandescent Unit 125 Watts			No. 4 Incandescent Unit 187 Watts			No. 5 Incandescent Unit 250 Watts			Any of	
Class of Service	Light Intensity in Foot Candles	Dlameter of Uniformly Lighted Area	Height of Lamp Above Area	Distance Between Lamps Where Two or More Are Used	Diameter of Uniformly Lighted Area	Height of Lamp Above Area	Distance Between Lamps Where Two or More Are Used	Diameter of Uniformly Lighted Area	Height of Lamp Above Area	Distance Between Lamps Where Two or More Are Used	Diameter of Uniformly Lighted Area	Height of Lamp Above Area	Distance Between Lamps Where Two or More Are Used	Approximate Watts Per of Area Lighted With J The Lamps
Desk or	3	5.47	3.65	7.84	6.1	4.07	8.75	7.65	5.1	10.96	8.65	5.77	12.4	4.27
Reading	2	6.70	4.47	9.6	7.5	5.00	10.72	9.35	6.24	13.4	10.06	7.07	15.2	2.83
Table	11/2	7.75	5.18	11.12	8.65	5.77	12.4	10.8	7.21	15.5	12.21	8.15	17.5	2.13
	1	9.46	6.32	13.6	10.6	7.07	15.2	13.25	8.83	18.96	15.0	10.0	21.44	1.41
General Lighting	<u>3</u> 4	10.65	7.12	15.3	12.25	8.17	17.55	15.30	10.19	21.84	17.35	11.56	24.8	1.055
D.B. M.B	1/2	13.4	8.94	19.2	15.00	10.00	21.44	18.75	12.48	26.8	21.2	14.14	30.38	0.645

Fittings. The form "H" shade holder, designed for these lamps, can be quickly and firmly attached to the standard socket shell by means of a split screw ring, or it will fit on sockets having rubber or porcelain rings. A locking spring enables one to readily attach or detach the shade or reflector. The standard finish is polished brass; list price 10c. each. Besides the shade holder the only fitting listed by us for use with these units is the extension tube fitting known as the form "T". This is a simple extension tube (gas pipe covered

with brass tubing) with canopy and crowfoot and standard Keyless lamp socket. List price without lamp, reflector and shade holder, **step** each. The Standard over-all length from crowfoot to end of socket is 11¹/₄ inches, and with No. 2 lamp over-all is about 15 inches. Extra lengths of tubing can be obtained cut to following Standard sizes:

Approximate over-all lengths (crowfoot to socket): $2\frac{1}{2}$ feet, $4\frac{1}{2}$ feet, $5\frac{1}{2}$ feet, and $6\frac{1}{2}$ feet. List price per foot (including gas pipe), 45c.

GENERAL ELECTRIC COMPANY

Main Lamp Sales Offices

HARRISON, N. J.



General Electric Company Schenectady, N.Y.

POWER AND MINING DEPARTMENT

March, 1907

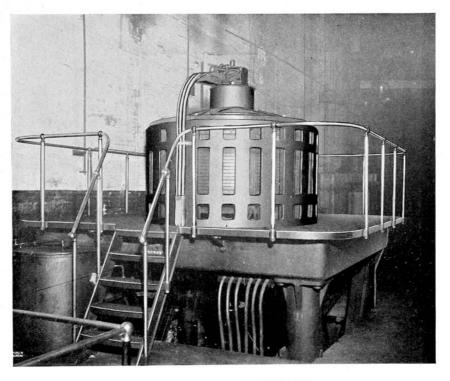
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Bulletin No. 4496

ELECTRIC PUMPING PLANTS

The following pages describe two electric pumping installations which may be regarded as typical of the most recent practice in this

Buffalo, N. Y., and the second installation refers to a 172,000 gallon electric pumping plant recently completed for the village of Scotia,



BUFFALO ELECTRIC PUMPING SET

work. They are taken as representative from a number of installations for which the General Electric Company have supplied electric motors.

The first description relates to a 25,000,-000 gallon municipal electric pumping plant at N. Y. The former may be considered as typical of pumping requirements in a large city with a population running into the four hundred thousands, and the latter as meeting the requirements of a village of about 5,000 inhabitants.

4496-2 Electric Pumping Plants

BUFFALO PUMPING PLANT

The pump and motor set which is installed at the municipal pumping plant at Buffalo, N. Y., has worked to the entire satisfaction of the Buffalo authorities, as will be seen from the testimonial letter, page 4, and is a good example of advanced practice in municipal pump installations. The set consists of a 1500 HP. General Electric Induction Motor direct coupled to a turbine centrifugal pump, the pump having a capacity of 25,000,-000 gallons of water per day.

The motor is of the well-known form LM induction type manufactured by the General Electric Company operating on the 2,000 volt Niagara circuit. The set is of the vertical type with the motor placed above the pump, as shown in the front page illustration.

There are two guide bearings and also a step-bearing located in the upper bearing bracket which carries the weight of the revolving parts. The step-bearing consists of two plates between which oil is forced and the weight of the rotor and revolving parts of the pump is carried partially by the action of the incoming water acting on the suction side of the pump, and the remainder by a film of oil, so that friction losses are minimized. Forced lubrication is also used for the guide bearings.

Before the electrical pump was installed, the work was done by two high duty steampumping engines. The new electrical pump delivers more water than the old sets, so that the pumping efficiency has been greatly increased. Such facts speak for themselves and are the best proof of the great advantages to be derived from the electric drive and the high efficiencies of motor driven pumps.

The following incident is of interest in connection with the operation of the electric pump:—

A large part of the pumping at Buffalo is done by steam driven sets, but on November 22nd, these sets met with an accident, and the whole work of pumping devolved on the electric pump which readily carried the increased load during the time the steam pumps were out of service.

The following abstract from the Buffalo Express of November 22nd, records this event as follows:—

"Under the forceful gusts of the hurricane which swept Buffalo early yesterday morning, about 15 feet of new wall at the pumping station gave way at about 4:45 o'clock and fell in upon the pumps.

"The falling bricks and structural iron broke the main steam pipe and put the electric-lighting plant out of commission. With the breaking of the main steam pipe, all the pressure of the boilers in the north and south houses was immediately exhausted and fires were drawn. It was not yet daylight when the wall fell in, and in the darkness and confusion which followed the crash, there was no water pumped at the station for about an hour.

"During that time the entire city had to depend upon the reservoir for its supply. In the dark the men had some trouble with the switches of the electric pump, but finally got it in action an hour later. The electric pump saved the day, for it was not until 9 o'clock last night that any of the steam pumps were started. The reservoir cared for the low-pressure system during the day and the electric pump whirled and buzzed at the rate of 27,000,000 gallons every 24 hours, supplying the high-pressure system. There was no part of the city without water for fire protection after 5 o'clock yesterday morning. The electric pump filled every main, only the pressure was reduced from 75 pounds to 50.

"Five of the pumps are so badly buried under wreckage that further investigation will have to determine if they can be patched up and put into service again. Some of them were running when the mass of bricks, mortar and structural iron crashed in upon them, and they were badly damaged.

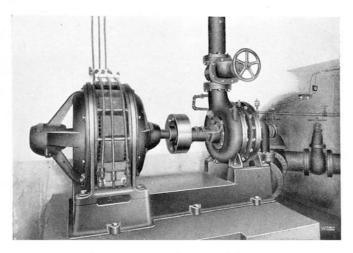
"The four largest steam pumps at the south end of the station were out of the danger zone and were kept out of service only until the main steam pipe could be repaired and they could be connected. Two of these are the 30,000,000-gallon pumps. When the wall fell in, the main steam pipe remained intact, supported by some timbers, but they soon gave way and the pipe broke of its own weight. From that time until 9 o'clock when the pipe was connected with the four largest steam pumps, the electric pump cared for the city."

Since the publication of the article referred to, the city of Buffalo has placed an order for a duplicate pump and motor, and the order for the motor and its equipment has been placed with the General Electric Company.

Electric Pumping Plants 4496-3

SCOTIA PUMPING SET

The two motor driven pumping sets recently installed at Scotia, N. Y., have given great satisfaction to the municipal authorities as will be seen from the testimonial letter given on the following page. The sets consist of two 600-gallon threestage 5-inch horizontal turbine centrifugal pany, with a short-circuited squirrel cage rotor winding. They are of robust construction and well adapted to meet the most exacting service requirements. The pumping sets are placed at the bottom of a 20-ft. pump pit and are controlled by means of a starting compensator and switches on a switchboard located upon the ground floor

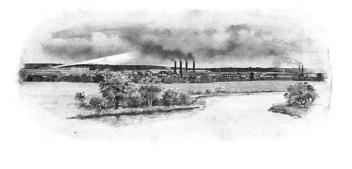


SCOTIA ELECTRIC PUMPING SET

pumps, each direct coupled to one 50 HP form "K" induction motor running at 1800 RPM operated from a 40-cycle three-phase 2000 volt circuit. The current is supplied by the Schenectady Illuminating Company.

The motors are of the induction type manufactured by the General Electric Comdirectly above the pumps. The pump and motor are mounted on a base common to both, as is shown in the accompanying illustration.

The General Electric Company have also supplied a large number of municipalities in different parts of the country with electrical pumping equipments, a list of which can be secured on application.



4496-4 Electric Pumping Plants

CITY OF BUFFALO, DEPARTMENT OF PUBLIC WORKS.

Gentlemen:-

Referring to your favor of the 29th inst. inquiring regarding the operation of the electric pump at the Buffalo Water Works, I beg to advise as follows:-

The electrically driven pump has been in operation for eighteen months, delivering 25,000,000 gallons per day, and is successful in every particular.

On November 22nd, 1906, about 50 ft. of the wall of the pumping station gave way, breaking the main steam pipe and putting all the steam pumps out of service, and the high pressure service was entirely dependent upon the electric pump, which supplied a quantity of water much in excess of its rated capacity.

The City has placed an order for a complete duplicate pump, and a third pump will be purchased in the near future.

Very respectfully yours,

Commissioner.

Scotia, N. Y.

Gentlemen:-

The electrically operated pumps, with which you equipped our pumping station, for supplying water to the Village of Scotia, N. Y., about a year ago, have been in continuous service ever since and their operation has been entirely satisfactory.

The Village has never been without water and no interruption in the service whatever has occurred since the plant was first started.

Yours very truly.

H.V. Mynderse

President:

General Electric Company Schenectady, N.Y.

SUPPLY DEPARTMENT

April, 1907

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Bulletin No. 4497

WAH

SECURITY SNAP SOCKETS



"Push the shell into the cap and turn it until it locks into position"

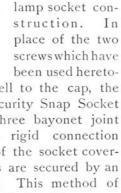
fore in fastening the shell to the cap, the cap and shell of the Security Snap Socket are held together by three bayonet joint catches, which form a rigid connection between the two parts of the socket covering. The bayonet joints are secured by an automatic catch or lock. This method of connection does away entirely with screws,

vet the shell and cap are securely and positively held together.

The Security Snap Socket is unequalled for fixture work. To attach the shell to the cap, all that is



Pendant Keyless Socket



Socket marks an

important step

in advance in

Bracket Keyless Socket with combined Shell and Shade Holder

0

12 12 1

necessary is to push the shell into the cap and turn it until it locks into position. The shell may be removed from the cap with equal facility and

without the necessity of tipping it, which, in a close fitting husk, is often almost impossible.

COMBINED SHELL AND SHADE HOLDER

Key and Keyless Sockets possessing the security snap feature are also equipped with the combined shell and shade holder, the advantages

Bracket Key Socket with com-

bined Shell and Shade Holder



Bracket Key Socket of which are constantly becoming more thoroughly appreciated.

PENDANT SOCKETS

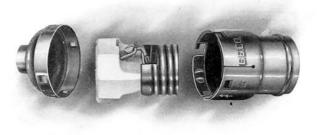
In addition to

the sockets heretofore manufactured by the General Electric Company, this Company now makes a pendant socket of the security snap type, having in the cap a moulded bushing which eliminates the necessity of screwing a bushing into the cap when the socket is to be used for pendant work. This bushing is suitable for use with either standard lamp cord or reinforced cord, and is rendered so by means of a removable inner bushing. This bushing has an opening $\frac{9}{32}$ of an inch in diameter, which makes it suitable for use with standard lamp cord. The removal of the inner bushing leaves a hole having a diameter of $\frac{13}{32}$ of an inch, which adapts the socket to use with reinforced

4497-2 Security Snap Sockets

cord. The saving of time resulting from the use of a lamp socket fitted with a bushing of this kind will be readily appreciated by both contractors and wiremen.

center contact has been used for years, and is designed with regard to strength and resiliency. A mica washer, between the center contact and the bottom of the screw shell,



Interior of Keyless Socket

SOCKET INTERIOR

renders a short circuit practically impossible.

The Security Snap Socket differs from the regular socket only in cap and shell The key mechanism is constructed without screws, is very strong, and has extremely



Interior of Key Socket

construction, the points of superiority possessed by the interior parts having been retained.

It will be noted that the porcelain is in one piece, which insures a very strong and rigid construction. Were the mechanism insecurely held between two pieces of porcelain, it would be apt to rattle, and trouble would be experienced as a result of the uncertain contact of the cam, which might render the socket inoperative. The spring long life, as has been proved by years of actual experience. The cam makes contact on the bottom of the screw shell, thus doing away with an excessive number of current carrying parts, and the shaft plays in a slot in the frame, allowing for indefinite wear. As the screw shell is rigidly held to the porcelain, there is no possibility of the cam failing to make contact, as would be the case if the cam made contact on a flexible spring which could be pushed out of position.

Security Snap Sockets 4497-3

Catalog No.	Description	Package Quantity	List Price
4147	Key Socket for 1/2-inch pipe	500	\$0.33.
4148	Key Socket for 3%-inch pipe	250	• • 39
4149	Keyless Socket for ½-inch pipe	500	.30
4150	Keyless Socket for 3/8-inch pipe	250	.36
4814	Key Socket, male thread on bushing for 3%-inch pipe	250	.39
4815.	Keyless Socket, male thread on bushing for 3%-inch pipe	250	.36
4151	Key Socket with moulded bushing for pendant use	500	.33
4152	Keyless Socket with moulded bushing for pendant use	500	.30
	WITH COMBINED SHELL AND SHADE	HOLDER	
4153	Key Socket for ½-inch pipe for 2¼-inch shades	500	\$0.39
4154	Key Socket for 3%-inch pipe for 21/4-inch shades	250	-45
4155	Keyless Socket for ½-inch pipe for 2¼-inch shades	500	.36
4156	Keyless Socket for 3%-inch pipe for 21/4-inch shades	250	.42
4157	Key Socket with moulded bushing for pendant use		
	for 2 ¹ / ₄ -inch shades	500	.39
4158	Keyless Socket with moulded bushing for pendant use		
	for 2¼-inch shades	500	.36
4159	Key Socket for 1/8-inch pipe for 31/4-inch shades	100	-47
4160	Key Socket for 3%-inch pipe for 34-inch shades	100	•53
4161	Keyless Socket for 1/2-inch pipe for 31/4-inch shades	100	.44
4162	Keyless Socket for 3%-inch pipe for 3¼-inch shades	100	.50

WITHOUT SHADE HOLDER

Key Socket with moulded bushing for pendant use 44163 for 3¹/₄-inch shades..... 100 .47 Keyless Socket with moulded bushing for pendant use 44164 for 3¹/₄-inch shades..... 100 .44

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SUPPLY DEPARTMENT

May, 1907

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A S.W

THOMSON SINGLE PHASE HIGH TORQUE INDUCTION WATTMETERS

The General Electric Company manufactures three types of Single Phase High Torque Induction Wattmeters, as follows:

Type I metal cover, for house installation. change in design has been in keeping with the rapid advancement in the art.

Accuracy, the prime requisite of a satisfactory meter, means not only initial accuracy under ideal operating conditions, but also



THOMSON HIGH TORQUE INDUCTION WATTMETER-TYPE I

Type IS-2 metal cover, for switchboard use.

Type IS-3 glass cover, for switchboard use.

These meters differ in many respects from their predecessors, and contain the essential features of an ideal meter, as each continual accuracy over long periods of use, and under those variations from normal conditions that are commonly experienced in central station practice. In the Single Phase High Torque Induction Wattmeters, the General Electric Company has succeeded in obtaining a continued maintenance of the

4498-2 Thomson Single Phase High Torque Induction Wattmeters

initial accuracy under all ordinary circumstances.

GENERAL DESCRIPTION-TYPE I WATTMETERS

The appearance of the General Electric High Torque Induction Wattmeter, Type I, is particularly pleasing. It is small, compact and simple, although strong and durable in construction, and is exceptionally light in weight.



Thomson High Torque Induction Wattmeter With Cover Removed

The mechanism is contained in a rectangular case which is provided with three supporting lugs or feet. The cover is pressed sheet aluminum and is light and stiff. Two rectangular windows sealed into the cover provide means for observing the register and meter disk.

MECHANICAL FEATURES REGISTER

The meter register is of the four dial type reading directly in kilowatt hours. One complete revolution of the most rapidly moving pointer on the Type I Meter equals 10 kilowatt hours.

No multiplying constants are used on 60 cycle meters of 15 kw. capacity or less, nor on 40 or 50 cycle meters of 10 kw. or less. On meters of larger capacities a constant of 10 or multiple thereof is used. This decimal system renders possible the use of the same unit (the kilowatt hour) for all registers, and the same value per revolution of each pointer.

COVER AND SEALING

The cover is held by two studs and wing nuts which firmly clamp it down on a felt packing, making a dust-proof and insectproof joint. The disk and register windows are set in putty, thus augmenting the dustproof qualities.

The meter is sealed by passing a single sealing wire through the wing nuts and their respective studs. This method of sealing is extremely simple and convenient and positively prevents tampering.

BINDING POSTS

The binding posts in meters up to and including 100 amperes are located at the sides near the top of the case. Meters having a capacity in excess of 100 amperes have binding posts at the sides near the bottom of the case. Fibre and felt guards secured to the case at the point where the wires enter prevent introduction of dust, etc. Both sides of the line are carried through the meter in all capacities up to and including 100 amperes.

ACCESSIBILITY

The entire mechanism is assembled upon a skeleton casting or frame which in turn is fastened to the meter case. By removing two retaining screws and the two sealing studs, the frame and mechanism can be removed for inspection or repair.

By removing the register and pivot, the moving element can be taken out. It is unnecessary to change the position of the magnets during this operation and therefore full load calibration is unaffected.

An automatic dog, between the worm wheel and register, permits_removal and replacement of the register without in any way affecting the proper mesh of worm and worm wheel.

CHANGE NOTICE

To accompany Bulletin No. 4498 Thomson Single-Phase High Torque Induction Wattmeters Page 7: The item under "Registers" should read as follows:

The register is of the four-dial type, reading directly in kilowatt hours on meters of low capacity. On larger meters, a dial face multiplier of 10, 100, 1000, etc., is required. By using this system, the actual energy units remain the same in all sizes, the reading being obtained by the addition of one or more ciphers to the indication of the first pointer. To permit greater accuracy where frequent readings are taken, the register on switchboard meters is constructed to record ten times faster than the corresponding capacity Type I meter. One revolution of the most rapidly moving pointer equals 10 kilowatt hours in meters without constants, except in the case of some low-capacity meters where the usual switchboard meter register would have a dial face multiplier of 1/10. To overcome the use of a fractional multiplier in such cases, a dial face is used having 1 over the right-hand dial, 10 over the second dial, etc. In other words, such dials read 1 kilowatt hour for one revolution of the most rapidly reading pointer. To distinguish these dials, the right hand circle is black, pointer and figures being white. This distinguishing feature will prevent errors due to any oversight in noting the different units in which the dials read.

The two permanent magnets are fastened rigidly together and by loosening two screws, may be removed as a unit from the supporting shelf.

JEWELS AND PIVOTS

Almost any material if well polished will give, *initially*, low friction, and, therefore, prove satisfactory as a bearing. But for satisfactory continuous operation this condition of low friction must be maintained, and to secure this the jewel and pivot must be of the hardest material and possess the highest possible polish. The Eastern sapphire and the diamond have proved to be the only materials which give satisfactory service in integrating wattmeters. The greatest care is exercised in selecting the stones used in the General Electric Company's meters, and they are cut, polished and inspected by skilled workmen.

The jewel is set in a brass plug which in turn rests on a compression spring. The strength of each spring is carefully tested by a high and low limit gauge and all springs not within the proper limits are rejected.

The pivots are made from the highest grade of piano wire, drawn under such enormous pressure that the finest grain is obtained. These pivots are glass hardened and polished.

ROTATING ELEMENT

The rotating element consists of an aluminum disk mounted on a small bronze shaft. The lower end of the shaft carries a removable steel pivot, while the upper end contains a suitable worm for transmitting the disk rotation to the register.

SHIPPING DEVICE

For protection during shipment or any subsequent transportation these meters are provided with a clamping device which holds the moving element securely, at the same time lifting it entirely free from the jewel bearing. This clamping device consists of a brass cap which is normally drawn down and

held by the jewel screw against the force of a lifting spring. When the cap is drawn down, the moving element is free to rotate. When the jewel screw is backed out, the cap is released, and, because of the spring, lifts the moving element and holds it firmly.

ELECTRICAL FEATURES SHIELDING

These meters are so designed that the magnetic circuit is practically closed upon itself, and stray fields which might tend to demagnetize the magnets are reduced to a minimum.

The magnets are further protected by their position; they are some distance from the coils, and the plane in which they lie is at right angles to any projected field.

PREVENTION OF CREEPING

All General Electric Induction Meters are designed so as to prevent "creeping" or rotating on potential alone. The disk contains two small holes placed near the periphery and diametrically opposite each other. These holes increase the resistance to the flow of the eddy currents in the disk. When these openings are in the neighborhood of the potential pole, any tendency to rotate on potential alone is overcome and the disk is therefore prevented from rotating more than half a revolution. When current is flowing in the series coils, rotation of the disk is in no way affected, nor the accuracy of the meter impaired.

LIGHT LOAD ADJUSTMENT

Light load accuracy is highly important in all meters, as a very large portion of the central station's revenue is derived from the individually small, long hour demand of its customers. That the best results be obtained, it is essential that means be provided for controlling light load accuracy, and the devices used must be simple and convenient, as their adjustment should easily be accomplished by inspectors.

4498 4 Thomson Single Phase High Torque Induction Wattmeters

These meters are provided with a light load adjustment or starting plate, consisting of a small sliding rectangular conductor placed between the potential coil and the disk. When this rectangular conductor is moved from its central position in the direction of rotation of the disk, the torque produced is positive; if moved in the opposite direction, the torque produced is negative. A lever is provided for moving the plate backward or forward over the meter disk, thus permitting a wide adjustment. The letters "S" and "F" are cast in the meter frame close to the lever arm indicating which way to move the lever for "slow" or "fast."

TORQUE

The importance of high torque, or turning moment, is not generally appreciated at its true value.

A meter should theoretically do no work except the generation of eddy (Foucault) currents in the disk. This is possible, however, only in theory; in practice, two classes of work are done, first, the generation of eddy currents, and, second, the overcoming of friction. The first varies according to the law of the perfect meter, but friction does not; hence, variations of friction produce inaccuracy. It is obvious that the work done according to the law of the meter should be very large compared with the work which is not, i.e., friction. The variable factor will then represent a variation on only a small proportion of the total energy expended.

Reduced to its practical elements this means that to retain accuracy for a long period and without depreciation in value, a meter must be so constructed as to do a relatively large amount of work in the generation of eddy currents. In other words, a high torque, permitting a heavy drag or load, is essential to permanent and sustained accuracy. The factor of "Torque per Unit Weight" should also be of high value, in order that errors due to friction shall be negligible. Both of these requirements can be obtained only by the careful proper proportioning of the various elements, and have been fully met in the Thomson High Torque Induction Meter.

MAGNETS

In order that a meter shall record correctly, the retardation of its moving element must vary directly with its speed. This retardation is produced by the mutual reaction of eddy currents generated in the disk and the magnetic field of the permanent magnets. It is proportional to the square of the magnet strength; consequently, a slight change in the magnet strength will cause serious inaccuracies of the meter.

The experience of the General Electric Company, extending over the past twenty years, has been so complete and thorough as to guarantee the results in the manufacture of permanent magnets. This experience is the result of an actual commercial production of more than three and one-half million magnets.

ACCURACY ON OVERLOADS

The losses in the meters are extremely low, hence permit accurate operation on heavy overloads, even for considerable periods of time, without detrimental effects either permanent or temporary.

The perfect shielding of the magnetic circuit, referred to above in relation to stray magnetic fields, protects the permanent magnets from the usual consequences of short circuits, or other sudden current surges.

INDUCTIVE LOAD ACCURACY

Accuracy on loads of low power factor is essential to an induction meter for general alternating current service.

Thomson Induction Meters are so designed and adjusted as to secure the highest possible inductive load accuracy, and may be relied upon to record true kilowatt hours either upon an entirely non-inductive load, such as incandescent lamps, or upon a highly inductive load, such as fan or other motors.

Thomson Single Phase High Torque Induction Wattmeters 4498-5

VARIATIONS OF FREQUENCY

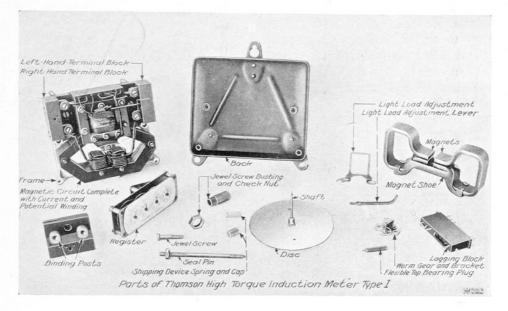
Thomson Induction Wattmeters in common with all other meters of their class, are designed and calibrated for the frequency upon which they are to be used.

In view of the fact that 125 to 133 cycle systems are now quite generally being converted into 60 cycle systems, all Type I meters ordered for use on 125 or 133 cycle by test, and constitutes an important consideration.

The accuracy of these meters is unaffected by a 10 per cent variation in voltage either above or below that for which they are calibrated.

TESTING

For convenience in testing before installation, a testing loop has been provided



PARTS OF THOMSON HIGH TORQUE INDUCTION WATTMETER-TYPE I

systems are provided with means for immediate re-connection on 60 cycle circuits.

These induction meters are practically unaffected by a 10 per cent variation either way from the normal rated frequency for which they are calibrated.

VARIATIONS OF POTENTIAL

It is highly important that meters be accurate, irrespective of potential variations. This is especially true of meters used on systems of moderate size where voltage regulation is not always perfect and potential variations occur on different sections of the lines, or during portions of the twenty-four hours. This characteristic may be readily determined in Type I meters. Any number of meters can be tested in series without recording the losses in the potential circuits by disconnecting this loop and connecting the potential coil of each meter to the source of potential at some point, before the wires enter the first meter of the series. The testing loop is conveniently placed on the left hand terminal board.

FINISH

The Type I meter is intended for house installation and therefore is made for side connections only. The finish is dull black japan, which has proved to be the most permanent and pleasing for the house type of meter. If desired, this meter can be fur-

4498-6 Thomson Single Phase High Torque Induction Wattmeters

nished with glass covers, of the same general outline as the aluminum covers, without additional charge.

CAPACITIES

Special attention is called to the fact that the Thomson High Torque Induction Wattmeter, Type I, is manufactured as a standard device for 2-wire and 3-wire service, and no auxiliary external devices are necessary for either application. The Type I meter is made for direct connection into the circuit up to and including 300 amperes, 2-wire, and 150 amperes, 3-wire service. Current transformers are not used unless the current is above these limits, or the voltage greater than 650 volts.

Potential transformers must be used above 650 volts.

SINGLE PHASE INDUCTION WATT-METERS FOR SWITCHBOARD INSTALLATION—TYPES IS-2 AND IS-3

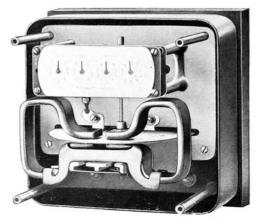
The General Electric Company strongly advocates the practice of metering individual generators rather than using a single meter to measure the total output of a station.



Switchboard Wattmeter-Type IS-2

By the use of a meter with each generator and feeder, a far better load factor on individual meters is obtainable, resulting

in greater accuracy. Furthermore, convenience of arrangement and connection is greatly increased, testing facilitated and



Switchboard Wattmeter—Type IS-2 With Cover Removed

additions to the switchboard may be made with minimum expense and difficulty.

For switchboard use the General Electric Company has developed a line of single phase meters known as Types IS-2 and IS-3.

GENERAL DESCRIPTION

These meters are in many respects similar to the Type I Wattmeters already described but are designed and adapted for switchboard use.

They differ widely from earlier single phase switchboard meters, not only in mechanical construction but also in electrical design. The new design is more compact, much neater in appearance and the instruments have greater accuracy than the earlier forms. At the same time, all the desirable and essential features are retained.

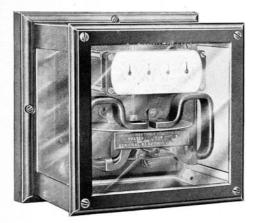
The Types IS-2 and IS-3 meters embody the many recent improvements that are common in other types of the General Electric Company's meters, and tests show them to be the most accurate switchboard meters ever placed in commercial service. The "Torque per Unit Weight" is the highest of any induction meter. The interior parts are secured to a

Thomson Single Phase High Torque Induction Wattmeters. 4498-7

frame which may be removed by loosening four screws, disconnecting the leads from the binding posts, and lifting the entire meter free from its case, thus greatly simplifying inspection.

REGISTERS

The register is of the four dial type, reading directly in kilowatt hours, and one complete revolution of the most rapidly moving pointer equals *one* kw. hour, instead of *ten* kw. hours, as in the Type I meter. Readings are taken at comparatively long periods on house meters but very frequently on switchboard meters. It is, therefore, essential that the register of switchboard meters indicate more rapidly than the house meter, thus permitting greater accuracy when frequent readings are taken.



Glass Enclosed, Switchboard Wattmeter-Type IS-3

A multiplying constant of 10, 100, 1000, etc., is used on meters above 15 kw. capacity for circuits of 60 cycles and higher, and on meters above 10 kw. capacity for 40 and 50 cycle circuits.

FINISH

The Type IS-2 meter has a cast metal cover and the Type IS-3 meter a rectangular glass cover. The finish of both meters is dull black, the front of the Type IS-2 cover having a pebbled surface with raised portions polished copper, making a very agreeable appearance. In the Type IS-3 meter, the frame, register, magnets, etc. are all finished in dull black.

CAPACITIES

The Types IS-2 and IS-3 meters are standard in capacities up to 150 amperes for 1150 and 2300 volt circuits. When used on 650 volt circuits and over, they are furnished with potential transformers, and for 2300 volt service are supplied with both current and potential transformers.

THOMSON HIGH TORQUE INDUCTION WATTMETER-TYPE I-SINGLE PHASE

FRONT CONNECTED, METAL OR GLASS COVER, JAPAN FINISH

100-120 VOLTS, 40-133 CYCLES, TWO-WIRE

Cat. No.	*Lights	Amperes	
51173	6	3	
51174	10	35	
51175	20	10	
51176	30	15	
51177	50	25	
51178	100	50	
51179	150	75	
51180	200	100	
51181	300	150	
33584	400	200	
33585	600	300	

*Rated on a Basis of 50 Watts per lamp.

4498-8 Thomson Single Phase High Torque Induction Wattmeters

THOMSON HIGH TORQUE INDUCTION WATTMETERS-TYPE I-SINGLE PHASE

FRONT CONNECTED, METAL OR GLASS COVER, JAPAN FINISH

200-240 VOLTS, 40-133 CYCLES, THREE-WIRE

200-240 VOLTS, 40-133 CYCLES, TWO-WIRE

Cat. No.	*Lights	Amperes	Cat. No.	*Lights	Amperes
33588 33589 33590 51191	12 20 40 60	3 5 10 15	$ \begin{array}{r} 19042 \\ 51182 \\ 51183 \\ 51184 \\ \end{array} $	$12 \\ 20 \\ 40 \\ 60$	3 5 10 15
$51192 \\ 51193 \\ 51194$	100 200 300	25 50 75	51185 51186 51187	100 200 300	25 50 75
$51195 \\ 51196$	400 600	100 150	51188 51189 33586 33587	400 600 800 1200	100 150 200 300

*Rated on a basis of 50 watts per lamp.

Note-Always state normal voltage of circuit.

THOMSON HIGH TORQUE INDUCTION WATTMETERS FOR SWITCHBOARD SERVICE-RECTANGULAR PATTERN

SINGLE PHASE PRIMARY CIRCUITS-60-133 CYCLES

TYPE IS-2-CAST METAL CASE

TYPE IS-3-GLASS CASE INTERIORS, DULL BLACK FINISH

DULL BLACK FINISH

*1000-1150 VOLTS

12000-2300 VOLTS

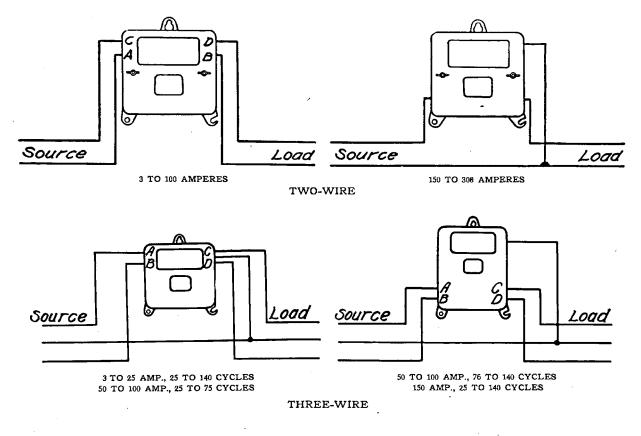
*1000-11	-1150 VOLTS 2000-2300 VOLT		00 VOLTS	*1000-11	50 VOLTS	†2000-2300 VOLTS		
Cat. No.	Amperes	Cat. No.	Amperes	Cat. No.	Amperes	Cat. No.	Amperes	
41429 41430 41431 41432 41511 41512 41513 41514	$5 \\ 10 \\ 15 \\ 25 \\ 50 \\ 75 \\ 100 \\ 150$	$\begin{array}{r} 41515\\ 41516\\ 41517\\ 41518\\ 41519\\ 41520\\ 41520\\ 41521\\ 41522\\ 41523\\ 41523\\ 41524\end{array}$	$5 \\ 10 \\ 15 \\ 20 \\ 30 \\ 40 \\ 60 \\ 80 \\ 100 \\ 150$	$\begin{array}{r} 41568\\ 41569\\ 41570\\ 41571\\ 41572\\ 41572\\ 41573\\ 41574\\ 41575\end{array}$	$5 \\ 10 \\ 15 \\ 25 \\ 50 \\ 75 \\ 100 \\ 150$	$\begin{array}{r} 41576\\ 41577\\ 41577\\ 41579\\ 41580\\ 41581\\ 41582\\ 41583\\ 41583\\ 41583\\ 41584\\ 41585\end{array}$	$ \begin{array}{c c} 5 \\ 10 \\ 15 \\ 20 \\ 30 \\ 40 \\ 60 \\ 80 \\ 100 \\ 150 \\ \end{array} $	

*Furnished with potential transformers.

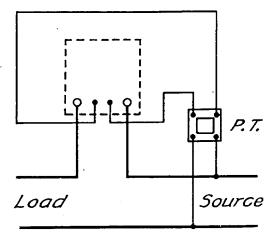
†Furnished with current and potential transformers.

Thomson Single Phase High Torque Induction Wattmeters 4498-9

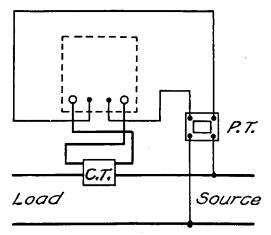
CONNECTIONS OF THOMSON INDUCTION WATTMETERS-TYPE I



CONNECTIONS OF TWO-WIRE THOMSON INDUCTION WATTMETERS SWITCHBOARD PATTERN-TYPES IS-2 AND IS-3



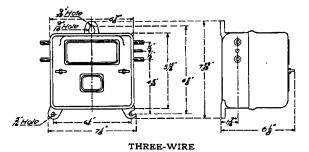
5 TO 150 AMP., NOT EXCEEDING 1150 VOLTS-WITH POTENTIAL TRANSFORMERS



5 TO 150 AMP., ABOVE 1150 VOLTS-WITH CURRENT AND POTENTIAL TRANSFORMERS

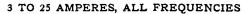
4498-10 Thomson Single Phase High Torque Induction Wattmeters

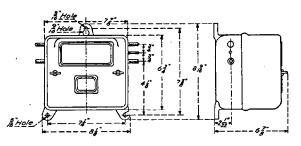
DIMENSIONS OF THOMSON INDUCTION WATTMETERS-TYPE I



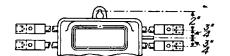


TWO-WIRE





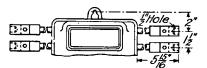
50 AND 75 AMP., THREE-WIRE, 75 CYCLES AND BELOW



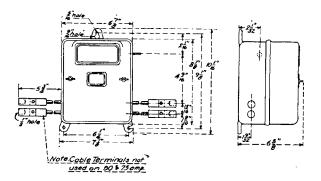
100 AMP. THREE-WIRE, 75 CYCLES AND BELOW



50 AND 75 AMP., TWO-WIRE, ALL FREQUENCIES



100 AMP., TWO-WIRE, ALL FREQUENCIES

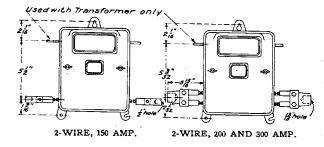


50 TO 100 AMP., THREE-WIRE, ABOVE 75 CYCLES 150 AMP., THREE-WIRE, ALL FREQUENCIES

50 TO 150 AMPERES

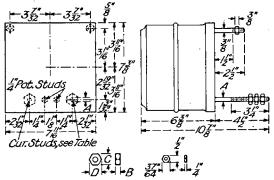
Thomson Single Phase High Torque Induction Wattmeters. 4498-11

DIMENSIONS OF THOMSON INDUCTION WATTMETERS-TYPE I-Continued

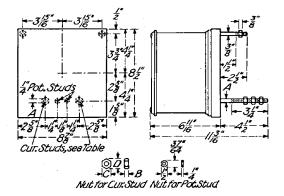


¹⁵⁰ TO 300 AMP., TWO-WIRE, ALL FREQUENCIES

DIMENSIONS OF TWO-WIRE THOMSON INDUCTION WATTMETERS SWITCHBOARD PATTERN-TYPES IS-2 AND IS-3



Nut for Cur.Stud Nut for Pot.Stua



CAPACITY	A	В	С	D
3-100 AMP	3⁄8″	3/8"	35″	81 ″
150 AMP .	1/2"	Ļ∕₂″	1.78"	$1\frac{7}{32}''$

CAPACITY	A	в	С	D
3-100 AMP	3/8"	3/8"	25″	\$1″
150 AMP	1⁄2″	1⁄2″	1 <u>1</u> ″	177



TYPE IS-3

3 TO 150 AMP., ALL FREQUENCIES

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General Electric Company Schenectady, N.Y.

TRANSFORMER DEPARTMENT

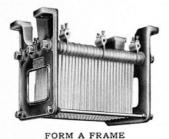
May, 1907

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Bulletin No. 4499

CAST GRID RHEOSTATS - TYPE CG

General Electric Cast Grid Rheostats consist of a series of grids supported on insulated rods between cast end pieces. Two styles are made, as shown in Figs. 1 and 2, the only difference being in the end casting. The taps or connections to the rheostats are made by separate terminals, which may be inserted at the desired points, and facilitate the building up of the rheostat with the proper resistance at each step. The rating



UNIFORMITY

The electrical properties of each size of General Electric grids approximate to ordinary commercial limits the ratings in the table on page 3. The grids are of uniform dimensions and material, and without warps, burrs, or cracks.

STRENGTH

The shape of the General Electric grid prevents undue strains being created when



FIGS. 1 AND 2 - CAST GRID RHEOSTATS

and resistances have been carefully selected to aid in the proper selection of grids for different conditions, and the ordering of correct rheostats is therefore comparatively simple.

Cast Grid Rheostats for railway service are superior to resistance coils made of flexible material wound or bent into shape. Grid resistances are more durable under severe operating conditions and more compact than band-iron coils and are therefore particularly desirable for railway equipment.

Tests in actual service have demonstrated that the General Electric Cast Grid Rheostats — Type CG — have the three principal requirements for this class of apparatus; viz., uniformity, strength, and reliability. they are built up into complete rheostats. The use of a central supporting rod increases the strength of the construction, and spring washers at the ends of the rods insure perfect contact between the grids.

RELIABILITY

The grids have their bosses squared true, and maintain a parallel position, thereby preventing contact at the outside ends and the possibility of short circuiting sections of the resistance. The frames are specially rigid in construction.

GENERAL CONSTRUCTION VENTILATION

Free circulation of air is provided, although the dimensions have been reduced and space economized as much as practicable. 4499-2 Cast Grid Rheostats - Type CG

INSULATION

Mica washers between grids are considerably larger in diameter than the boss of the grid, giving a very large creeping surface. Dust gathering on the bosses is therefore sketch is sent out with each order giving a clear explanation as to where the terminals should be inserted to give the proper resistance.

These terminals are equipped with two

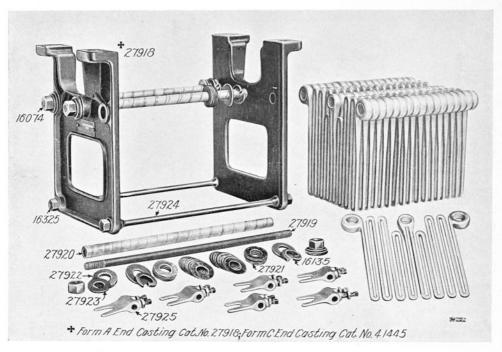


FIG. 3-CAST GRID RHEOSTAT FRAME PARTS, FORM A

Cat. No. 16074 Nut $(\frac{1}{2}'' - 11 \text{ Hex.})$. Cat. No. 16135 Lock Washer. Cat. No. 16325 Nut $(\frac{1}{2}'' - 13 \text{ Hex.})$. Cat. No. 27918 End Casting. Cat. No. 27919 Rod for Grids. Cat. No. 27920 Mica Insulating Tube. Cat. No. 27921 Mica Washer $(\frac{5}{6}'' \ge 1\frac{3}{4}'' \ge \frac{1}{32}''$ thick). Cat. No. 27922 Steel Washer $(\frac{13}{16}'' \ge 1\frac{7}{8}'' \ge \frac{1}{8}'')$ thick). Cat. No. 27923 Steel Washer $(\frac{11}{16}'' \ge 1\frac{1}{4}'' \ge \frac{3}{32}'')$ thick). Cat. No. 27924 Tie Rod.

Cat. No. 27925 Terminal complete.

unlikely to reduce the resistance. Mica sleeves on the supporting rod and mica washers of a thickness of $\frac{3}{4}$ inch at each end prevent grounding on the frame.

All mica used is specially selected and will not deteriorate under the most severe operating conditions.

TERMINALS

The terminals are not a part of the grid proper, and if terminals are necessary the order for grids should state so specifically. Six terminals are furnished with each complete *rhcostat*, unless more are ordered. A set screws for fastening the leads and preventing them from working loose as a result of any severe and continual vibration to which they may be subjected.

NOMENCLATURE

Each rheostat is designated by the type letters "CG" followed by a group or groups of symbols, separated by dashes. The symbols in each group consist of three parts, as follows:

1st part—A *figure* indicating the size or capacity of the grids in the group. The grids are numbered from 4 to 14, the small-

Cast Grid Rheostats - Type CG 4499-3

est number corresponding to the lowest resistance. These numbers, it will be seen from the table, are the significant figures in the corresponding catalogue numbers.

2nd part — A *letter* indicating the way in which the grids are connected within the group:

A, indicates all grids in series.

B, two in multiple, the sets in series.

C, three in multiple, the sets in series.

3rd part - A figure indicating the number of grids in the group.

EXAMPLES

Rheostat CG-8A18 is composed entirely of No. 8 grids connected in series, and contains 18 grids.

CG-8B18 is composed entirely of No. 8 grids connected two in multiple, and contains 18 grids. CG-8C18 indicates that the same grids are used, but that they are connected three in multiple.

CG-4A12-7B6 indicates that the rheostat contains 12 No. 4 grids connected in series, and six No. 7 grids connected two in multiple, and the groups connected in series.

OLD TYPE GRID

The old type of grid with terminals cast on the grid itself and the present form with separate terminals have the same resistance and current capacity, and are interchangeable. They therefore retain the old catalogue numbers which are cast on each grid. At the time the change was made, however, a few grids were shipped with new catalogue numbers. For the benefit of customers who received these grids the corresponding numbers will be found in the second column of the table given below.

The new grids and terminals can be placed in the same box as the old style grids.

FRAME PARTS

Type CG Rheostats are made in two styles, Forms A and C. In Form A, which is shown disassembled on the opposite page, the end frame casting has Catalogue No. 27918 as given on the engraving. Form A Frames are designed to be bolted beneath the car. Form C Rheostats, Fig. 2, first page, are intended to be bolted to the flooring of the car and take end castings Catalogue No. 41445 instead of No. 27918.

STOCK AND SHIPMENTS

The necessary stock of parts to make Cast Grid Rheostats with any possible combination of grids tabulated on this page is always maintained at the factory, and all orders can be filled promptly.

Cat. No.	Obsolete Corresponding Cat. Nos.	Grid No.	Resistance in ohms per Grid at 70° C.	Continuous Ca- pacity in Amps. at 175° C. Rise.	Intermittent Ca pacity in Amps. at 250° C. Rise 10 seconds on 20 seconds off
26504	26518	4	.023	75	150
26505	26519	5	.030	68	135
26506	26520	6	.038	60	120
26507	26521	7	.047	55	105
26508 26509 26510 26511	26522 26523 26524 26524 26525	8 9 10 11	.059 .074 .092 .092	50 45 40 35	90 80 70 65
26512	26526	12	.113	33	60
26513	26527	13	.142	31.5	55
26514	26528	14	.177	30	50

GENERAL ELECTRIC CAST GRID RHEOSTATS - TYPE CG

NOTE. — On all orders the new type of grid is supplied, and the necessary number of terminals should be ordered extra, except when complete rheostats are ordered. With complete rheostats 6 terminals are furnished without extra charge.

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SUPPLY DEPARTMENT

May, 1907

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* Bulletin No. 4500

HDW

CONSTANT CURRENT TRANSFORMER PANELS

FOR SERIES ARC AND SERIES INCANDESCENT LIGHTING SYSTEMS

Constant Current Transformer Panels have lately been completely redesigned and embody several improvements over the panels

which have been in successful operation for a number of vears.

The devices on the panels have been remodeled, simplified, and made more durable and now provide greater safety to the operator, improved insulation, and better protection to the circuit.

In the following description the panels are divided into two classes, viz:

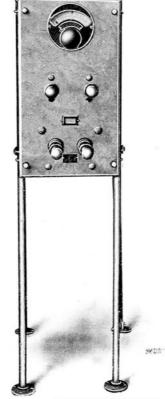
ISOLATED ARC PANELS— For installation in front of the transformers they control, and not intended to form a part of the main switchboard.

ISOLATED INCANDESCENT PANELS—Similar to the Isolated Arc Panels, but designed for controlling one, two, or three transformers for series incandescent lighting.

ISOLATED ARC PANELS

The small arc panels mounted on pipe supports for installation immediately in front of the transformer are generally used, as they provide a compact, simple and inexpensive

*Supersedes Bulletin No. 4293.



25, 35 or 50 LIGHT ARC PANEL

arrangement for transformer control. The high tension leads can be somewhat shortened by the use of these panels, since it is unnecessary to carry them

from the transformer to the main switchboard. They are equipped with single throw primary plug switches, but may be altered to provide for transferring the primary. This chauge, however, will increase the price and delay shipment.

The principal changes embodied in the new small panels are: The abolition of the ammeter cable, the improved method of support, and the increased insulation of all the plug switches.

Test Panels

In addition to the very complete line of C. C. transformer panels for commercial arc lighting which are described herein, the General Electric Co. has lately placed on the market a small panel to be used for the purpose of testing arc lamps.

These panels are constructed as follows:

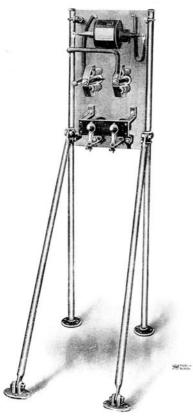
A Blue Vermont marble panel $16'' \ge 16'' \ge 1\frac{1}{2}''$ is mounted on steel brackets which are designed for fastening to the wall. The 4500-2 Constant Current Transformer Panels

equipment of the panel consists of;-

1—Type "R" ammeter.

2—Primary plug switches equipped with primary fuses.

The capacity of the panel is 12 lamps at either 1150 or 2300 V.



25, 35 or 50 LIGHT ARC PANEL (Back View)

These panels should be of great use to central stations for the purpose of testing out the arc lamps before they are placed in commercial service.

A front view of this panel together with wiring diagram, catalogue numbers, etc. will be found on page 7.

ISOLATED INCANDESCENT PANELS

A line of small panels has been developed for the control of constant current transformers for series incandescent lighting, which are similar to the isolated are panels except that panels for controlling two and three transformers are also included.

WATTMETER SUB-BASES

It is often desirable to record the total input of energy to the transformer in kilowatt hours and a wattmeter for this purpose is recommended. Wattmeters mounted on subbases and provided with the necessary transformers can be applied to any of the standard panels except the two and three circuit isolated incandescent panels. This complete device, when desired, should be ordered by catalogue number from the table of capacities given on pages 7 and 8. A wattmeter sub-base can be readily added to a panel already installed.

INSTRUMENTS

One Type R round pattern ammeter is furnished for each transformer controlled, and is permanently connected in the second-



TYPE R AMMETER

ary circuit unless the transformer has a multi-circuit secondary, when ammeter jacks are provided so that the instrument may be connected in either circuit.

The Type R instruments are adapted to this service as they are small, of neat appearance accurate and substantial. They are practically dead beat, but will respond to a minute change in current value. Furthermore, they are free from frequency, wave form and heating errors, and are shielded from external

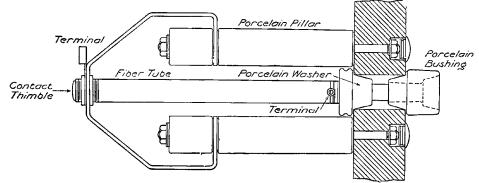
Constant Current Transformer Panels 4500-3

magnetic influences, as the entire electrical portions are completely surrounded by a laminated iron shield.

Five or ten ampere instruments are furnished depending upon the ampere capacity of the lamps, and in each case the ammeters are provided with markers which may be set at the requisite current value. With the front of the sub-base, it adds to the appearance of the board. A full description of this meter is given in the Bulletin on the Thomson High Torque Induction Meter.

PRIMARY PLUG SWITCHES

Although the primary plug tube switches,



PLUG SWITCH

markers properly set any deviation of the current may be readily detected. It may be noted from the illustrations that the scale is very open in the center, permitting the instruments to be read with great precision. which have always been used for constant current transformer service, have given satisfaction, they have been changed to obtain increased contact surface between the plug and the receptacle and are now capable of



PLUG FOR PLUG SWITCH

RECORDING WATTMETERS

The Thomson High Torque Induction Meter Type IS-2 is standard for all switchboard and isolated are panels. As this meter is made back connected it is mounted on the front of the sub-base. It is provided with a metal case, finished to correspond with other instruments on the panel. The Type IS-2 Meter is designed with particular reference to switchboard requirements, and not only does it possess high initial accuracy under the most adverse conditions, but because of its high torque it will retain this accuracy over long periods of service.

Being small and compact, if placed on the

carrying 100 amperes continuously without undue heating. This type of switch, when used on isolated panels, has the tube fuse clips attached.

SECONDARY PLUG SWITCHES

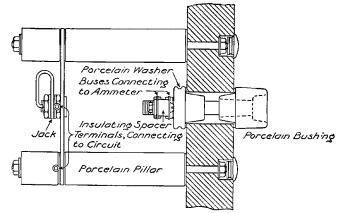
The duties of the plug tube switches in the secondary side of the transformer are somewhat different from those in the primary side and while they are obliged to stand in some cases 8500 volts, the current carrying capacity may be very small. For this reason they are constructed of brass and are well insulated from the panel, making it unnecessary to depend on the insulating qualities of

4500-4 Constant Current Transformer Panels

the marble. The receptacle and plug are shown on page 3. The plug has an improved shaped handle to better protect the operator.

Secondary plug switches comprise open

The bus ammeter jack entirely eliminates the use of cables on constant current transformer switchboards. The construction of the device is similar to the other secondary switches, but in addition has two small buses



AMMETER JACK

circuiting plug switches, short circuiting plug switches, and ammeter jacks.

Open circuiting plug switches are provided on all panels and are used to disconnect the line from the secondary of the transformer when testing for ground or open circuit. It also answers the purpose of disconnecting one which connect to the ammeter. The receptacle is shown on page 4.

FUSES

All the primaries of constant current transformers are provided with fuses to protect the windings of the transformers. These fuses



PLUG FOR AMMETER JACK

of the circuits of a multi-circuit transformer for repair without interrupting the other circuit.

Short circuiting plug switches are only included in the equipment of multi-circuit transformer panels, and serve the purpose of connecting both secondary coils in series on one lamp circuit when desired.

Where one ammeter is to be used to read the current in more than one circuit, a bus ammeter jack is permanently connected in each circuit. By inserting the plug in any ammeter jack, the ammeter is thrown in series with that circuit. are made part of the primary switch and are mounted on the back of the panel. They are of the tube expulsion type and have always been found to be effective.

PANELS AND SUPPORTS

The material used for all panels is polished blue Vermont marble $1\frac{1}{2}$ " thick. The panels are mounted on two pipe supports 64" long and are braced from the floor by pipes which are furnished with the panel. At the end of the pipe braces are pivoted flanges so they may be braced from the wall instead of the floor if desired.

Constant Current Transformer Panels 4500-5

FINISH

The finish of the instruments on the front of the panels is **dull black**. The handles of the plugs are stained black and polished. The porcelain bushings are colored brown.

PLUG RACKS

Plug racks for the reception of plugs when not in use are provided with all panels. These racks are shown attached to the panels in the various illustrations. To cover special cases where more plugs are used, a plug stand as illustrated can be supplied.



CONSTANT CURRENT TRANSFORMER PANELS FOR A. C. SERIES ARC LIGHTING 1150 AND 2300 VOLT PRIMARY

										For Cor	For Controlling	
										One 25 or 35 or 50-Light Transformer	One 75 or 100 Light Transformer	
Round Pattern Ammeter	, Ty	pe R	, with	cur	rent ti	ansfo	rmer	(exc	ept			
on 25 Light Circuit)			•					•	•	1	1	
Ammeter Jacks .		•	· .		•				•		2	
Ammeter Jack Plug						• .	•	•		·	1	
Open Circuiting Plug Sy	witch	es				•				2	4	
Short Circuiting Plug S	witch	ies								1	2	
Primary Plug Switches	with]	Fuse	Clips	;	•	•				2	2	
Primary Tube Fuses	•		•			•				4	4	
Plug Rack	•		•	•			•	•	•	1	2	
Panel, $28'' \ge 16'' \ge 1\frac{1}{2}''$	•		•	•	•	•			•	1		
Panel, $28'' \ge 20'' \ge 1\frac{1}{2}''$	·	<u> </u>	<u>.</u>	•		•	•	.		<u> ·</u>	1	

EQUIPMENT OF ISOLATED ARC PANELS

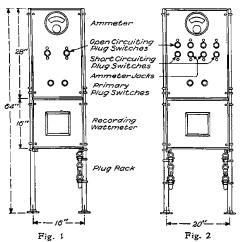
Pipe supports, braces and connections on the back are included.

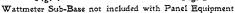
CONSTANT CURRENT TRANSFORMER PANELS FOR SERIES INCANDESCENT LIGHTING 1150 AND 2300 VOLT PRIMARY

EQUIPMENT OF ISOLATED INCANDESCENT PANELS

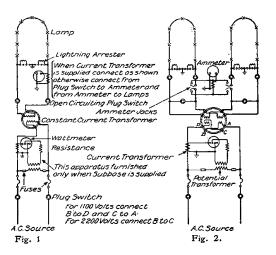
	Single	Double Sec- ondary Trans.		
	1 Trans.	2 Trans.	3 Trans.	1 Trans.
Round Pattern Ammeter, Type R, (with cur-				
rent transformer when necessary) .	1	2	3	1
Ammeter Jacks		· · ·		2
Ammeter Jack Plug				1
Open Circuiting Plug Switch	2	4	6	4
Short Circuiting Plug Switch		l _		2
Primary Plug Switches with Fuse Clips	2	4	6	2
Primary Tube Fuses	4	6	8	4
Plug Rack	1	2	4	2
Panel, $28'' \ge 16'' \ge 14''$	1	· · ·		· ·
Panel, $28'' \ge 20'' \ge 1\frac{1}{2}''$	·			1
Panel, 28" x 24" x 1 ¹ / ₄ "	l —	1		
Panel, $28'' \ge 32'' \ge 1\frac{1}{2}''$	1	_	1	

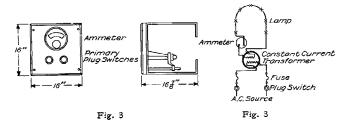
DIMENSIONS AND CONNECTIONS OF CONSTANT CURRENT TRANSFORMER PANELS FOR ALTERNATING CURRENT ARC LIGHTING 1150 AND 2300 VOLT PRIMARY





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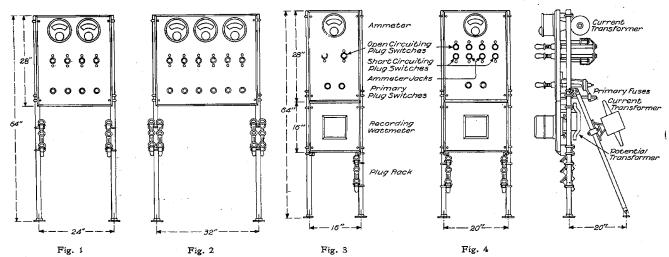
PANELS

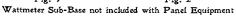
Prim. Voltage	Fig. No.	No. of Lights	Cat. No.
1150-2300 1150-2300 1150-2300 1150-2300 1150-2300	1 1 2 3	25 35-50 75-100 12-testing	44685 44686 44687 44688

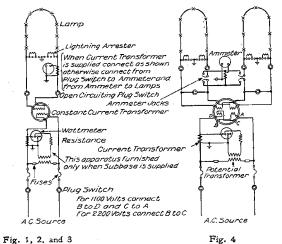
Fuses of the proper capacity should always be ordered (see table below). They are included in cost of panel.

		PRIMARY FUS	ES		1	WA	TTMETER SU	B-BASES	
No. of	Amp. (Amp. Capacity		Cat. No.		Amp. (Capacity	Cat.	. No.
Lights	1150 V.	2300 V.	1150 V.	2300 V.	Lights	1150 V.	2300 V.	1150 V.	2300 V.
25 32 50 75 100 12	15 25 30 50 75 8	8 12 15 25 30 4	51293 51295 51296 51298 23125 51290	51290 51292 51293 51295 51296 51287	25 35 50 75 100	20 30 40 60 80	10 15 20 30 40	44689 44690 44691 44692 44693	44694 44695 44696 44697 44698

DIMENSIONS AND CONNECTIONS OF CONSTANT CURRENT TRANSFORMER PANELS FOR SERIES INCANDESCENT LIGHTING 1150 AND 2300 VOLT PRIMARY







Panels 1150-2300 Volts

Kw. Capacity	Amp. Capacity		CAT. NO.	· ·
of Trans.	of Lamps	Single Circuit	Two Circuit	Three Circuit
$\begin{array}{r} *4.4-8.8-17.5\\ 4.4\\ 4.4-8.8\\ 17.5-24.5\\ 24.5\\ 35\\ \end{array}$	$\begin{array}{c} 1.75 - 3 - 3.5 \\ 3 - 3.5 \\ 5.5 \\ 5.5 \\ 5.5 \\ 3.5 \\ 6.5 \end{array}$	$\begin{array}{c} 44619 (\mathrm{Fig. 3}) \\ 44620 (`` 3) \\ 44621 (`` 3) \\ 44622 (`` 3) \\ 44622 (`` 3) \\ 44631 (`` 4) \\ 46632 (`` 4) \\ \end{array}$	$\begin{array}{c} 44623 \ (\text{Fig. 1}) \\ 44624 \ (\ \ \ 1) \\ 44625 \ (\ \ \ 1) \\ 44626 \ (\ \ \ 1) \end{array}$	44627 (Fig. 2) 44628 (** 2) 44629 (** 2) 44630 (** 2)

*4.4 Kw. at 1.75 Amp. only.

Fuses of the proper capacity should always be ordered (see below). They are included in the price of the panel.

	PRIMARY FUSES					WA	TTMETER SUB-P	ASES	
Trans. Kw.	Amp. Capacity Cat	Cat. No.		Amp, Capacity		Cat. No.			
Irans. Kw.	1150 V.	2300 V.	L150 V.	2300 V.	- Trans. Kw.	1150 V.	2300 V.	1150 V.	2300 V.
4.4 8.8 17.5 24.5 35	4 8 15 25 30	2.5 4 8 12 15	51287 51290 51293 51295 51295 51296	51286 51287 51290 51292 51292 51293	4.4 8.8 17.5 24.5 *24.5 35	5 10 20 30 30 40	$ \begin{array}{c} 5 \\ 5 \\ 10 \\ 15 \\ 15 \\ 20 \end{array} $	44633 44634 44635 44636 44636 44637 44638	$\begin{array}{r} & 44639 \\ & 44640 \\ & 44641 \\ & 44641 \\ & 44642 \\ & 44643 \\ & 44643 \\ & 44644 \end{array}$

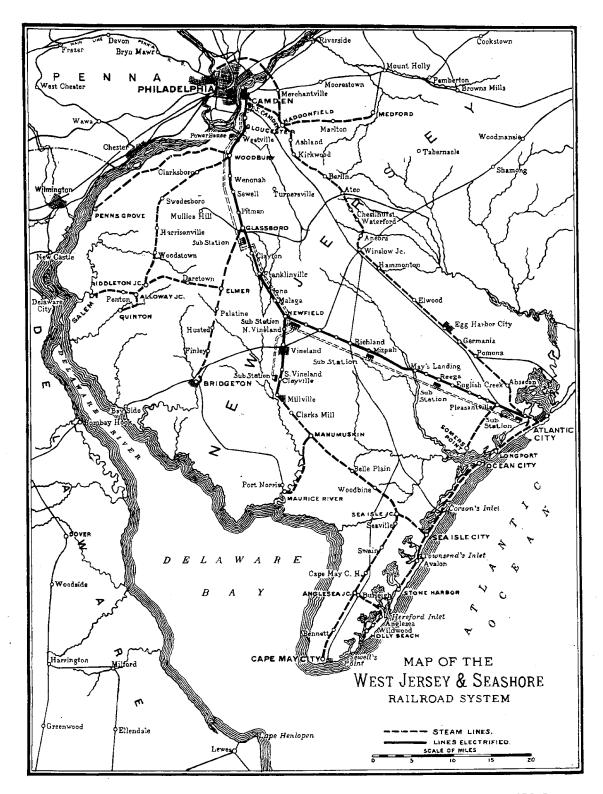
*For Multi-Circuit Transformers

The Electrification of the West Jersey and Seashore Railroad

> General Electric Company Schenectady, N. Y.

No. 4501 A Second Edition

February, 1908



MAP SHOWING THE ELECTRIFIED PORTIONS OF THE WEST JERSEY AND SEASHORE RAILROAD

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THE ELECTRIFICATION OF THE WEST JERSEY AND SEASHORE RAILROAD

THE West Jersey and Seashore Railroad, a division of the Pennsylvania system which has hitherto been operated by steam, has been equipped for electric operation over the lines extending from Camden to Atlantic City, a distance of 65 miles, and from Newfield to Millville, a distance of 10 miles.

The contract for the entire work of electrification was awarded to the General Electric Company and through them certain portions were sub-let. The electrical equipment throughout is of standard General Electric design.

The contract included the erection of a power house, eight substations, one of which is in the power house, the electrical equipment of approximately 150 miles of single track, the building of 71 miles of duplicate high tension transmission line, and the electrical equipment of 68 cars, in addition to a great deal of other work always incident to extensive undertakings of this nature.

A remarkable feature of the whole undertaking is the time in which the work has been accomplished. The site was chosen for the power house on January 17th, 1906; the first pile was driven two days later, and on July 1st the first train to take current from the power house was run on the newly electrified tracks. The execution of such a contract within the above time has established a new record.

This work has an added interest inasmuch as it called for the electrification of a main line double track steam road from terminal to terminal of a greater length than any steam road yet electrified in this country. The magnitude of the undertaking can best be appreciated by studying the map published, together with the following description:

Beginning at the Camden end of the line a new terminal has been constructed which adjoins the present ferry terminal. The work at this point includes the building of a number of stub end tracks with suitable sheltered platforms between them and threequarters of a mile of new double track trestle with stone piers and steel superstructure at street intersections. This latter structure connects the new terminal with the existing lines at a point near Haddon Avenue, where the tracks are at grade.

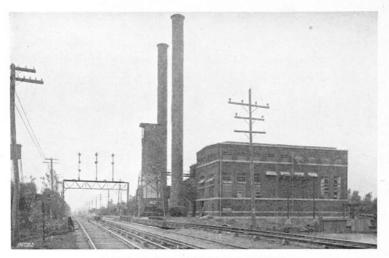
It will be noticed on the map that the Pennsylvania Railroad Company has two roads connecting Camden with Altantic City. It is the longer of these routes that has been electrified, as there is a local traffic on the longer route that can be handled more economically and expeditiously by electric traction than is possible with steam haulage.

The line from Camden to Atlantic City is a double track road throughout, and is a three track road between Camden and Woodbury. From the Camden terminal to Newfield the road is laid with 100 pound rails of the Pennsylvania Railroad standard cross-section, and from Newfield to Altantic City it is laid with 85 pound rails of the A. S. C. E. section.

From a point about two miles from Altantic City a new right of way has been secured. After crossing the thoroughfare on a new drawbridge the tracks cross the Philadelphia and Reading Railroad on an elevated structure and then enter the Atlantic City terminal on a descending grade. This terminal, like that at Camden, is new and consists of a number of stub end tracks with concrete platforms between them, these being protected with steel umbrella shelters. This station is located to the south of the present steam road terminal.

From Camden to Atlantic City the road has been equipped with a third rail, with the exception of a stretch of track 4.4 miles in length between Haddon Avenue and South Gloucester, where the tracks passing through the city streets at grade are furnished with overhead trolleys.

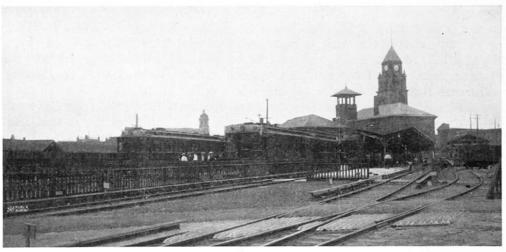
In addition to this through route, the line from Newfield to Millville has been electrified. On this portion of the road the overhead trolley has been installed. New terminal facilities



POWER HOUSE AT WESTVILLE, N. J.

have been provided here. The line from Newfield to Millville is a single track road and is laid with 100 pound rails of standard P. R. R. cross-section.

The importance of the undertaking is further emphasized by the density of the traffic on the electrified section of the road, which can be shown in a measure by giving the



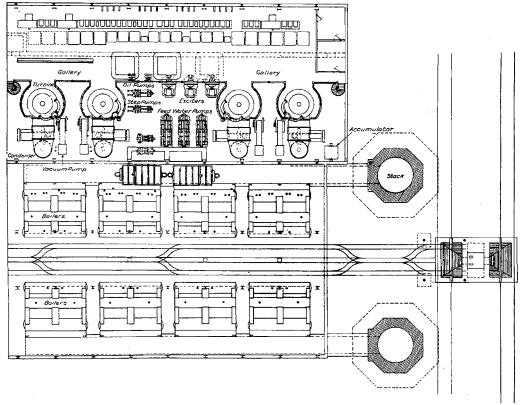
NEW TERMINAL STATION AT ATLANTIC CITY

schedule provided for. The express service to Atlantic City consists of three car trains running on a headway of 15 minutes in each direction at a speed, on straight level track, of 60 miles per hour, and the local service is provided for by two car trains between Camden and Millville running at half-hourly intervals, and single cars between Camden and Woodbury at ten minute intervals. The initial schedule that was put into service for the first few months of electrical operation included three car express trains between Camden and Atlantic City at one hour intervals, the running time being 90 minutes, and a local service

of two, three, and four car trains run at a minimum interval of 15 minutes during the rush hours between Camden and Glassboro, every fourth train going on to Millville. Motor baggage and mail cars are attached to the passenger trains as conditions require. It should be mentioned that each car in the electric service is a motor car, no trailers being used.

GENERAL SCHEME OF ELECTRIFICATION

The general scheme of electrification consists of generating A.C. power at a potential of 6,600 volts at the power house, where it is stepped up to 33,000 volts. At this latter

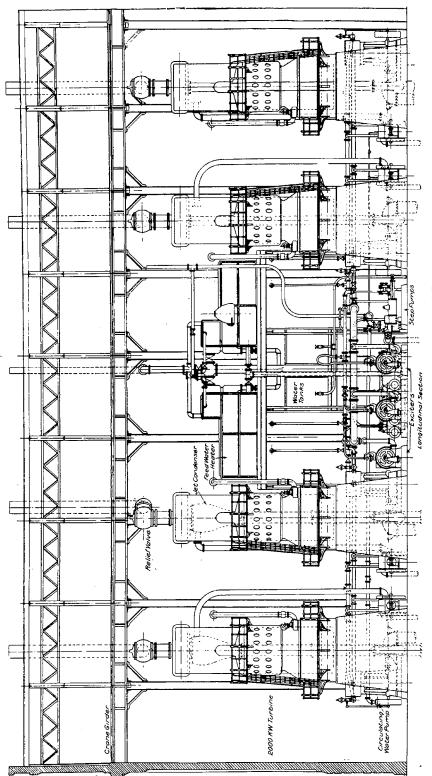


PLAN OF POWER HOUSE AT WESTVILLE, N. J.

pressure it is transmitted over the high tension transmission lines to the substations, where it is reduced to a potential of 430 volts by means of step down transformers, and then led to the rotaries and converted to direct current at 650 volts, at which pressure it is fed to the third rail for operating the cars.

THE POWER HOUSE

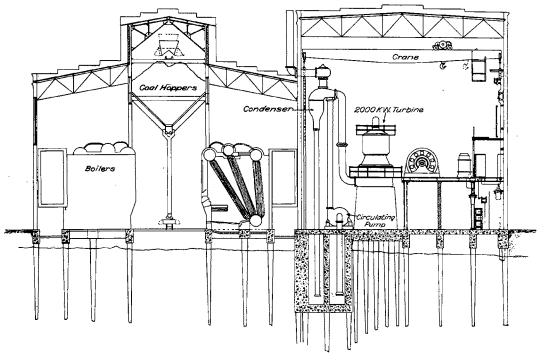
The power house is situated at Big Timber Creek, just to the north of Westville, N. J., at a point 5.6 miles from the Camden Terminal, where there is an abundance of water for boiler feed and condensing purposes. It has already been stated that the site for the building was chosen January 17th, 1906, and that the first pile was driven on January 19th, and as this building in all probability was erected at a greater speed than any other power station hitherto built in the United States, some additional data may be of interest to show the rapidity with which the work progressed.





The power house, including boiler room and stacks is built on approximately 850 concrete piles. The foundations, which were started on March 15th, are of reinforced concrete and are superimposed upon the piles in such a manner that the latter project about one foot into the mass of concrete, making a thoroughly homogeneous foundation.

The boiler foundations were completed by March 25th and those for the steam turbines by June 5th. The erection of the steel work for the main building was begun on April 18th. On March 5th the foundations for the stacks were started and were completed by the 25th



TRANSVERSE SECTION OF POWER HOUSE

of the same month. The steel work for the stacks was started on April 11th, and the first stack was erected, lined, and ready for use by June 29th.

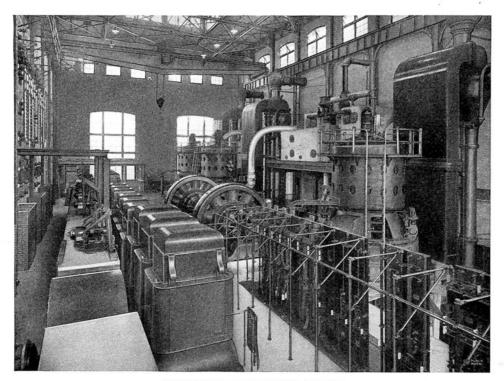
A host of other dates and figures might be given, but the most significant of all, as showing the rapid progress of the work, is, that on July 1st, five and one-half months from the date upon which the first pile was driven, two boilers were under steam at working pressure, a turbine and all the necessary auxiliaries were running, the substation in the power house was in operation, and the first car to take current from the power house was run on the line. This fact will speak more eloquently for the rate at which the work was executed than a whole chapter of figures and dates.

For the sake of brevity, the main portion of the electrical equipment of the power house is given below in tabular form:

Three 2,000 kw. 6,600 volt, 25 cycle three-phase Curtis Turbo Generators Two 75 kw. 125 volt Curtis Turbo Exciters Nine 700 kw. 25 cycle, Air Blast Transformers Two Blowers, capacity of each 20,000 cubic feet per minute The switchboard consists of:

Three 3-phase Generator Panels Two Exciter Panels Two Blower Motor Panels One Synchronizing Equipment Three 33,000 volt Transformer Panels Two sets of Lightning Arresters and Switches Six Static Potential Indicators Two 33,000 volt outgoing Line Panels

It will be seen from the above that the present normal capacity of the generating station is 6,000 kw. However, there is sufficient room provided in the lay-out of the building



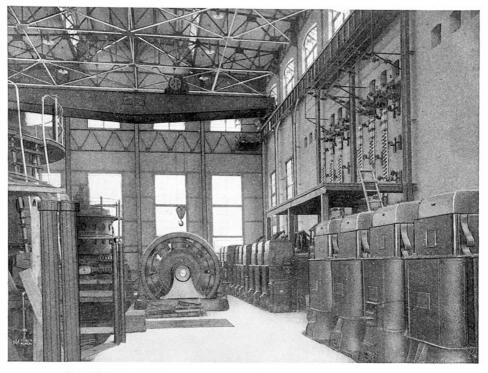
INTERIOR VIEW OF POWER HOUSE

for an additional 2,000 kw. turbo generator set, together with the necessary auxiliaries. The foundation for the extra turbine is already built. In addition to this provision for extra power, one of the end walls of the station is of a temporary nature, in order that increasing demands for power may be met with a minimum of expenditure in the future.

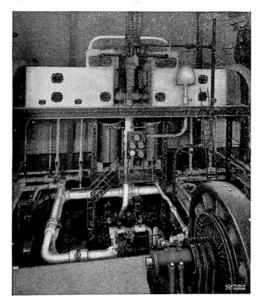
The most important items among the auxiliaries are as follows:

- (a) Two Curtis turbine exciter sets
- (b) Three Williamson Brothers barometic condensers
- (c) Three I. P. Morris and Co. dry air pumps
- (d) Three I. P. Morris and Co. centrifugal circulating pumps
- (e) Two Cochrane feed water heaters
- (f) Two Worthington boiler feed pumps

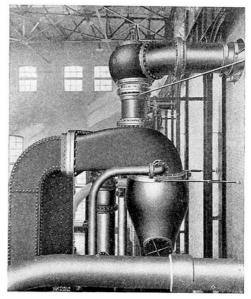
- Two Worthington make up pumps (g)
- (h) Two Worthington step bearing pumps
- (*i*)
- Three Worthington step bearing water return pumps One R. D. Wood and Co. accumulator for step bearing (j)



INTERIOR VIEW OF POWER HOUSE, SHOWING SUBSTATION GALLERY



FEEDWATER HEATERS, ETC.

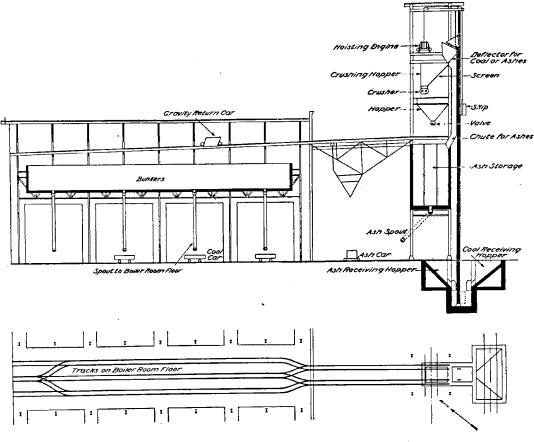


CONDENSER HEAD

BOILER HOUSE

The boiler house is furnished with 12 Stirling water tube boilers arranged in pairs to form six batteries. Each boiler is rated at 358 h.p. and is provided with a superheater capable of delivering steam at 175 pounds pressure and at a temperature of 125° Fahrenheit in excess of that of saturated steam. The Stirling Boiler Co. of Barberton, O., were sub-contractors for both the boilers and boiler settings.

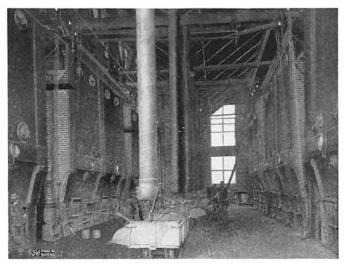
The type of coal and ash handling machinery is shown by the illustrations. The coal is dumped from the railway cars into the receiving hopper over which the rails are laid, as



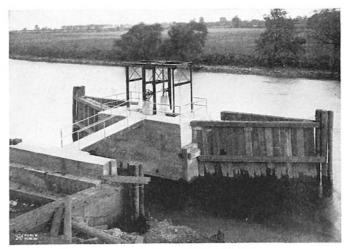
COAL-HANDLING APPARATUS

shown in the plan. As will be seen, the receiving hopper has a slanting bottom, to feed the coal by gravity through a valve which is only opened when the skip is in the correct position for loading. The loaded skip is raised by means of the hoisting engine till it reaches the level of the deflector, when it is automatically tipped into the crushing hopper, the smaller coal passing through the screen and the larger coal being broken in the crusher in transit. From this hopper the coal is fed into the gravity return car by means of the valve at the bottom, when it is conveyed by the automatic railway over the coal bunkers into which it is tipped. The empty skip is returned automatically by a system of counter weights. From the bunkers the coal is again fed to the cars on the boiler room tracks. The ashes are

taken from the boiler house in cars and dumped into the receiving hopper, from where they are raised in a similar manner to the coal, but with the deflector thrown in the reverse direction from that shown in the illustration. The ashes are conveyed from the ash chute to the ash storage bin, from whence they are conveyed by means of a chute to cars on the railway track.



INTERIOR OF BOILER ROOM



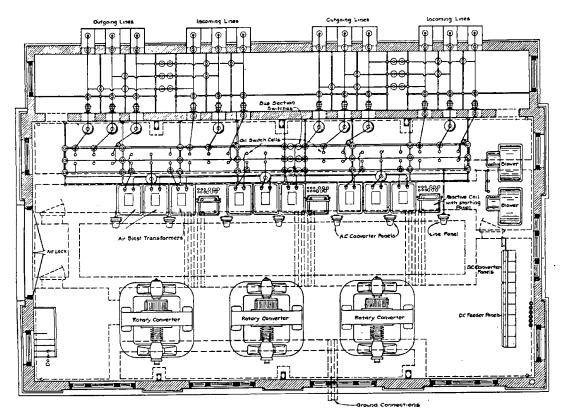
VIEW OF CONDENSER INTAKE

SUBSTATIONS

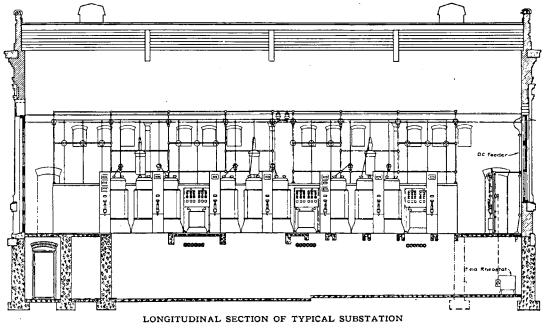
The high tension three-phase current is reduced in pressure and converted to a direct current at 650 volts in eight substations distributed along the line as follows:

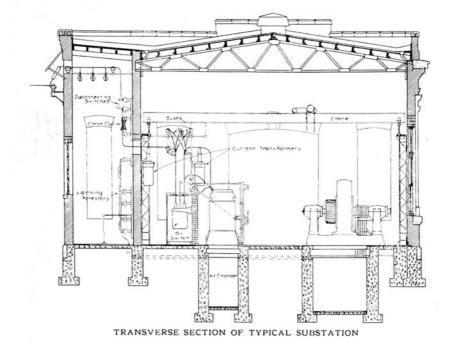
One is located in the power house at Westville. There are three terminal substations, situated respectively at South Camden, Clayville, and Atlan ic City, and four intermediate substations, one at Glassboro, one at Newfield, one at Mizpah, and one at Reega.

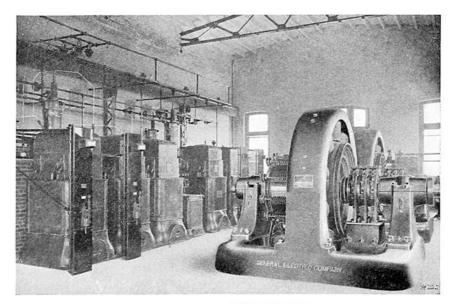
The equipments in the several different substations vary according to the requirements of the portion of the road they supply.



PLAN OF TYPICAL SUBSTATION



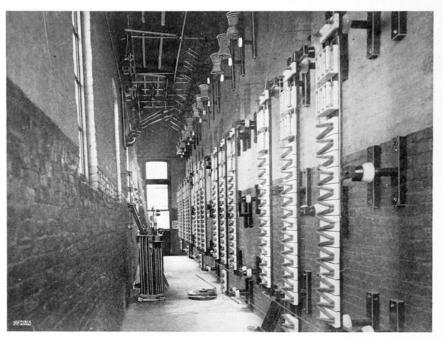




INTERIOR VIEW OF SUBSTATION

Table I shows the number and capacity of rotary converters installed in each substation, together with the ultimate capacity. In addition to this data, the square feet and cubic feet per ultimate kw. capacity of each substation is given.

The rotary converters are all of standard General Electric design, and are capable of running at 150% full load for two hours with a temperature rise not exceeding 55° . The



LIGHTNING ARRESTER COMPARTMENT IN SUBSTATION

TABLE	I	

	Rotary Converters Already Installed		Ultimate	Square Feet per Kw.	Cubic Feet per Kw.
SUBSTATIONS	No. of Units	Kw. Capacit y of Each	Kw. Capacity.	(Ultimate ((Ultimate Capacity.)
South Camden	2	750	2500	.97	20.4
Westville (In Pr. H.)	2	750	2250	*	*
Glassboro	2	750	2500	.97	20.4
Newfield	2	750	2500	1.24	26.0
†Clayville	2	500	2500	.97	20.4
Mizpah	2	500	2500	.97	20.4
Reega	2	750	2500	.97	20.4
Atlantic City	2	750	3500	.96	20.4

* Included in Power House.

† The 500 kw. machines are temporary, 750 kw. units to be installed.

transformers are supplied with taps giving one-third and two-thirds of the working voltage to enable the converters to be started from the A.C. side. This method of starting needs no synchronizing, and should the D.C. polarity of the machine chance to come in the wrong direction it is readily changed by means of the field reversing switch provided for this purpose.

By this method, any of the rotary converters can be started, run up to full speed, and be delivering power to the line within a minute.

Three air cooled transformers are provided for operation in conjunction with each rotary, and these are located in each case with a view to the further extension of the



EXTERIOR VIEW OF SUBSTATION

substation, and as they are all of standard design it is not necessary to go into details regarding their construction.

The disconnecting switches and lightning arresters in each substation are located in a separate room, the high tension circuits are of bare copper wire supported on insulators on a pipe framework, and each pole of the oil switches is enclosed in a separate brick compartment. In all cases the instruments and oil switches are of the General Electric design.

For the purpose of illustration, the intermediate substations with two 750 kw. rotary converters have been selected as being typical. These illustrations render a detailed description unnecessary, but it should be mentioned that every precaution has been taken to provide for the continuous operation of the road under all traffic and weather conditions.

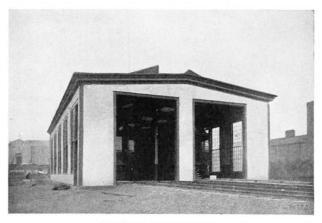
The substation buildings are of red brick, trimmed with Indiana limestone facings,

and the floors are of concrete. Each substation is furnished with a hand operated crane, capable of handling any of the machinery installed.

It is a matter of interest that the substation buildings, including the foundations, were built in sixty working days, and that the installation of machinery was accomplished in thirty working days.

INSPECTION SHEDS

An inspection shed has been built at each of the three terminals. The largest of these, a three track shed is situated at Camden and has accom-



CAR INSPECTION SHED

modations for nine cars, an office, storeroom, and a small machinery shop. The Atlantic City shed is smaller than that at Camden, having only two tracks, while that at Millville is yet smaller, being a single track shed. The track pits are provided with steam heat and are lighted by electricity; compressed air is provided for cleaning purposes. The third rail is not continued into the inspection shed, the overhead trolley being used.

THE HIGH TENSION TRANSMISSION LINE

The 33,000 volt high tension transmission line is in duplicate throughout. It is Y con-

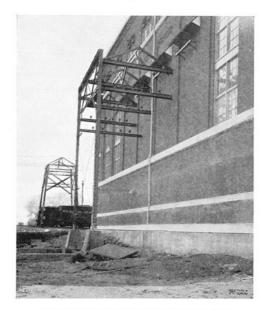


VIEW OF HIGH TENSION TRANSMISSION LINE, SHOWING ARRANGEMENT OF INSULATORS, GUARDS, ETC. nected with the neutral grounded and consists of six No. 1 B. & S. hard drawn solid copper wires mounted on porcelain insulators The poles are of chestnut, their height being 45 feet, with extra long poles where special conditions require them. They are spaced 125 feet apart, but at street crossings the spacings are reduced to 100 feet. Head guys are used at distances of approximately one-quarter of a mile. There are two cross-arms, the top arm being 12 feet in

length, carries four insulators, and the lower arm, which is 8 feet 6 inches, carries two. The six wires form two inverted equilateral triangles, and the insulators are 42 inches apart; the wires in each triangle are transposed

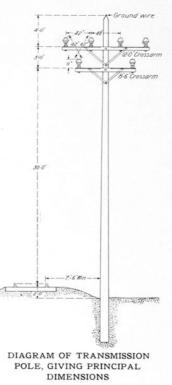


A unique feature of the transmission line is the method



VIEW SHOWING THE CONSTRUCTION WHERE THE TRANSMISSION LINE LEAVES THE WESTVILLE POWER HOUSE

The is the method of protection from lightning, which consists of a seven strand galvanized steel cable $\frac{5}{16}$ inch in diameter strung for the entire length of the line on top of the transmission poles, 4 feet above the nearest active wire,



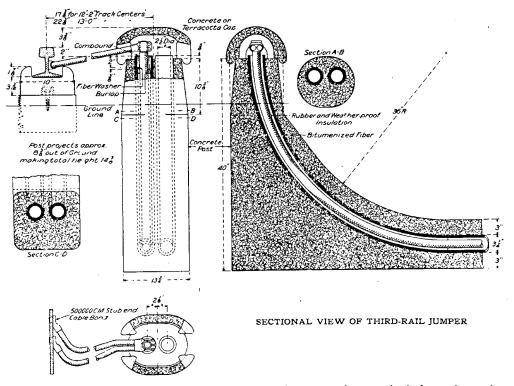
and provided with ground connections at every fifth pole. This form of protection from lightning is believed to be an efficient supplementary adjunct to the arresters.

THE THIRD RAIL

The proposition of installing the third rail for a double track road of this length, in the prescribed time, demanded a considerable amount of skill on the part of those organizing the work, and the fact that a large amount of steam traffic was going on at the same time materially added to the difficulties of the undertaking.

The rails used for this purpose are of the Pennsylvania Railroad standard cross-section and composition; they are in lengths of 33 feet, weigh 100 pounds per yard, and have a conductivity about equal to that of a copper rod of 1,200,000 c.m. This type of third rail was used in order that it might be interchangeable with the track rails.

The insulators are of reconstructed granite, and are held in position by a metal centering cup which is secured in the long ties by means of a lag screw. The general form of these insulators will be seen in the illustrations, which also show the method of retaining them in position. An advantage of this method of securing the position of the insulators is that

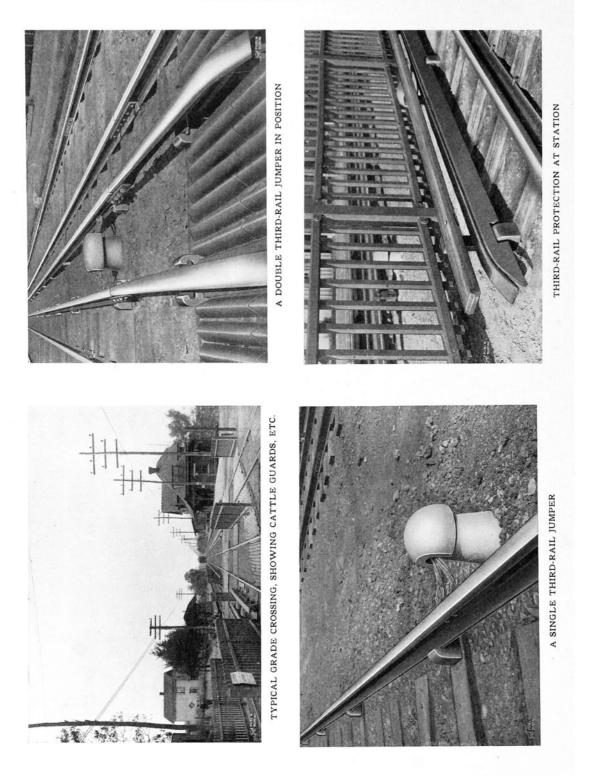


on the ties being depressed by the passage of a train no tension strain is brought to bear on them.

The third rail is bonded with concealed ribbon bonds which have solid copper terminal compressed into one-inch holes drilled in the rail. There are two bonds to a joint, and as each has an area of 500,000 c. m. this gives a total area of copper per third rail joint equal to 1,000,000 c. m. The work of bonding the third rail was accomplished at the rate of 660 bonds per day.

The third rail jumpers are of a specially neat design. They are used at all grade crossings and whenever a continuous third rail is impracticable, the cable is drawn into a black bituminized fiber tube, which is laid in a solid concrete protection. The illustration shows a double jumper.

The third rails are arranged in such a manner that each track may be isolated from the other, but normally the third rails are electrically connected midway between the substations through a combined switch and fuse box, thus obtaining the combined conductivity of the



third rails. There are also section insulators opposite each substation, so that in the event of an accident on any part of the system only a short section of the third rail would be dead.

The Company's right of way is fenced in, and at all crossings this fence turns in from the property line to meet Climax cattle guards at the edge of the crossing. In this way the public is prevented from reaching the third rail.

At all stations, and in the Atlantic City and Camden yards, the third rail is protected by a wooden top and side guard. This consists of a two-inch plank carried on castings attached to the top of maple posts, which are secured to the third rail at intervals of about six feet. The top casting is of such form that although it is provided with a web for strength, no part



VIEW TAKEN AT CAMDEN, SHOWING WHERE THIRD RAIL ENDS AND TROLLEY BEGINS

of it extends either above or below the protection plank. The approaches of the third rail are made of cast iron.

Opposite all platforms the rail is further protected by a plank fastened to the side of the rail. Wherever possible the rail is kept between the tracks, and is therefore on the side of the track farthest from the station platform, and inter-track fences are provided to prevent crossing the tracks. In order to prevent passengers or others on the platforms from touching the third rail shoes on the platform side of the car, there is a protecting plank, similar to the third rail protection, but in this case the plank is carried on castings fastened to the ties. This is used at all stations, even where the third rail gives way to the trolley, although there is a switch on the car which enables the contact shoe being cut out when operating from the trolley.

A point of great interest is to be found in the fact that the third rail system has been adopted at both terminal stations where there are a number of platforms, and it will be interesting to engineers to learn that this system was adopted on the score of less difficulties being encountered in its installation than would have been the case had an overhead trolley been erected.

BONDING OF MAIN TRACKS

The bonding of the main track between Camden and Altantic City was a work of great magnitude, which will be appreciated when it is remembered that a heavy steam traffic was in progress during the whole period. It is a matten of interest to know that all holes were drilled by hand and also that the bond terminals were expanded by means of screw compressors. Two GE bonds of the "concealed" type were used per joint, each with a capacity of 400,000 c. m.

TROLLEY LINE

The trolley construction between Newfield and Millville and on the stretch of track 'between Hadden Avenue and South Gloucester is of the span type, with poles spaced at a distance of 100 feet; where practicable the high tension transmission poles have been used for supporting the span wires. Through Camden, tubular steel poles are used for the greater part of the trolley construction. The trolley is suspended 22 feet above the top of the track rails.

There are no copper feeders used with the third rail, but those for the trolley lines are as follows:

Two 750,000 c.m. Feeders from South Camden to Haddon Avenue

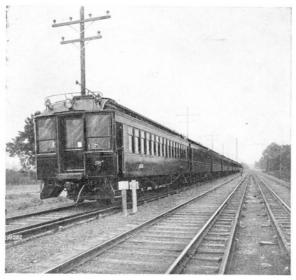
One 500,000 c.m. Feeder running from South Camden to Brown's Crossing

The copper feeder for the trolley between Newfield and Millville is 750,000 c. m. section. The length of line between Newfield and Millville is approximately ten miles. The trolley

wire is No. 0000 grooved section, and the bonding is exactly similar to that already described on other portions of the road. The span wires are of stranded galvanized steel $\frac{3}{8}$ inch in diameter. The lightning arresters are installed at approximately 1,000 feet apart. All puff-offs, strain ears, feeder ears, and splicing sleeves are of bronze, and as these items, together with all other line material, such as frogs, etc., are of standard pattern, a further description would be superfluous.

ROLLING STOCK

To provide for the initial service 62 passenger cars and six combination baggage and



TYPICAL ELECTRIC TRAIN

mail cars were provided, all of which are motor cars furnished with similar equipments of motors and control apparatus.

MOTOR AND CONTROL EQUIPMENT

The electrical equipments were furnished and installed by the General Electric Company. These consist of two GE-69 motors, which are 200 h.p. units, on each car, while the control system is of the Sprague-General Electric Automatic Multiple Unit type. The controllers are so arranged that current is cut off from the motors throughout the train and the brakes are applied automatically should the motorman release his hold on the controller handle.

On account of the short time at the disposal of the contractors it was not possible to follow the usual cut and try methods in installing the brakes, control apparatus, and piping, and therefore carefully made detailed drawings of all conduit work and hangers were prepared in advance and, in accordance with these plans, the equipments were installed simultaneously at the different car shops as soon as the car body framing was sufficiently advanced to permit it. This method of installation in addition to facilitating the speed of equipping the cars has the advantage of securing uniform and interchangeable work.

For the sake of brevity, these motor and control equipments will not be entered into in detail, as they are of standard General Electric design. With the exception that each car is provided with a trolley and third rail shoe, the control system is similar to that on the 24 equipments supplied to the Boston Elevated road some eighteen months ago. These equipments are also similar to those built for the local traffic on the electrified portions of the New York Central lines. A switchboard provided with the necessary switches for transferring from trolley to third rail and *vice versa* is situated in the vestibule. The headlight and air compressor switches and fuses together with the current limiting relay are mounted on the same panel. The lightning arresters, trolley cut-out switch, and trolley fuse are mounted in a box which is situated between the trolley bases on the roof of the car.

All cars are provided with a 50 c. p. incandescent electric headlight and two electric markers or route lamps on the hood at each end. In the interior of the car there are five 5-light clusters and in the saloon there is a single lamp. There are two lights in each vestibule.

The cars are heated by Gold Cylindrical Heaters, one being under each seat, a total of 28 heaters per car. There are two coils in each heater, providing three degrees of heat.

CAR BODIES

In general design the cars are similar to the standard Pennsylvania coaches, with the exception that the height is somewhat less in order to decrease the weight.

The general dimensions of the cars are as follows:

Length over buffers .							۰.		55 f	feet	$5\frac{1}{2}$ in	ches	i
Length over body and s	:11-								46		6	" "	
Length over bouy and s	1112	·	•	•	•	•	•	•	22	* *	-		
Truck centers	•	•	•	•	•	·	۰.	•	55	.,		.,	
Width over all		•	•		•	•	•	•	10	• •	14	••	
Height from top of rail	to to	p of	root	ca	ar lig	(ht)			13	"	$3_{rac{13}{16}}$	* *	
Total weight of car fully	r equ	ippe	ed or	n tra	ack	•	•		89,	000	pound	ls	

Each passenger car has a seating capacity of 58 persons.

The combination baggage and mail cars are of the same general dimensions as the passenger cars and have similar vestibules. The mail compartment and the baggage compartment are respectively 20 feet and 29 feet 91 inches long inside. The arrangement of the baggage compartment is similar to the standard Pennsylvania Railroad combination cars and the fittings and arrangements in the mail compartment are in accordance with the standard requirements of the Post-office Department.

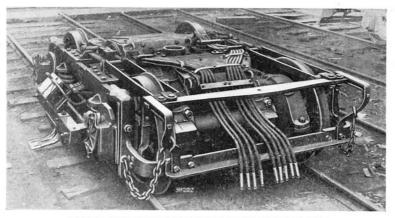
The interiors of the passenger cars are handsomely finished in mahogany. Both ends of the cars are provided with vestibules and have the standard arrangement of steps, trap doors, and vestibule side doors. The seats are of the standard Pennsylvania pattern, made by the Hale and Kilburn Manufacturing Company. On the roof, in the center of each car, there is an illuminated numeral panel which permits the car number being read from either side.

The Wason Manufacturing Company of Springfield, Mass., built 22 of the passenger cars and 6 of the combination baggage and mail cars; the American Car and Foundry Company of Wilmington, Del., built 22 passenger cars, and the J. G. Brill Company of Philadelphia, Pa., built 18.

TRUCKS

The motor and trailer trucks are of the M. C. B. double side bar equalized type, somewhat similar to those used on the cars of the Interborough Rapid Transit Company and the Long Island Railroad, but with a greater wheelbase. The general dimensions of the trucks are as follows:

Gauge of truck	4 feet $8\frac{1}{2}$ inches
Distance between backs of wheel flanges	4 '' $5\frac{3}{8}$ ''
Wheel base	7 ''
Weight of motor truck complete without motors .	14,934 pounds
Weight with trailer truck complete	9,653 **
Weight on center plate (car body light) motor truck	25,384 ''
Weight on center plate (car body light) trailer truck	26,065 ''



TRUCK EQUIPPED WITH TWO GE 200-H.P MOTORS

The wheels of the motor truck are steel tired with separate cast steel spoke centers. They are 36 inches in diameter, with M. C. B. standard treads. The tires are 3 inches thick, shrunk and bolted to the steel center. The hub of one wheel on each axle of the motor truck is extended and to this hub the forged steel gear is shrunk after the wheel has been pressed on the axle. The axles are of open hearth steel and conform to the test requirements of the Pennsylvania Railroad standard specifications. The journals are 5 inches by 9 inches, the diameter of the axle at the wheel fit is 8 inches, and diameter between wheels is 7 inches finished all over.

Schoen solid rolled steel wheels 33 inches in diameter are used on the trailer truck. The trailer truck axles have $4\frac{1}{4}$ inch by 8 inch journals, are $5\frac{3}{4}$ inches in diameter at the wheel fit, and tapered to $4\frac{3}{4}$ inches in diameter at the center.

The motor and trailer trucks for 65 cars were built by the Baldwin Locomotive Works of Philadelphia, and for three cars by the J. G. Brill Company of Philadelphia.

BRAKES

Each car is equipped with a complete complement of hand and quick service automatic air brakes.

A control line extends through the entire train, insuring uniform pump labor on all cars. These brakes enable the motorman to divide the process of release into as many steps as may be desired, and give the same flexibility as with a straight air-brake equipment.

The auxiliary reservoir pressure is maintained by means of a quick recharge feature, through three separate ports, which enables a large number of brake applications to be made in quick succession without depleting the system. The brake system also includes a quick service feature which, when a service application is made, establishes communication between the brake cylinder and brake pipe pressure, thus materially assisting the auxiliary reservoir in building up the brake cylinder pressure in the usual manner.

The motor driven air compressors consist of duplex single acting air pumps, driven by motors of the railway type. The motors are entirely enclosed and require no additional housing of protection of any kind. The governors are of Standard General Electric pattern. and are protected by a hinged cover which can be readily dropped to facilitate inspection.

The General Electric Company installed all the brake apparatus and piping, with the exception that the car builders supplied the foundation brake rigging.

The conversion of the lines of the West Jersey and Seashore Railroad from steam to electric traction was carried out as follows:

The construction of the terminals, inspection sheds double tracking, changes in existing tracks, grading, new bridges, changes in telegraph lines, and the installation of a special telephone system, were carried out by the regular Engineering and Maintenance of Way Departments of the Railroad Company.

The installation of the interlocking plants and automatic block signaling was carried out by the Union Switch and Signal Company in accordance with plans of the Signal Department of the Railroad Company.

The new cars and trucks required for the electric service were designed by the Motive Power Department and the Railroad Company.

The entire contract for the electrical equipment, including the construction of the power house, substations, and the electrical equipments on the cars, was awarded to the General Electric Company. The work was carried out under the direct charge of the Engineering and Construction staff of the General Electric Company in accordance with plans and under the supervision of Mr. George Gibbs, Chief Engineer of Electric Traction of the Railroad Company.



LIGHTING DEPARTMENT

August, 1909

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H. L.W

CQ GENERATORS AND BALANCER SETS

The General Electric Company is manufacturing a full line of direct current generators in capacities ranging from $1\frac{1}{2}$ kw. to $17\frac{1}{2}$ kw., which are known as the Type CQ generators. These machines are particularly well The bearing heads are so designed that the generators can be installed on the floor, walls or ceiling, adapting them for crowded locations and places where a generator of different construction could not be used. The



CQ GENERATOR

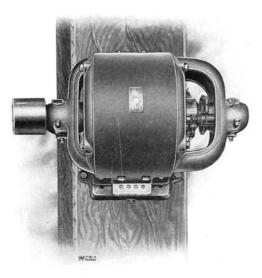
adapted for supplying current for use in small isolated lighting or power plants; in fact for any purpose requiring small belt-driven direct current generators. Their design is the result of long experience in the construction of small motors and generators, and they are built with improved machinery by experienced workmen, and only the highest grade of material enters into their construction. CQ generators run at slow and moderate speeds, take up but little floor space, are of robust construction and have high efficiency for machines of their capacity.

The table on page 7 gives the ratings, weights and principal dimensions of standard CQ compound wound generators which are designed to give either 125 or 250 volts at full load. These generators are also made for

Second Edition

4503A-2 CQ Generators and Balancer Sets

three-wire operation to act as balancer sets as will be described later.



CQ GENERATOR INSTALLED ON UPRIGHT

FRAME

The generator frame and pole pieces are made of soft steel of high permeability. The field coils are held in place by the extended tips on the pole pieces and the pole pieces are securely fastened by bolts to seats formed on the inside of the frame with the nuts on the outside so that they can be readily removed when necessary.

The good quality of the material used in the frame and pole pieces, together with the short magnetic circuit, reduce iron losses to a minimum, and allow of high efficiencies being obtained in these generators.

ARMATURE AND FIELD

The armature core is built up of steel laminations, japanned to prevent eddy currents. In the larger sizes the assembled core is provided with air ducts for ventilation. Two cast iron spiders which extend as flanges to support the armature coils clamp the laminations tightly together. The completed armature is thoroughly insulated so that it is impervious to moisture and practically indestructible, except under extreme overloads. The armature coils are form wound, of insulated copper wire, and are thoroughly insulated and tested to avoid possibility of short circuits. The coils are securely held in toothed slots punched in the armature discs and extend out over the end flanges. They are bound by band wires to prevent vibration or movement of the coils. This form of winding provides a large radiating surface for the armature conductors, and consequently reduces the heating. The individual coils can be readily removed and replaced when necessary.

The field coils are thoroughly insulated, compact and can be readily removed, as previously explained, by taking out the pole pieces. Each coil is subjected to a special treatment which renders it practically impervious to moisture.

BEARINGS

The CQ generators are designed with bearings of ample size to insure cool running and are lubricated automatically by rings revolving on the shaft and dipping into oil



BRUSH-HOLDER, YOKE AND BRUSHES

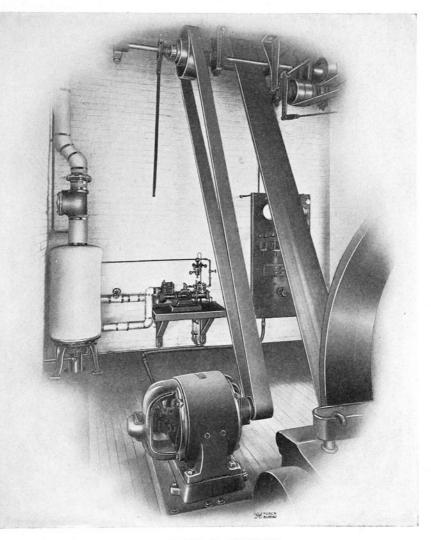
wells. The bearing linings are made of special composition bearing metal in one piece, and are held in position by the bearing heads which are securely bolted to the frame.

Generators can be adapted for wall or ceiling installation by turning round the bearing heads 90 or 180 degrees, so that the cap screw

CQ Generators and Balancer Sets 4503A-3

holding the bearing linings will be vertically above the shaft. This adjustment is readily made by removing the bolts holding the bearing brackets to the frame and turning the bearing head on the shaft without having to

tator and the pulley can be reversed relatively to the frame. This is specially important where the generator has to be fastened to the walls or ceiling, as the terminal block of the machine will always be accessible and the gen-



CO GENERATOR IN OPERATION,

remove the armature. The bearing brackets protect the internal parts of the motor, and at the same time allow sufficient ventilation to insure cool running.

The two bearing brackets are also interchangeable so that the position of the commuerator can be driven from that end of the machine which is most convenient.

COMMUTATOR AND BRUSH-HOLDERS

The commutator segments are made of carefully selected hard drawn copper. The

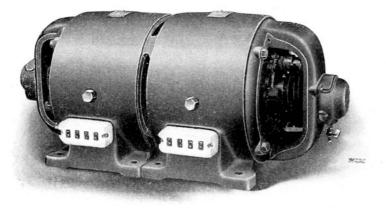
4503A-4 CQ Generators and Balancer Sets

mica between the segments is selected so as to wear evenly with the copper and the armature conductors are soldered directly into slots provided in the segments.

The brush-holder is of substantial construction and embodies all those features necessary in a first-class brush-holder. The brushes are of high grade carbon and slide in finished box guides. They are supplied with flexible copper pigtails of ample current carrying capacity and are held firmly against the commutator by a lever arm, which gives practically a uniform pressure throughout the whole wearing depth of the brush. An auxiliary spring of sufficient flexibility attached to the lower fore more expensive to construct than machines of the same output and high speed.

Standard CQ generators are compound wound, 120 to 125 volts and 240 to 250 volts full load, as shown in the table, page 7. The ratings are conservative and the machines will run full load without undue rise of temperature of any part.

Standard CQ generators will deliver their output continuously without the temperature of any part rising more than 45 degrees C. above the surrounding air and will operate for two hours with 25 per cent. overload or stand momentary overloads of 50 per cent. without injurious heating.



CQ BALANCER SET

side of this lever is used to allow the brushes to respond quickly to any irregularities of the commutator surface due to wear, thus preventing jumping and consequent sparking.

The care taken in the construction of the commutator and the excellent electrical constants of the generator will insure sparkless operation from no load to full load without shifting the brushes, thus reducing wear and increasing the life of the commutator.

SPEED, VOLTAGE AND CAPACITY

The slow speeds at which the CQ generators operate minimize friction losses, but the machines are somewhat heavier and there-

BALANCER SETS

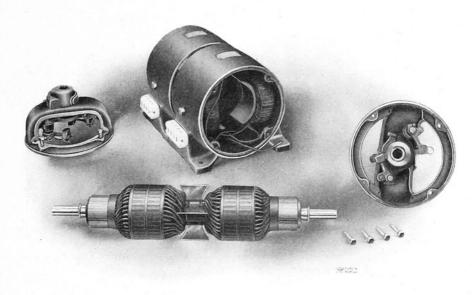
These generators are peculiarly adapted for use as balancer sets for three-wire systems. In such cases the design adopted is simple and compact, as shown in the accompanying illustrations. Two generator frames are riveted together through spacing blocks and both armatures are mounted on a common shaft which dispenses with the necessity of a third bearing common to this type of unit and at the same time simplifies the construction and economizes floor space. The shaft between the armatures is strengthened by means of an intermediate armature head which increases the section, and, therefore, the strength at the point of maximum deflection.

CQ Generators and Balancer Sets 4503A-5

A fan is provided mounted between the armatures so as to draw in a sufficient volume of air through the interior portions of the two machines to keep the heating of all parts within conservative limits, ample ventilating openings being provided between the spacing blocks. Although these sets are somewhat enclosed in the middle, the same heating will

bined current of the two machines compensating for the increased load on the generator side. Balancer sets are flat compounded so as to keep the voltage on each side equal, irrespective of the load.

These balancer sets afford a very convenient method for obtaining a neutral on three-wire systems, and can be used in systems



VIEW OF DISASSEMBLED BALANCER SET

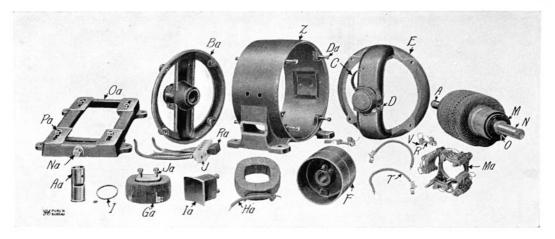
be guaranteed as in standard CQ generators and the efficiencies are high.

The balancer sets can be placed across a three-wire 250 volt system and will compensate for unbalanced load in either side of the system. When the load is balanced, both machines operate as unloaded motors, but when unbalanced, one machine operates as a generator and the other as a motor, the comof large capacity provided the amount of unbalancing between the two sets on the system does not necessitate a neutral current beyond the capacity of the set. To avoid misunderstanding, it is advisable when ordering these machines to give the voltage across the outside wires and the amount of current in the neutral, rather than the kilowatt capacity.

DIMENSIONS, RATINGS AND PARTS OF STANDARD CQ GENERATORS

A view of a disassembled CQ compound wound generator with parts named will be found on the following page. A dimensioned diagram giving ratings, speeds, weights and principal dimensions of standard compound wound CQ generators will be found on page 7.

4503A-6 CQ Generalors and Balancer Sets



VIEW OF A DISASSEMBLED CQ GENERATOR

- Key for Armature Shaft Oil Well Cover А
- C
- Overflow Plug D
- E Commutator End Bearing Head
- F Pulley
- Ι

. .

- Oil Ring Porcelain Terminal Block
- J M Commutator
- N Armature Shaft

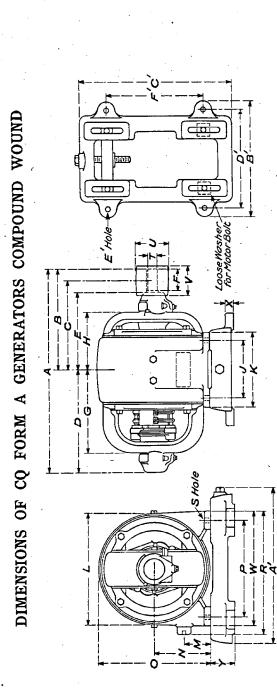
- 0
- R
- Thrust Collar Brush-holder Body Brush-holder Cable Т
- V Carbon Brush with Pig Tail Z Magnet Frame V
- Aa Bearing Lining, Pulley End Ba Pulley End Bearing Head
- Da Cap Screw for Bearing Head Ga Field Spool

- Ha Field Spool Lead Ia Pole Piece Ja Cap Screw for Pole Piece Ma Brush-holder Yoke
- Na Adjusting Screw for Base Oa Sliding Base Pa Float Bolts

- Ra German Silver Shunt

In Ordering Parts give Machine Number and Rating from Name Plate

CQ Generators and Balancer Sets 4503.4-7



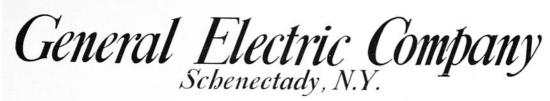
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PRINCIPAL OFFICES, SCHENECTADY, N. Y.

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(Address nearest office.) BOSTON, MASS., 84 State Street. NEW YORK, N. Y, 30 Church Street. SYRACUSE, N. Y., Post Standard Building BUFFALO, N. Y , Ellicott Square Building. NEW HAVEN, CONN., Malley Building. PHILADELPHIA, PA., Witherspoon Bldg. BALTIMORE, MD., Continental Trust Building. CHARLOTTE, N. C., Trust Building. CHARLESTON, W. VA., Charleston National Bank Bldg PITTSBURG, PA., Park Building. RICHMOND, VA., 712 Mutual Building. ATLANTA, GA., Empire Building. NEW ORLEANS, LA., Hennen Building. CINCINNATI, OHIO, Perin Bldg., Fifth and Race Sts. COLUMBUS, OHIO, Columbus Savings & Trust Bldg. CLEVELAND, OHIO, Citizens Building. NASHVILLE, TENN., Stahlman Building INDIANAPOLIS IND, Traction Terminal Building. CHICAGO, ILL., Monalnock Building. DETROIT, MICH , Majestic Bldg. (Office of Soliciting Agt.) ST. LOUIS, MO., Wainwright Building. KANSAS CITY, MO., Dwight Building. OKLAHOMA CITY, OKLA, Culbertson Bldg. (Office Sol't g Agt.) DALLAS, TEXAS, Scollard Bldg. (Office of Soliciting Agt.) BUTTE MONTANA, Ph enix Building. DULUTH, MINN, Providence Building MINNEAPOLIS, MINN., Phoenix Building DENVER, COLO., Kittredge Building. SALT LARE CITY, UTAH, Newh use Building. SAN FRANCISCO, CAL, Union Trust Building LOS ANGELES, CAL., Delta Building. PORTLAND, ORE., Worcester Building SEATTLE, WASH., Colman Building. SPORANE, WASH., Paulsen Building. FOREIGN FOREIGN DEPARTMENT, Schenectady, N. Y., and 30 Church St., New York, N. Y LONDON OFFICE, 83 Cannot St., London, E. C., England For all CANADIAN Business, Canadian General Elec ric Company, Ltd.,

Toronto, Ontario.



MAIN LAMP SALES OFFICES, HARRISON, NEW JERSEY.

June, 1907

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A.O.W

Bulletin No. 4506

THE EDISON GEM FILAMENT 50 WATT LAMP

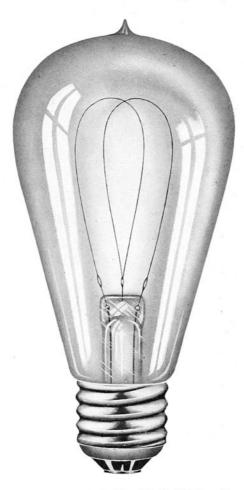


Fig. I. Edison GEM (Metallized) 50 Watt Lamp, Regular Type—90 to 130 Volts—19 to 20 C. P.—2.5 Watts per Candle.

The discovery and introduction of the GEM (or metallized) filament by the General Electric Company has effected a radical improvement in the quality of incandescent lamps.

The new GEM filament is obtained from the ordinary carbon filament by subjecting it to the intense heat of the electric furnace. This operation (twice repeated) renders the filament much more refractory and capable of withstanding a materially higher temperature for a given life and deterioration. The higher temperature thus permitted gives increased lighting efficiency with a saving of 20% in the current over that required by the ordinary carbon filament lamps to produce a given illumination.

4506-2 The Edison GEM Filament 50 Watt Lamp

The improvement given by the GEM filament over the carbon filament is graphically shown in Fig. 2 giving the gain in efficiency for the same life, or the gain in life for the same efficiency. The standard adopted with the new GEM filament to replace the ordinary 16c. p. carbon filament lamp is a 50 watt 19 to 20 c. p. lamp. The improvement secured by the GEM filament thus results in a 25% increase of candle

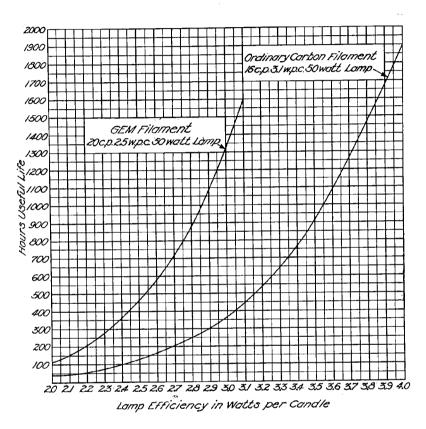


Fig. II. Useful Life Curves of New GEM Filament Lamp and Present Carbon Filament Lamp.

TABLE I

Present C	arbon Filame	ent Lamp	TI f1	New G	EM Filamen	t Lamp
Initial Eff. in watts per candle	Total Watts for 16 c.p.	Total Watts for 20 c.p.	- Useful Life of both new and old lamp	Initial Eff. in watts per candle	Total Watts for 20 c.p.	Saving in Power new lamp over old lamp.
3.1	50	62	450 hours	2.5	50	20 percent

The Edison GEM Filament 50 Watt Lamp 4506-3

power, with total watts unchanged, instead of keeping the candle power unchanged and reducing the total watts per lamp. This is considered desirable for the following reasons:

It maintains current consumption per lamp the same as at present.

It gives a higher candle power which is needed in competition with other illuminants.

Gives consumers the increased light in the lamp instead of necessitating an increase of installation to secure the maximum light obtainable with the same current consumption.

Gives central stations same output per lamp as at present thus avoiding the necessity of increasing number of consumers or lamps connected per consumer.

CHARACTERISTICS

The GEM 50 watt lamp, as may be seen from the illustration, is the same as the ordinary 16 c.p. in size of bulb, and in all respects save filament. The GEM filament is made of two loops connected in series. The use of the two loops is necessitated by manufacturing requirements, and they are constructed so as to give the same ratio of mean spherical and mean horizontal candle power as is given by the standard oval 16 c.p. filament.

The GEM filament is somewhat less affected by changes of voltage than the ordinary carbon filament, because the GEM filament behaves like a metal (hence the term "metallized") in resistance changes, giving an increase of resistance with increase of voltage and decreased resistance with decrease of voltage—just the reverse of the ordinary carbon filament. The light given by the GEM filament is of superior brilliancy and whiter in color than that of the ordinary carbon filament.

The GEM lamp gives equally satisfactory service on either direct or alternating current circuits, and is supplied for the usual commercial voltages of 90 to 130.

RATING

The GEM lamp is rated in total watts; candle power values not appearing on the label. The rating unit is thus changed from candle power to watts per lamp which is really the proper unit inasmuch as electric light is sold on the watt hour basis. Candle power values will not be abandoned, but will be used in a more definite way, as, for example, in reference to a lamp with a given reflector.

The design of label employed is shown below. Each label has three voltage markings arranged in steps two volts apart.

These voltages are termed "top," "middle," and "bottom" voltages or first (V1); second (V2), and third (V3) voltages. This arrangement provides for adapting the new



lamp to existing situations by for GEM Lamps varying the efficiency to suit different conditions, and to secure satisfactory life.

Customers requiring lamps of maximum efficiency 2.5 w.p.c., will order lamps with top or first voltage corresponding to the circuit voltage. Customers requiring lamps of slightly lower efficiency—2.65 w.p.c.—will order lamps with middle or second voltage corresponding to the circuit voltage. Customers requiring lamps of still lower efficiency—2.8 w.p.c.—should order lamps with

TABLE II
Table of Average Values GEM-50 Watt Lamp at 1st, 2d and 3d Voltages

With Voltage of Cir-		Mean Horizontal		Mean Spherical	Spherical Candle		W.P.C.	Ordinary Carbon Filament of
cuit the Same as	Watts	Candle Power	Candle Power	Candle Power	Power Factor	Hours Useful Life	Candle Hour Area	Corresponding Life
First Voltage (V1) Second Voltage (V2) Third Voltage (V3)	50 48.5 47.3	$\begin{smallmatrix} 20\\18.3\\16.7\end{smallmatrix}$	$2.50 \\ 2.65 \\ 2.83$	$16.5 \\ 15.1 \\ 13.8$	$82.5\%\ 82.5\%\ 82.5\%\ 82.5\%$	450 640 940	8,330 10,840 14,530	16 c.p.—3.1 w.p.c. 16 c.p.—3.3 w.p.c. 16 c.p.—3.5 w.p.c.

4506-4 The Edison GEM Filament 50 Watt Lamp

bottom or third voltage corresponding to the circuit voltage, giving a life the same as the ordinary carbon lamps of 3.5 w.p.c.

The average values that will be given for 100 to 130 volt lamps at the various voltage markings, are given in the foregoing table.

EFFECT OF HIGH EFFICIENCY LAMPS

The advantage of the GEM lamp to a consumer on central station service is, of course, obvious. As the new GEM lamp consumes the same total watts (50) as the old carbon lamp, the gain to the consumer is in the increased light he receives for the same expenditure. In the following table is shown the cost of power and lamp renewals to a consumer for 1000 hours of light with the new and old lamps. would be obviously the same as those shown above for the consumer.

The value cannot be determined by sole reference to central station costs or operating conditions. The value comes in enabling the central station to supply light more efficiently and at less expense to the consumer, and thus to meet and resist competition and increase the use of electric light.

In an analogous case in the gas business the introduction of a higher efficiency lamp the Welsbach mantle—proved to be of substantial benefit to the gas business and there is every reason to expect that similar benefits to electric lighting will follow the introduction of the GEM lamps.

TABLE III

Cost of 1000 Candle Hours of Light, including Cost of Power and Lamp Renewals for Different Lamp Efficiencies at Various Rates per Kilowatt Hour.

Rates per Kw. Hour	Ordinary Ca (Cost 16		GEM lamp 2.5 w.p.c.
in cents	3.5 w.p.c.	3.1 w.p.c.	(Cost 20 cents)
$ \begin{array}{c} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 11 \\ 12 \\ 13 \\ 14 \\ 15 \\ 16 \\ 17 \\ 18 \\ 19 \\ 20 \\ \end{array} $	$\begin{array}{r} 4.5\\8.0\\11.5\\15.0\\18.5\\22.0\\25.5\\29.0\\32.5\\36.0\\39.5\\43.0\\46.5\\50.0\\53.5\\57.0\\59.5\\64.0\\67.5\\71.0\end{array}$	5.18.211.314.417.520.623.726.829.933.036.139.242.345.448.551.654.757.860.964.0	$\begin{array}{c} 4.5\\ 7.0\\ 9.5\\ 12.0\\ 14.5\\ 17.0\\ 19.5\\ 22.0\\ 24.5\\ 27.0\\ 29.5\\ 32.0\\ 34.5\\ 37.0\\ 39.5\\ 42.0\\ 44.5\\ 47.0\\ 49.5\\ 52.0\\ \end{array}$

The value of higher efficiency lamps such as the GEM to a central station company cannot be directly shown. Were central stations selling in light units (candle hours) instead of power units (watt hours) the gains

THE CENTRAL STATION POLICY FOR THE GEM LAMP

There should be no question of the wisdom of adopting high efficiency lamps such as the GEM to extend and develop electric lighting

The Edison GEM Filament 50 Watt Lamp 4506-5

service to the fullest extent.

In adopting the new lamp, companies have their choice of employing the GEM lamp at either first, second, or third voltage (as stated in the description of the new label) and of thus giving their consumers—

The highest efficiency available with total wattage of 50 watts and candle power value of 20, or

Lower efficiencies with total wattage below 50 watts and with longer life giving lessened renewal costs.

In Table VI full data are given on renewal costs per Kw. hour for the GEM and ordinary carbon lamp.

Progressive practice should lead all central stations now using carbon lamps of an efficiency of 3.1 w.p.c. to adopt in their stead the GEM lamp at first voltage and full efficiency of 2.5 w.p.c., thereby keeping the watt consumption per lamp the same as at present.

Companies at present using 3.5 w.p.c. carbon lamps could adopt one of the following from table IV: basis at different rates will be secured with that efficiency which makes the sum of lamp renewals and cost of current a minimum. These values for the new GEM lamp are given in Table V. This table shows that for all rates above 5 cents per kilowatt-hour a consumer would obtain his light at a minimum cost, including cost of purchasing his own renewals, by using the new 2.5 w.p.c. lamp.

The accepted practice is to supply lamp renewals free and save the consumer this part of the expense. It would seem, therefore, that this full efficiency of 2.5 watts per candle would be the desirable one for central station companies to supply, because at any lower efficiency the consumer could afford to buy his own lamps and would save money by so doing. Enlightened and progressive central station practice finds benefit in making the consumers' interest its own, and should therefore supply the lamp that secures a minimum lighting cost, i. e., the new 2.5 w.p.c. lamp.

Table V indicates the efficiency giving

TABLE IV

With voltage of circuit same as	Mean Horizontal Candle Power	Total Watts	Reduction in watt consump- tion per lamp over 3.5 w.p.c. carbon lamp
First voltage (V1)	20.0	50.0	6 watts or 10.7 %
Second voltage (V2)	18.3	48.5	7.5 watts or 13.4 %
Third voltage (V3)	16.7	47.3	8.7 watts or 15.5 %

Where the first voltage cannot be adopted, the second voltage is to be recommended to replace 3.5 w.p.c. carbon lamps as this rating allows the consumer to share the improvement, receiving 12% more light for 13% less wattage. Lamp renewal costs are very low for 3.5 w.p.c. carbon lamps, and the majority of stations could afford the slight increase therein for the GEM lamp (see Table VI).

EFFICIENCY OF NEW LAMP, GIVING MINIMUM LIGHTING COSTS

The minimum cost of lighting to the con-. sumer paying for light on the kilowatt-hour minimum lighting costs for any assumed case of power costs. Take an isolated plant for example, whose total cost for power delivered at the lamp is 3 cents per Kw. hour. From the table we see that the minimum costs would be given with the lamp burning at an efficiency of 2.7 w.p.c. which corresponds to the second voltage range. Likewise an installation where power costs run about two cents per Kw. hour at the lamp would call for an efficiency of 2.8 w.p.c. which corresponds to the third voltage range. 4506-6 The Edison GEM Filament 50 Watt Lamp

COMPARATIVE DATA—COST, RENEWALS, ETC.

In Table VI will be found useful comparative data on the GEM 50 watt and the ordinary carbon filament lamps. The cost of renewals of the GEM lamp is but slightly more than that of the ordinary carbon lamp, and as shown in Table VI the use of the various voltage ranges permits varying the cost of renewals per Kw. hour from about eight-tenths cent to about fourtenths cent, giving a range of costs comparable with that of the ordinary carbon lamp.

The economy of the GEM lamp is, however, far more than sufficient to offset the increase of renewal cost, and as shown in Table III

TABLE V

TOTAL COST OF LIGHT PER 1000 HOURS' SERVICE OF 20-CP NEW GEM-FILAMENT LAMP (AT VARIOUS EFFICIENCIES)

Including Cost of Lamp Renewals and Power at Various Rates Shown LAMP PRICE 20C. (LAMP LIFE AS GIVEN BY FIG. 2) (Minimum costs are underlined and starred)

Lamp Effici-	Total Watts	Lamp Re- newal Costs per Kilowatt-			Total	Cost of	Cost Pl		AND L.		NEWALS)	•.	
ciency in Watts per Candle	per 20-cp Lamp	Hour in Cents	@ 1c.	@ 2c.	@ 3c.	@ 4c.	@ 5c.	@ 6c.	@ 7c.	@ 8c.	@ 9c.	@ 10c.	@ 12c
2.1	42	2.7	\$1.55	\$1.974		\$2.81	\$3.23	\$3.65	\$4.07	\$4.49	\$4.91	\$5.33	\$6.17
2.2	44	1.95	1.29	1.74	2.18	2.61	3.06	3.50	3.94	4.38	4.92	5.26*	6.14*
2.3	46	1.43	1.11	1.58	2.04	2.50	2.96	3,42	3.88	4.34*	4.80*	5.26	6.18
2.4	48	1.06	0.99	1.47	1.95	2.43	2.91	3.39*	3.87*	4.35	4.83	5.31	6.27
First Voltage				1	ŀ		1			1.			
2.5	50	0.8	0.90	1.40	1.90	2.40	2.90*	3.49	3.90	4.40	4.90	5.40	6.40
2.6	52	0.614	0.83	1.36	1.88	2.40*	2.92	3.44	3.96	4.48	5.00	5.52	6.56
Second Voltage	}		[Į	Ĩ					1	1		
2.7	54	0.469	0.79	1.33	1.87*	2.41	2.95	3.49	4.03	4.57	5.12	5.66	6.74
2.8	56	0.37	0.76	1.32*	1.88	2.44	3.01	3.56	4.13	4.68	5.24	5.81	6.93
Third Voltage)	1		1]		
2.9	58	0.29	0.74	1.33	1.91	2.49	3.07	3.65	4.23	4.81	5.39	5.97	7.13
3.0	60	0.23	0.73	1.34	1.94	2.53	3.14	3.74	4.34	4.94	5.54	6.14	7.34
_ 3,1	62	0.183	0.73*	1.35	1.97	2.59	3.21	3.83	4.45	5.07	5.69	6.31	7.55

TABLE VI

COMPARATIVE DATA ON GEM FILAMENT 50-WATT LAMP AND ORDINARY CARBON FILAMENT LAMPS

	GE	M Filament L	amp		6 c. p. Carbo liament Lar			. Carbon nt Lamp
<u> </u>	At top or 1st voltage (V1)	At "Middle" or 2nd volt- age (V2)	At "Bot- tom" or 3rd voltage (V3)	At 3.1 w.p.c.	At 3.5 w.p.e.	At 4 w.p.c.	At 3.1 w.p.c.	At 3.5 w.p.e.
Mean Horizontal C. P. Eff. in Watts per candle Total Watts Useful life (to 80% of C. P.) in hrs. K. W. hours consumed during useful life Candles per K. W.		18.3 2.65 48.5 640 31. 377	16.7 2.83 47.3 940 44.5 353	16 3.1 49.6 450 22.3 320	163.556.90050.4285	16 4. 64 1800 115.2 250	$20 \\ 3.04 \\ 60.8 \\ 415 \\ 25.2 \\ 329$	20 3.48 69.6 830 57.7 286
Cost of famp in cents to custo- mer using 10,000 a year Lamp renewal costs per Kw. hr. Cost of 1000 candle hours of light at 10c. per Kw. hr. Cost of light or income per lamp per 1000 hrs. service at 10c. per Kw. hour	.20 \$0.88 \$0.25	.20 \$0.645 \$0.265 \$4:85	.20 \$0.45 \$0.28 \$4.73	.16 \$0.71 \$0.31 \$4.96	.16 \$0.317 \$0.35 \$5.60	.16 \$0.14 \$0.40 \$6.40	.16 \$0.63 \$0.34 \$5.08	.16 \$0.28 \$0.348 \$6.96

The Edison GEM Filament 50 Watt Lamp 4506-7

its cost of operation is, for an equal amount of light, far below that of the ordinary carbon filament, except in the cases of extremely low rates per Kw. hour of one cent or less.

HOLOPHANE REFLECTORS

Great as are the gains in efficiency with the new filaments, still greater gains are possible by the more efficient use of lamps. To the end of promoting more efficient use, a line of Holophane reflectors has been designed for the 50 watt lamp. These are made in the types "B." "C" and "D," uniform with those provided for the high c.p. incandescent units, and are illustrated below with the characteristic candle power distribution curves of each, showing the candle power values to be obtained beneath the lamp.

These Holophanes should be used with the ordinary 24-inch clamp shade holder, or the form "O" holder, Cat. No. 46626. As in the case of the regular GEM units the three forms of Holophanes provided give the following distributions.



FORM "O" HOLDER (³/₄ size) Used with Holophanes for 50 Watt

Gem Lamps. Standard Finish -Polished Brass

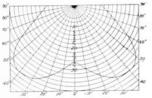
Cat. No. 46626 Form "O" holder brings shade into same position as the ordinary 24" clamp shade-holder.



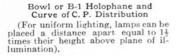
HOLOPHANES FOR 50 WATT GEM LAMPS

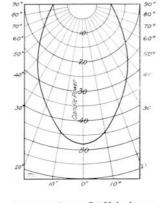












Concentrating or C-1 Holophane and Curve of C. P. Distribution (For uniform lighting, distance be-tween lamps should equal 3 their height). Distributing or D-1 Holophane and Curve of **C**. P. Distribution

0 10

20

20

30

70 6n

(For uniform lighting, distance be-tween lamps should equal their height.)

4506-8 The Edison GEM Filament 50 Watt Lamp

The Concentrating or "C" type gives a concentrating distribution beneath the lamp suitable for locations where the light is to be concentrated over a relatively small area, and in the case of high ceilings, show windows and narrow spaces. These are to be generally recommended for use with single lamps (of this size) over desks and tables.

The Distributing or "D" type of Holophane gives a distributing candle power suitable for low ceilings or wherever it is desired to distribute the light over a wide area.

The Bowl or "B" type of Holophane gives a very desirable candle power distribution superior in many respects to that of the "D" type in that the light is brought down and spread out at the useful angles of 30 to 40 degrees from the vertical and very little light is lost at the upper angles of 10 to 20 degrees below the horizontal which is an objection to the "D" type of distribution. The "B" Holophane is recommended for general lighting of interiors.

These Holophanes can be used with the ordinary carbon lamp in 10, 16 and 20 c.p. using the same size bulb (SS-19) as employed with the GEM 50 watt lamp.

PRICES

The price of the 50 watt GEM lamp and the Holophanes therefor, is given in the following table.

It is desirable to have lamps used with the "C" and "D" type of Holophanes "bowl" frosted. As the 50 watt lamp is regularly supplied clear it is necessary to specify "bowl" frosting where desired.



EDISON GEM 50 WATT LAMPS AND HOLOPHANES



TABLE OF SIZES AND PRICES

				CANDLE PO	WER IN DOWNW.	ARD DIRECTION		LIST PRIC	e s
Description	Volts	Total Watts	No. Lamps in Standard		With C-1 Holophane	With D-1 Holophane	Incand. Edison		B-I, C-1 & D-1 Holophanes
of Lamp		Per Lamp	Package	57-inch Diam.	6 ² -inch Diam.	7§-inch Diam.	Plain	Frosted	(Stand. Pkg. Quantity 50)
GEM 50 Watt in 2 3 -inch bulb	90-130 20-90	50 50	200 200	30 30	45 45	25 25	\$0.25 .30	$0.27\frac{1}{2}$. $32\frac{1}{2}$	\$0,45

LIST PRICE OF FORM "O" SHADE HOLDER-\$0.05

GEM 50 Watt lamps will be delivered f.o.b. Harrison, N. J., with freight allowed on standard package quantities only, to all points on or east of the Mississippi River to Salt Lake City, Utah. Denver, Colo., Sioux City, Iowa, Kansas City, St. Joseph and St. Louis, Mo., Butte, Mont., Omaha, Nebr., Waco, Dallas, Fort Worth and Houston. Tex. For an added charge of $\frac{1}{2}$ cent per lamp net, freight will be allowed to following points: San Francisco, Sacramento, Stockton, Los Angeles, San Diego and Oakland, Cal., Portland, Ore, and Seattle, Wash.

Shades and fittings will be delivered f.o.b. Harrison, N. J., with freight allowed in standard package quantities to Atlanta, Ga., Boston, Mass., Chicago, Ill., Cincinnati, Ohio, Cleveland, Ohio, New Orleans, La., New York City and St. Louis, Mo., and to the following points after charges per reflector indicated are added to charges given in the above table: Denver, Colo., 3 cents, Salt Lake City, Utah. 4 cents, San Francisco, Cal. and Portland, Ore., 2 cents.

General Electric Company Schenectady, N.Y.

SUPPLY DEPARTMENT

June, 1907

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ELECTRIC FLAT IRONS

Ironing by electricity is now recognized as an important feature of domestic and industrial work. The following points are a few of the many which recommend Electric Flat Irons for general use:

1—They are always clean, smooth and ready for use.

2-There is no smoke, soot or dirt.

3—There is no hot fire or disagreeable odor of combustion.

able outlet—in the smaller sizes at any lamp socket.

7—They require no holding pad as their handles are always cool and the liability of burned fingers is lessened.

8-Decreased fire risk.

GENERAL ADVANTAGES

In the Home, electric irons mean cool laundries and better work with less labor.



COMMERCIAL LAUNDRY AT BUFFALO, N. Y. USING ELECTRIC FLAT IRONS

4—The temperature is easily regulated and the iron is always just hot enough for the work in hand.

5—There are no journeys between ironing table and stove.

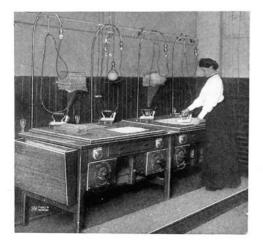
6-They can be used wherever there is a suit-

Ironing can be done in any part of the house, or in summer on the back porch as well as in the laundry.

In Commercial and Hotel Laundries much higher efficiency per operator in both quantity and quality of work is obtained with

4507-2 Electric Flat Irons

electric irons. No energy is used when the iron is idle and the actual cost of operating the ironiug room is reduced.



SMOOTHING BLUE PRINTS WITH ELECTRIC IRONS

In Tailor Shops space is saved and the absence of the usual stove, relieves the employees from poisonous gases and stifling heat. Work never has to wait for a hot iron.

In Factories more sanitary conditions

prevail and the fire risk is reduced. Space, time and labor are saved. Special electric irons for various forms of work are being continually designed and correspondence is solicited with factories wishing to improve their efficiency in this department.

For Architects and Draughtsmen a sixpound electric flat iron will be found valuable in drying and smoothing blue prints.

Photographers who use dry mounting tissue will obtain better results by using a sixpound electric flat iron in their work.

In Hospitals where cleanliness and pure air are essential, the electric flat iron is naturally desirable.

For Travellers a small iron can be conveniently included in a travelling outfit and by its use the wrinkles can be removed from garments in the hotel room.

VALUE OF A FLAT IRON LOAD TO CENTRAL STATIONS

Electric Flat Irons are valuable revenue earners for central stations. In demonstration of this, the results obtained by a typical station serving a population of 18,000 in Central Ver-

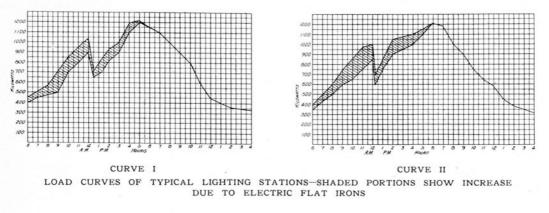


DISTRIBUTING CENTERS OF GENERAL ELECTRIC FLAT IRONS IN THE UNITED STATES

Electric Flat Irons 4507-3

mont may be quoted. Comparison was made of the incomes for July 1905, when there were no irons in service, and July 1906 with about 200 installed. It was found that 150 of these irons increased the station's actual consumption in July 1906, over the previous year

casting. The fiber handle is mortised and fits around the upper part of the handle supports; it is securely bolted, well insulated from the metal and cannot work loose or become heated in service.



about \$100, or 66 cents per iron.

None of these irons is installed in a commercial laundry or factory and as this station makes a minimum charge of \$1 per month for lighting, the introduction of the flat irons raises the consumption above this minimum charge to a point where each additional kilowatt is practically net gain.

Curves are given on this page which show the improvement of the day load by electric flat irons. Curve I is from the records of a company in a city of 25,000. One hundred flat irons are in use all day in a factory and 500 irons are distributed among the residences. Curve II is a Tuesday load curve in a city of about 30,000 and shows the effect of 500 irons on the lines.

Electric Flat Irons are not only valuable revenue earners but serve as the opening wedge for the introduction into the home of the many practical electrical devices that are becoming indispensable conveniences.

CONSTRUCTION

Simplicity and durability are the special features of General Electric Flat Irons. The body and handle supports are a one-piece

THE HEATING ELEMENT

The illustration below shows the parts of a six-pound iron including the cartridge type heating unit used in all General Electric Flat Irons. It consists of an edgewise-wound spiral of special resistance ribbon, insulated between turns, and enclosed in a mica-lined, copper cylinder. The iron may be left idle



ER-POUND IRON WITH HEATING UNIT REMOVED

on the circuit indefinitely without burning out and the unit is practically indestructible. When renewals are necessary, however, the cartridge unit can be removed and replaced by anyone in five minutes, making the iron in every respect as good as new.

SHAPE

In designing the General Electric Flat Irons

4507-4 Electric Flat Irons

special care has been given to the shape. Stove-heated irons must *store* heat and are necessarily solid masses of metal. Where the



SIX-POUND IRON, PULL-OFF PLUG, FLEXIBLE CABLE AND ATTACHING PLUG

heat is generated in the iron itself, storage capacity is unnecessary and the energy, instead of heating a large mass of metal is available for useful work. The General Electric Irons are so shaped as to facilitate the flow of heat to the working surface at the same time giving sufficient radiating surface to prevent overheating if accidentally left standing idle on the circuit.

STANDS

The Triple-Deck Stand shown in the illus-



TRIPLE-DECK FLAT IRON STAND

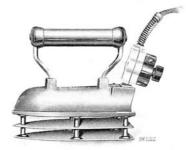
tration thoroughly insulates the ironing tables from heat. It consists of three plates of thin sheet metal, about three-fourths of an inch apart, mounted on steel pins.

INDICATING SWITCH

The Indicating Switch, Cat. No. 42441, is similar to the ordinary indicating wall snap switch and shows whether the current is "on" or "off." It is conveniently mounted on the attaching plug at the heel of the iron and by it the operator can secure the best heat suited for the work. For light material the current is turned off from time to time, making it impossible for the iron to become hot enough to scorch, while



on heavy work the high **INDICATING SWITCH** temperature necessary may be continuously maintained by leaving the switch at "on." A



SIX-POUND IRON WITH INDICATING SWITCH

glance shows whether the current is on or off and the iron is therefore not likely to be left in circuit when not in use.

ACCESSORIES

Each General Electric Iron is equipped with eight feet of flexible cable and attaching plug for wall receptacle or socket. Where the Indicating Switch is not used, a plain Pull-off Plug, Cat. No. 42442 is supplied to connect the cable to the iron.

TRAVELLER'S IRON

This iron weighs three pounds, takes 250 watts and can be attached to any lighting socket. It gives sufficient heat for all light pressing, such as required on light dress goods, ribbons, laces, shirtwaists, etc. It is especially adapted for use in the sewing room or bedroom and can be conveniently carried by travellers, removing the necessity of trusting delicate fabrics to the laundries.

Finish. The iron has a japanned wooden handle; all metal parts are heavily nickel plated.



THREE-POUND TRAVELLER'S IRON

DOMESTIC IRON

The Domestic Iron weighs six pounds and takes 500 watts. Its weight, balance and temperature are just right for the average home laundry. With the indicating switch it can be used on light pressing, although the three-pound iron is recommended for this class of work.

The six-pound iron is also suitable for use in garment factories, dress-making establishments, neckwear factories, cleansing and dyeing houses, hotel laundries, hospitals, etc., etc., and for pressing blue prints, mounting photographs, etc.

LAUNDRY IRON

Electric Flat Irons 4507-5

For general use in commercial and hotel laundries the standard six-pound, 500 watt iron will be found satisfactory, but an eightpound, 600 watt iron is made for heavy work on wet material.

The three-pound iron should be used on light delicate fabrics.

A Morocco face Polishing Iron having a blunt rounded toe is also made.

Finish. The eight-pound iron has a dull aluminum finish. The Morocco Irons are nickel plated. The handles are of black fiber.

Views are shown in this Bulletin, of laundries equipped with electric flat irons, which illustrate the increased personal comfort of the operators. In one case where the electric

irons replaced gasheated irons, which were cumbersome and difficult to regulate, each operator could do 30 per cent. more work per day.



MOROCCO IRON

TAILOR'S IRONS

The General Electric Tailor's Goose is made in four weights, 12-pound, 15-pound, 18-pound and 24-pound, and takes from 700 to 800 watts. It is ten inches long by three and threequarter inches wide. The 12-pound iron



TAILOR'S HEAVY ELECTRIC FLAT IRONS-12, 15 AND 18 POUNDS

Finish. Six-pound irons are furnished in a dull aluminum finish or highly polished nickel plate. The handles are of black fiber.

makes an excellent seaming iron for ladies tailors, as it maintains the hot toe necessary in such work. The 15-pound and 18-pound

4507-6 Electric Flat Irons

irons will be found suitable for regular tailor's work, as they have the necessary weight and heat for heavy pressing. The 24-pound iron is designed to replace the machine iron and in many cases is preferable.

Finish. Tailor's irons are nickel plated and have japanned wooden handles.

SPECIAL IRONS

Where none of the standard irons already described meet the requirements of an individual case, a special design will be made for customers wishing a number of irons. For example, the six-pound, 500 watt iron was found too hot for a certain necktie factory and



TWELVE-POUND IRON AND STAND



A BATTERY OF ELECTRIC FLAT IRONS

coils specially wound for 300 watts were used with excellent results. A large underwear factory also was equipped with five-pound irons having special handles and cables attached in a particular manner. Those interested should write to the nearest sales office, stating character of work and general details as to the present methods of doing it.



DISTRIBUTING ELECTRIC FLAT IRONS

GENERAL ELECTRIC FLAT IRONS

THREE-POUND AND SIX-POUND IRONS WITH PLAIN PULL-OFF PLUG

Cat. No.	Weight	Voltage	Watts	Finish	List Price
38123	3 Lbs.	95-105	250	Nickel Plate	\$8.00
38124		106-115	44	44 54	56
38125 47354	44 · ·	116-125 200-225		66 66 55 65	9.00
47355	"	200-220		** **	44
48058	6 Lbs.	95-105	500	66 66	8.75
48059		106-115		41 66	
48060 48061	"	116-125	66 55	44 44 44 44	65
48062	"	200-225 226-250	51	54 44	9.75
36814		95-105	46	Aluminum	8.50
36815	"	106-115	\$1	6 6	£6
36816 40806		116-125	66	ų .	
43481	"	200-225 226-250		65 66	9.50
		220-250			
NOTE:-F	or Three-Pound In	ons equipped with Co	mhination Indicativ	ng Switch Cat. No. 42441, ad	1 \$1.00 to List Pric
•				INDICATING SWITC	
45415	e The	05 105		Nickel Plate	#0.7F
45416	6 Lbs.	95-105 106-115	500 "	66 66	\$9.75
45417		116-125	"	66 66 56 66	
45418		200-225	64 54	22 22 24 44	10.75
45419		226-250			
48063 48064		95-105 106-115	44	Aluminum	9.50
48065		116-125	65	64	
48066	46 -	200-225	64	66 64	10.50
48067		226 - 250		~	
	EIGH?	-POUND IRONS	WITH PLAIN	PULL-OFF PLUG	
39921	8 Lbs.	· 95-105	600	Aluminum	\$10.00
39922	· · · ·	106-115	- 44	- 44	
39923	"	116-125	45	64 65	
40805 43482		200-225 226-250	55	- 63	11.00
90902		220-200			· · · · · · · · · · · · · · · · · · ·
	EIGHT-POUN	ID IRONS WITH	COMBINATION	N INDICATING SWIT	сн
48068 -	8 Lbs.	95-105	600	Aluminum	\$11.00
48069		106-115		,66 66	
48070		116-125 200-225			12.00
48071 48072	"	226-250	4		41
				<u></u>	
				CATING SWITCH PLU ENTLY CONNECTED	JG
45320	12 Lbs.	95-105	750	Nickel Plate	\$17.00
45321		106-115		46 44 46 46 ·	
45322 45323		116-125 200-225		44 44	18.00
45324	"	226-250	54	46 4 6	"
47356	15 Lbs.	95-105		66 61 56 55	"
47357 47358	44	106-115 116-125			"
47359	56	200-225	**		19.00
47360		226-250	46	66 65 36 66	"
	18 Lbs.	95-105 106-115		14 48 66 86	
47361		106-115	46	£6 65	
47361 47362		200-225	41	66 44	20.00
47361 47362 47363	"		1 11	46 54	56
47361 47362 47363 47364 47365	44 54	226-250		"	
47361 47362 47363 47364 47365 47365 47366	" " 24 Lbs.	226-250 95-105	1000	46 44	21,00
47361 47362 47363 47364 47365 47366 47366 47367	44 54	226-250 95-105 106-115	1000 ** **	46 46 86 66	
47361 47362 47363 47364 47365 47365 47366	" 24 Lbs.	226-250 95-105	1000 **	46 44	

ADDITIONAL PLUGS, CABLES AND HEATING UNITS

Cat. No. 42441Combination Plug and Indicating Switch with 8 ft. Cable and Socket Attaching Plug\$4.00" " 42442Pull-off Plug complete with 8 ft. Cable and Attaching Plug3.00Extra Cartridge Unit for either 3 lb., 6 lb., or 8 lb.Irons 95-125 Volts2.50Extra Cartridge Units for " " " " " 200-250 " 3.00

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Toronto, Ont.

General Electric Company Schenectady, N.Y.

RAILWAY DEPARTMENT

June, 1907

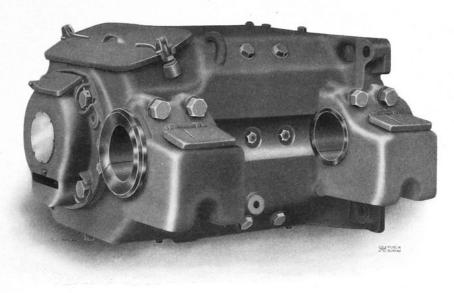
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H. S.W

COMMUTATING POLE RAILWAY MOTORS

The gradual increase of operating voltages on direct current electric railroads, especially on large systems or interurban roads, has introduced new requirements in railway motor design largely relating to the commutation and non-flashing properties of the motor. The commutating pole 200 HP. These motors are called GE-202, GE-204, GE-205, GE-206, GE-207 and GE-208, arranged in order of size. As occasion demands, other motors will be constructed in sizes to meet railway service conditions.

The two smallest motors, namely GE-202 and



GE-205 Railway Motor, Back

type of railway motor is specially well adapted to meet the conditions due to this development, and the General Electric Company has therefore designed and manufactured a line of these motors which embody all the requisites for this class of service.

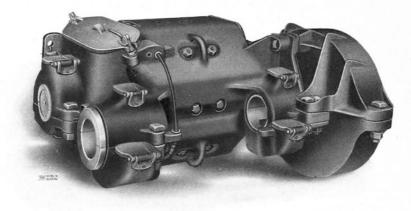
At the present time six different motors are manufactured varying in output from 50 HP. to GE-204 are constructed with a split frame designed to allow the bottom part to be swung down into a pit for inspection or renewal of parts. The largest motors are of the box frame type with large bored openings at each end through which the armature can be readily inserted or removed. The general construction of both types is similar to that employed in the

4508-2 Commutating Pole Railway Motors

General Electric Company's well-known railway motors, the chief point of difference lying in the addition of commutating poles.

ADVANTAGES AND ADAPTATION

The theory and functions of commutating poles have long been understood, but it will not be out of place here to give a brief summary of their action and the advantages obtained by their use. The commutating poles, located between the main exciting pole pieces, are connected up with their windings in series with one another and with the armature. The magnetic strength of the commutating poles varies therethrough careless handling by motormen than the present standard railway motor. This fact is of importance on heavy grades or where cars are provided with equipments geared for high speed work, and at the same time are required to stop and start frequently in cities. If for electric locomotives or other special applications, forced ventilation is used, high continuous outputs can be obtained from these motors as the current input can be considerably increased without commutation difficulties occurring, the heating of the motor being kept within normal limits by the increased ventilation, which may be effected by means of a blower.



GE-204 Railway Motor, Back

fore with the current through the armature and a magnetic field is produced of such intensity as to properly reverse the current in the armature coils short circuited during commutation. The pole pieces are so proportioned and wound as to compensate for armature reaction and practically non-flashing and sparkless commutation is insured up to the severest overloads. As the magnetizing current around the commutating poles is reversed with the armature, the poles perform their functions equally well in whichever direction the motors are running.

Due to the remarkably good commutating characteristics of commutating pole railway motors, their overload capacities are considerably increased, and a more rugged form of motor is obtained which is less subject to injury The following description of the split and box frame types of commutating pole railway motors gives the more salient points in their construction.

MAGNET FRAME

Split Type of Frame—This frame is made of steel cast in bowl-shaped top and bottom halves machined along the edges and bolted together with four bolts. The two bolts on the suspension side are hinged so that the lower half can be swung down into a pit for inspection or cleaning after the back bolts have been removed.

The main exciting pole pieces are bolted to the frame at an angle of 45 degrees to the horizontal. The commutating pole pieces are

Commutating Pole Railway Motors 4508-3

bolted to the frame at points midway between the exciting poles.

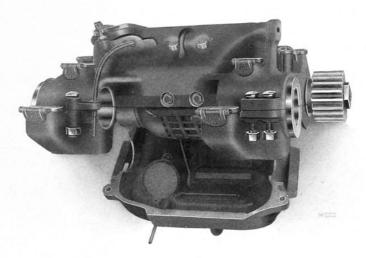
Bails are cast on both upper and lower frames for handling the motor.

Small holes fitted with malleable iron covers and gaskets are provided at both ends of the motor for inspection or ventilation whenever service conditions will permit.

The supporting brackets for the armature and axle bearings are located on the outside of the top, bottom and sides with the commutating poles between.

Bails are provided in the four corners of the frame to facilitate handling the motor and planed bosses on the four corners permit of its being set up in exact position when desired.

An opening is provided below the commutator and at the side, also three openings—one in the side, one on top and one on the bottom of the frame at the pinion end. These open-



GE-204 Railway Motor, with frame lowered for inspection

frame and are cast integral with the top magnet frame. The linings are held rigidly in the supporting brackets by means of caps which are bolted tightly against them.

Box Type of Frame — This type of frame is made of cast steel in one piece so as to form a hollow cube with rounded corners. Large bored openings are provided at each end of the frame through which the armature can be readily inserted or removed. The frame heads carrying the armature shaft bearings are supported in the recessed ends of the magnet frame and held in place by bolts.

The axle bearing caps are tongued and bolted to vertical machined surfaces on the frame. The main exciting pole pieces are located at the ings are closed by covers with gaskets which can be taken off for ventilation whenever service conditions permit.

In both types of frame the opening over the commutator is inclined at an angle to allow the brush-holders being readily reached either from under the car, or if desired through a trap door in the floor of the car. This opening is closed by a malleable iron cover with a felt gasket resting on a machined seat, the cover being held in place by a readily adjustable cam locking device.

The armature and field leads are brought through rubber bushed holes on the side next to the truck bolster, thus reducing the movement of the leads to a minimum during the swiveling of the truck around curves.

4508-4 Commutating Pole Railway Motors

BEARINGS

All bearings are designed for oil and waste lubrication, as this system has met with great success for railway motors ever since its original introduction by the General Electric Company.

The armature shaft linings are bronze sleeves finished all over and lined with a thin layer of babbitt metal securely anchored and soldered in place. The babbitt metal furnishes an ideal bearing surface and is so thin that it will not allow the armature to rub on the poles in case it is melted out by overheating. In both axle and armature bearings the oily waste used for lubrication is packed in large oil wells and bears on the shaft through an opening in the side of the bearing linings.

Waste oil from the armature shaft bearings is prevented from entering the interior of the motor by deflectors which throw it into grooves from which it is conducted away.

This form of bearing is fully equal in simplicity and reliability to the standard box journal bearing. The method of lubrication and treatment is practically the same and the boxes are reached through large hand holes protected by swing covers with felt gaskets. The covers are held in place by strong springs.

The amount of oil required for the bearings is exceedingly small and wide experience indicates that no other type of bearing equal to this has ever been placed on a railway motor.

All motors are constructed with very liberal wearing surfaces to ensure a long life to the bearings and reduce wear and tear to a minimum.

FIELD COILS

The mummified type of main field coil and commutating coil is used. These coils are wound either with wire or with copper strip as may be necessary. The strip is insulated between turns with asbestos and the sections are separated from each other by an insulating partition of oiled asbestos and mica. The coils, whether of wire or strip, receive a wrapping of cotton tape and are thoroughly filled with an insulating compound by the vacuum process. They are then thoroughly insulated with several wrappings of specially prepared tape and as a final protection, chiefly against mechanical injury, are taped with a heavy cotton webbing and thoroughly filled with japan.

This method of construction for the coils makes them solid and compact and well adapted to radiate heat and withstand moisture. The small weight of the coils facilitates their handling and repairs are easily made in case of injury. The coils are securely clamped to the frame when the pole pieces are bolted in.

ARMATURE

The armature core is built up of soft iron laminations interspaced with air ducts which provide good ventilation.

The armature coils are wound on forms with insulation between the adjacent coils in the unit or poly coil which is pressed to shape in a steam mold. The coils are then covered with insulating material of high quality, and as a final protection principally from mechanical injury, are taped and filled with an insulating compound.

The windings are specially well protected from dust, oil or mechanical injury. The pinion end core head extends under the end windings with a flange reaching up past the ends of the coils. The windings at both ends are covered with a strong canvas dressing securely bound in place. In accordance with a long established practice of the General Electric Company, binding bands are not allowed to project above the armature core and the ends of the band wires are secured by means independent of the solder.

COMMUTATOR

Conforming to the General Electric Company's standard practice, the commutator segments are made of hard drawn copper insulated throughout with the best grade of mica. The cone micas are built up and pressed hard and compact in steam molds. The mica between the segments is made of a softer quality to make it wear down evenly with the copper.

Great care is taken in the construction of the commutator. The cone surfaces are carefully machined and cleaned from burs and sharp edges to prevent short circuits between the segments, and creepage distances are made long to prevent grounding.

Commutating Pole Railway Motors 4508-5

The shells and caps are made of cast steel or malleable iron in strong sections in order to prevent breakage and keep the shape of the commutator true. Before tightening the commutator nut or bolts, the segments are clamped tight by the cap which is pressed home in a hydraulic press.

The liberal wearing depth of the segments and the excellent commutation of the motor insure a long life to the commutator. current passing through the spring or pivoting pins. The brushholders are adjustable to allow for wear of the commutator. They are securely clamped in the proper position and can be readily removed through the opening in the frame over the commutator.

VENTILATION

Particular attention has been given to ventilation. Free circulation of air between the in-



GE-205 Railway Motor, Front

BRUSHHOLDERS

The brushholders, two in number, are made of cast bronze, and from two to four carbon brushes are used per holder, depending on the size of the motor. The brushes slide in finished ways and are pressed against the commutator by independent fingers, which give a practically uniform pressure throughout the working range of the brushes.

The springs which actuate the fingers are designed so as to bear only slightly on the pin on which the fingers pivot, thus preventing any undue friction on the pin and reducing wear to a minimum.

There is a "pig tail" or shunt between the fingers and the brushholder body to prevent terior and the exterior of the motor can be obtained as already described under the heading "MAGNET FRAME," by the removal of the malleable iron covers whenever service conditions permit.

Armatures are constructed so that when running, a large volume of air is drawn into the interior of the core, and expelled through ducts opening along the exterior.

Good ventilation with the small electrical and mechanical losses obtained in these motors keep them cool and greatly add to their capacity in service. The ventilation is secured without sacrificing in any way the proper protection of the armature windings, a strong point in the construction of the motors.

4508-6 Commutating Pole Railway Motors

GEAR, PINION AND GEAR CASE

The gears are made of a superior grade of cast steel, and the pinions from a special stock of forged steel, extra hammered to improve the quality of the metal. The gear teeth are accurately cut, and the width of face and pitch is such as to insure ample strength.

The gear cases are made of malleable iron and are suspended at three points from the magnet frame to prevent vibration. Strengthening ribs radiate from the supporting points to prevent the case from cracking. The case is bolted to the motor frame in such a way as to minimize lateral vibration, and the contact surfaces between the case and frame are made large to prevent undue wear.

The three point suspension has proved so successful a feature in the operation of General Electric motors that it is considered a salient point in their design.

SUSPENSION

In the box frame type of motors, the front of the frame is provided with a lug which rests on a bracket secured to the truck transom. The motor is prevented from rising by a forged strap bolted over the top of the lug. When the truck is out from under the car, motors can be mounted on or taken off the truck from above, no pit being required.

In the case of the split frame motors, lugs are cast on the upper half of the frame to which a suspension bar is bolted. The lower half of the motor frame can be swung down for inspection and repairs without disturbing the rest of the motor.

ADVANTAGES

These motors have the advantages with regard to compactness and accessibility of parts for repair and inspection that exist in present standard G. E. railway motors.

In addition we would call attention to the following special qualities possessed by these motors which will commend them to all practical users of railway motors :---

- 1. Very substantial mechanical construction.
- 2. Practically sparkless commutation even on heavy overloads.
- 3. Flashing at commutator largely reduced, if not entirely eliminated.
- 4. Less wear on commutator.
- 5. Cleaner and more reliable motor because of the reduced carbon and copper dust from brushes and commutator.
- 6. Marked reduction in heating of commutator.
- 7. Increased life of brushes.
- 8. Lower magnetic densities and smaller core loss.
- 9. Increased efficiency and free running capacity, because of lower core and commutator losses.
- 10. Improved shape of speed curve giving greater economy during acceleration.
- 11. Lighter field coils to handle.
- 12. Greater service capacity of motors possible by forced ventilation.

RATING

The capacities of these motors for continuous service are high owing to their good electrical efficiency and ventilation. The ratings of the motors are based on a temperature rise by ther mometer of not more than 75 degrees C. above the surrounding air taken at 25 degrees C. after an hour's run at rated load and voltage.

Motors are wound for operation at 600 volts as standard and have a liberal margin of safety at this voltage, as good commutation is a special characteristic of this type of motor.

General Electric Company Schenectady, N.Y.

TRANSFORMER DEPARTMENT

June, 1907

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HIWI

Bulletin No. 4510

ELECTRICALLY-OPERATED, RATCHET-DRIVEN RHEOSTAT SWITCHES

Since compactness and safety are prime requisites in modern switchboard practice, remotecontrol apparatus with low tension wiring has become generally standard.

Heretofore motor-driven or chain-operated rheostat switches have been generally used but the General Electric Company has recently developed a simple and compact electrically-operated, remote-control switch which is less exadapted for cutting resistance in and out from a distant point, for any purpose where automatic "no-voltage" and "overload-release" features are not essential.

These remote-control switches are operated by a ratchet wheel and pawl movement actuated by solenoids taking but little current.

The switchboard apparatus consists of a small single-pole, double-throw knife switch,

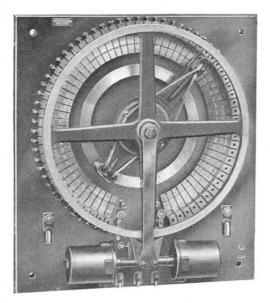


FIG. 1. RATCHET-DRIVEN RHEOSTAT SWITCH

pensive to install than the motor-driven type, although it retains all the advantages of that type. On account of its simplicity it is much superior to chain drive or other auxiliary mechanisms.

While remote-control rheostats of the kind herein described were designed primarily for varying the field strength of generators, their use is not necessarily limited to this service, as they are which is closed to the right or left according to the direction of rotation desired for the switch arm. The solenoids of the switch have a common plunger acting directly on the switch arm through pawls and while the knife switch remains closed the proper solenoid is energized intermittently and a continuous step-by-step rotation given to the arm. 4510-2 Electrically-Operated, Ratchet-Driven Rheostat Switches.

OPERATION

The switch arm is mounted on the axle of a wheel with a knurled rim and is rotated by means of the pawls, which engage the rim of the wheel. A core actuated by two solenoids (A,A, Fig. 2) moves the pawls to the right or left, depending on which solenoid is energized. When the solenoids are not energized the pawls are disengaged and are in their normal position at rest equidistant from the two solenoids as shown in Fig. 1.

To cut resistance into the field circuit, the

to the right, a similar cycle of operations takes place and the arm of the dial switch moves in a counter clock-wise direction.

To protect the apparatus in case the controlling switch, B, is left closed, a limit switch, D, is provided at each end of the switch dial. When the dial switch has reached the end of its travel in either direction, this limit switch is automatically opened and the solenoid circuit thus interrupted.

CAPACITY AND RATING

The operating solenoids of the standard

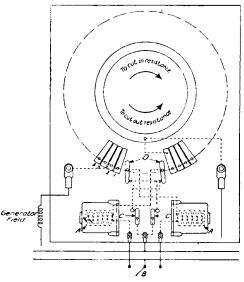


FIG. 2. DIAGRAM OF CONNECTIONS RATCHET-DRIVEN RHEOSTAT SWITCHES

single-pole switch, B, (Fig. 2) is closed to the left. This energizes the left-hand solenoid, pulls the core to the left, engaging the left-hand pawl in the knurled rim of the wheel and moving the dial switch arm in a clock-wise direction. When the core of the solenoid has reached the end of its travel, the solenoid circuit is automatically broken by a small switch, C, which is mechanically opened by the core. As soon as the solenoids are de-energized, the pawl, actuated by a spring, immediately returns to its central position, the circuit of the solenoid is automatically closed by the switch, C, and the same cycle of operations is repeated until the switch, B, on the controlling board is opened.

If it is desired to cut resistance out of the field circuit the single-pole switch, B, is closed

switch are wound for 125 volts, direct current, and require less than one ampere to operate. The dial switches are designed for standard voltages up to and including 500 volts and in three sizes, as follows:

50 amps. with 70 divisions.

100 amps. with 65 divisions.

200 amps. with 46 divisions.

Special switches of larger capacities can be furnished when necessary, with solenoids wound for any standard voltages up to 600 volts.

REGULATION AND RELIABILITY

With this type of electrically operated switch, perfect adjustment of the resistance can be obtained with a minimum cost for apparatus and operating current. It is evident from the construction of the switch that there are no high-speed, revolving parts which will continue to cut in or cut out resistance after the main control circuit has been opened. In other words, the resistance can be adjusted with great precision. The simplicity of all the mov ing elements makes the device exceptionally reliable and durable.

SUMMARY

On account of its simplicity the cost of the ratchet-driven switch is naturally considerably less than that of a motor-operated switch having the same capacity. Another desirable feature of the ratchet-driven type is its compactness and the great reduction in weight as compared with the motor-operated type.

Some of its advantages as compared with

the motor-operated switch may be summarized as follows:

Lighter Less cost Self contained Closer regulation Occupies less space Parts more accessible Requires less attention

INSTRUCTIONS FOR ORDERING

When ordering electrically-operated, ratchetdriven, field-rheostat switches, state ampere capacity of field circuit and voltage of directcurrent operating circuit. The single-pole, double throw switch to be installed on the controlling board is not furnished unless specially ordered.

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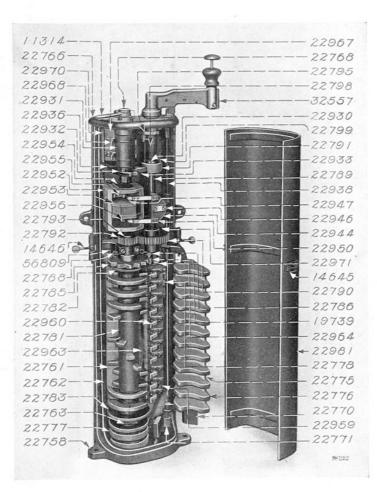
SUPPLY DEPARTMENT

July, 1907

Bulletin No. 4513

PARTS OF TYPE C CONTROLLERS

C-6-A Controller



Cat. No.	Description
32557	Operating handle
11314	*Reversing handle
	*Reversing handle . *Not included in complete controller. Must be ordered separately.
	Following are the interchangeable parts:
22758	Following are the interchangeable parts: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder
22758	 Following are the interchangeable parts: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft
22758	 Following are the interchangeable parts: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position)
22758 9987	Following are the interchangeable parts: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder

4513-2 Parts of Type C Controllers

Cat. No.	Description
22762	Washer strip for packing
1288	Screw fastening Nos. 22761, 22762 to frame (10-24, 3" F. H.), per 100
22763	Binding nut with set screw for magnet spool (13"-18, 1" thick, Hex. Brass Sp'l) . Set screw for No. 22763 (4"-20, 4" Headless Sp'l), per 100
22764	
14646	Hinge bolt with pin and nut
4030 22766	Spring conter for pin ($\frac{1}{32}$ \times $\frac{1}{3}$), per 1000
56716	CAP for top of controller Long screw fastening cap to frame (3"-16, 1" R. H. Brass), per 100
22767	Short screw fastening cap to frame $(\frac{3}{4}, 16, \frac{17}{4}, R, H, Brass)$ per 100
22980	Short screw fastening cap to frame ($\frac{2}{3}$ "-16, $\frac{2}{3}$ " R. H. Brass), per 100 Washer for Nos. 56716, 22767 ($\frac{2}{34}$ " x $\frac{1}{16}$ " x $\frac{1}{16}$ " thick, Fiber), per 100
22768	Water can for reversing cylinder shaft, with set screw
22769	Set screw for water cap $(\frac{1}{4}$ "-20, $\frac{9}{16}$ " Sp'1 Blued), per 100
22981	SHEET IRON COVER, complete
14645	Slotted lug for cover, with rivets
22770	HINGED POLE PIECE, complete, with hinge brackets and hinge pins
22771	Spring catch, complete, for pole piece, with two screws
22772	Screw fastening catch to pole piece stop (10-24, ⁷ / ₄ " F. H.), per 100
22773	ARC DEFLECTOR, complete Screw fastening arc deflector to pole piece (No. 10, 1½" R. H. Blued), per 100
19628 19630	Insulating bushing used with No. 19628
22775	Arc deflector back
22776	Unvision plate for arc deflector
1188	Screw fastening back to division plates (No. 10, 1" F. H.), per 100
22777	MAIN MAGNET SPOUL, wound, complete, with terminal
22778	Terminal, per 100
22779	Binding screw (14-24, $\frac{5}{16}$ " R. H. Blued), per 100
22780	Lock washer for No. 22779 ($\frac{17}{64}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100
22781	CONTROLLING CYLINDER, complete, with shaft, insulation disks, collar and star wheel
2 278 2	Insulation disk (upper)
22783	
22784	Insulation disk (lower) Collar, with pin $(1\frac{1}{3}'' \times \frac{1}{3}'' \times \frac{1}{3}''$ thick)
22785	Star wheel with pin. Must be fitted
22786	Check pawl, with roller for controlling cylinder
19739	Roller, with pin
22787	Pivot pin for pawl
40438	Washer for pin $(\frac{15}{2}" \times \frac{1}{3}" \times .125")$, per 100
16118	Spring cotter for pin $(\frac{1}{2}^{"} \times \frac{1}{2}^{"})$, per 1000 Tension spring for pawl (32 turns, .07196" Ph. Brz. wire, $\frac{1}{2}^{"}$ diam., closed)
22788 56809	Pin fastening spring to frame 1.25 turns, 0.0196 Ph. Brz. wire, $\frac{1}{2}$ diam., closed 1.25 Pin fastening spring to frame
22789	OPERATING SHAFT, complete, with gear and interlocking collar
22790	Operating gear, with Pin (22 teeth, 10 pitch)
22791	Interlocking collar, with pins
227 92	Pinion for operating gear and controlling cylinder
22793	Retaining wesher for pinion $(1'' \times 1'' \times 105'')$ Bross Sp ⁽¹)
.56743	Screw fastening Nos. 22792, 22793 to controlling cylinder shaft (14-24, $\frac{1}{2}$ " F. H.), per
00704	100
$22794 \\ 22795$	SAFETY BREAK CAM, for operating shaft with pin
22796	Fiber buffer for cam, per 100
22797	Brass washer plate, for buffer, per 100
9891	Screw fastening Nos. 22796, 22797 to cam (8-32 4" F. H. Brass), per 100
22798	Spring for cam and interlocking collar (23 turns, .091" Steel wire)
22799	Pin fastening spring to interlocking collar and cam
22930	Brass sleeve for operating shaft $(\frac{7}{6}^{*} \times 1\frac{1}{4}^{*} \times 2\frac{1}{16}^{*}$ long) REVERSING CYLINDER, complete, with collar and star wheel
22931	Star wheel, with pin. Must be fitted
$22932 \\ 40439$	
22933	Interlocking pawl, with pin for spring
22934	Pin fastening tension spring to pawl
22935	Pivot pin for pawl
10365	Pivot pin for pawl Washer for pin $(\frac{7}{16}'' \times \frac{7}{4}'')$, per 100 Spring cotter for pin $(\frac{7}{4}'' \times \frac{3}{4}'')$, per 1000
16118	Spring cotter for pin $(\frac{1}{2}'' \times \frac{3}{2}'')$, per 1000
22936	Tension spring for pawl (15* turns, 191" Steel wire * diam closed)
22937	Spring post fastening to frame $(\frac{3''}{3''}$ -16, $1\frac{1}{3''}$ long) SHAFT FOR SAFETY BREAK, complete, with check pawl, pin for spring and lever
22938	arm
22939	Roller, with pin, for check pawl
22940	Pin for tension spring
22941	Pin for tension spring . Tension spring for check pawl (19 $\frac{1}{2}$ turns, 07196" Ph. Brz. wire, $\frac{1}{2}$ " diam., closed) .

Parts of Type C Controllers 4513-3

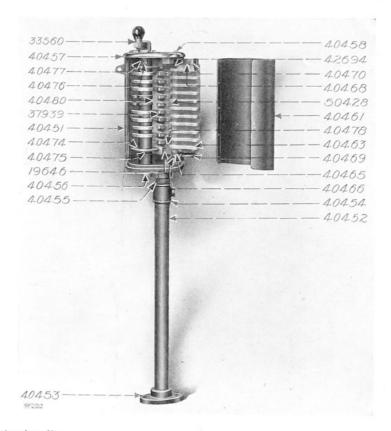
Cat. No.	Description
22942	Spring post, fastening to cap plate $(\frac{3''}{16}, \frac{13''}{100})$
$22943 \\ 22944$	CONTACT BLOCK, complete, for safety break
$22944 \\ 22945$	Contact block Screw fastening block to lever arm (14-24, $1\frac{1}{16}$ " F. H.), per 100
22946	Washer plate for screw
22947	Unreinforced contact finger, with spring
22949	Support for finger, per 100
$\begin{array}{r}1193\\22950\end{array}$	Screw fastening finger and support to contact block (8-32, ½" F. H.), per 100
22951	Washer plate for No. 1193, per 100 Safety break blow-out box, complete, with pole piece, contact bases and magnet spool
22952	Blow-out box
22953	Partition for box
10305	Screw fastening partition to box (No. 6, $\frac{3}{4}$ " F. H.), per 100
$22954 \\ 13848$	Pole piece for blow-out box
50428	Screw fastening pole piece to box (No. 10, $\frac{3}{4}$ " F. H.), per 100 Screw fastening pole piece to frame (14-24, $\frac{3}{4}$ " R. H. Blued), per 100
22955	Contact base (upper)
22956	Contact base (lower)
$\begin{array}{c}13852\\19682\end{array}$	Screw fastening contact base to blow-out box (No. 10, 3" F. H.), per 100 Binding screw for contact base (14-24, 3" R. H. Blued), per 100
22780	Lock washer for No 19682 (44° x 4° x 060" Ph Brz.) per 100
22957	Lock washer for No. 19682 (17" x 1" x .060" Ph. Brz.), per 100
22778	Terminal, per 100
22959	CONTROLLING CONTACT BLOCK, complete, with contact bases .
$19669 \\ 14426$	Screw fastening block to frame (14-24, $1\frac{1}{4}$ " R. H.), per 100
22960	Contact finger, with spring
19682	Screw fastening finger to contact base (14-24, §" R. H. Blued), per 100
22780	Washer for No. 19691, $(\frac{1}{64}^{2} \times \frac{1}{2}^{2} \times .060^{\circ}$ Brass), per 100 Contact finger, with spring . Screw fastening finger to contact base (14-24, $\frac{3}{8}^{\circ}$ R. H. Blued), per 100 Lock washer for No. 19682 ($\frac{1}{64}^{\circ} \times \frac{1}{2}^{\circ} \times .060^{\circ}$ Ph. Brz.), per 100 Copper connection strip for finger base, per 100
22962	Copper connection strip for finger base, per 100
$22778 \\ 22963$	Finger shield
22964	Trollev shield
16282	Screw fastening shields to block (No. 10, §" F. H.), per 100
22965	Fiber insulation strip under controlling contact block REVERSING CONTACT BLOCK, complete, with contact bases
$22967 \\ 19669$	Screw fastening block to frame (14-24, 14" R. H.), per 100
14426	Washer for No. 19669 ($\frac{14}{54}$ " x $\frac{1}{2}$ " x .060" Brass), per 100
22968	Contact finder
22969	Connact inger and contact base, per 100 Screw fastening Nos. 22968, 22969 to contact base (14-24, 3" R. H. Blued), per 100
19682	Screw fastening Nos. 22968, 22969 to contact base (14-24, $\frac{3}{2}$ " R. H. Blued), per 100
$\begin{array}{c} 22780\\ 22778\end{array}$	Lock washer for No. 19682 ($\frac{17}{64}$ x $\frac{17}{2}$ x .060" Ph. Brz.), per 100
22970	Fiber shield
10214	Screw fastening shield to block (No. 8, ½" F. H.), per 100
22971	Fiber shield . Screw fastening shield to block (No. 8, $\frac{1}{2}$ " F. H.), per 100
$\begin{array}{r} 40511\\ 22972 \end{array}$	*Small fiber cleat for holding wire to frame
40581	Screw fastening No. 40511 to frame $(10-32, 14'' R, H, Blued)$, per 100
40582	Lock washer for No. 40581 (14 x 13 x .050" Ph. Brz.), per 100
19691	Screw fastening No. 22971 to frame (14-24, 11" R. H.), per 100
19646	Screw fastening No. 22972 to frame (14-24, 1" R. H.), per 100
$22759 \\ 22760$	Wire guard Screw fastening wire guard to base of frame (14-24. §" F. H.), per 100
22100	Connection wire for contact boards (No. 10 B. & S. rubber covered, requiring approxi-
	mately 3 feet)
	*Not used on controller as now manufactured; listed for convenience of customers having
	controller with old style wiring.
	C-6-K Controller
34343	Operating handle
11314	Operating handle
	*Not included in complete controller. Must be ordered separately.

	Following are the interchangeable parts of the C 6-K controller which differ from those of
	the \tilde{C} 6-A:
40333	FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder
	shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft
	rubber packing and all spring and fulcrum pins riveted in position)
40334	OPERATING SHAFT, complete, with gear, interlocking cam and collar
40335	Interlocking cam, with pin

Cat. No.	Description		
40336	Collar, with pin for operating shaft		
40337	Salety break cam for operating shall		
40338	Spring for safety break and interlocking cams		
40339	Interlocking pawl, with pin for spring	·	
40340	Pin fastening tension spring to pawl, per 100	1	
40341	Pivot pin for pawl		
21392	Washer for pin $(\frac{137}{32} \times \frac{37}{4} \times .060'')$, per 100		
40342	Spring holder		
40343	Screw fastening No. 40342 to frame (3/-16, 3/ Fill. H.), per 100		
40344	SHAFT FOR SAFETY BREAK, complete, with cam pawl and lever arm		
44605	Roller with pin for cam pawl		
	C-8-A Controller		

32557	Operating handle			· .					• •									+:	
11314	*Reversing handle .								+1										
	*Not included in comp	lete d	ontr	oller.	M	lust	be	ord	ered	sei	bar	itel	V.						
	Following are the int of the C 6-A:													ich	diffe	er f	from	the	ose
44180	Cap for top of Contro	oller				1	223		2	32	22	12	23	22	÷	22	2		1.2
44181	CONTROLLING CY	LIN	IDE	R. c	om	olete	N .	ith	sh	aft.	in	sula	tion	ı d	isks	. C	ollar	a	nd

C-26-A Controller



33560	*Operating handle .	12	1.0	12	12.0	12	122	7.2	27	12					132	2312	2225		
	*Not included in comp	slete	con	tral	lor		inst	no	nen.	arad	con	ara	in						
	Following are the int	angle	ana	and	a h	···		00	orac	crea	sep	uru	iery	•					
10151	EDAME	ercm	inge	eaor	e po	iris.													
40451	FRAME, complete,	inclu	ides	sad	Jus	ting	an	d se	et so	crew	S								
40452	Wire tube Base for wire tube				·									2 ⁷⁷					
40453	Base for wire tube				100	10			•	ं	20	•	<u>.</u>		<u></u>		÷.	÷.	•
	Dase for whic tube				1.00		1.10	1.00		1.0							 		
40454	Tee for wire tube .															1.1			

Parts of Type C Controllers 4513-5

Cat. No.	Description
$\begin{array}{r} 40455\\ 40456 \end{array}$	Coupler for tee and frame Set screw for No. 40455 (§"-16, §" Sq. H. Cup rount blued), per 100
40457	CAP for top of controller Screw fastening cap to frame $(\frac{3}{4}"-16, \frac{3}{4}" R. H. Brass)$, per 100 Washer for No. 40458 $(\frac{13}{2}" x \frac{3}{4}" x \frac{1}{16}"$ thick fiber), per 100 Water cap, with chain and link Sheet iron cover, complete
$40458 \\ 40459$	Screw fastening cap to frame $(\frac{4}{3}$ -16, $\frac{4}{3}$ R. H. Brass), per 100 .
40460	Water cap, with chain and link
40461 40462	ARC DEFLECTOR, complete, with pole piece, hinge pin and nuts
40463	Division plate for arc deflector Hinge pin for arc deflector Nut for hinge pin ($\frac{5}{16}''$ -18, $\frac{3}{16}''$ thick Hex.), per 100 Nut with pin for hinge pin ($\frac{5}{16}''$ -18, $\frac{3}{16}''$ thick Hex. Sp'l), per 100 Adjusting screw for hinge pin ($\frac{1}{2}''$ -13, $\frac{1}{8}''$ Headless Sp'l) Set screw for No. 40466 (14-24, $\frac{1}{2}''$ Headless Sp'l), per 100
40464	Hinge pin for arc deflector, per 100
$\begin{array}{r} 42694 \\ 40465 \end{array}$	Nut for hinge pin $(\frac{16}{16}$ -18, $\frac{1}{16}$ thick flex.), per 100
40466	Adjusting screw for hinge pin (1"-13, 11" Headless Sp'1)
$40467 \\ 40468$	Set screw for No. 40466 (14-24, $\frac{1}{2}''$ Headless Sp'l), per 100
40469	Hinge bracket for pole piece (upper) Hinge bracket for pole piece (lower) Screw fastening Nos. 40468, 40469 to pole piece (14-24, §" F. H.), per 100
2028	Screw fastening Nos. 40468, 40469 to pole piece (14-24, §" F. H.), per 100
$\begin{array}{r} 40470 \\ 1288 \end{array}$	Spring catch, complete, with two screws for pole piece
40471	BLOW-OUT COIL, wound, complete, with leads CONTROLLING CYLINDER, complete, with shaft, insulation disks, collar, stop
40472	CONTROLLING CYLINDER, complete, with shaft, insulation disks, collar, stop and releasing spring
40473	Complete set of copper contact segments with screws, per set
	Contact segments and screws for same are listed below.
$40474 \\ 40475$	Insulation disk
40476	Cylinder stop with pin
40477	Releasing spring
$40478 \\ 19646$	Screw fastening No. 40478 to frame (14-24, 1" R. H.), per 100
22780	Screw fastening No. 40478 to frame (14-24, 1" R. H.), per 100 Lock washer for No. 19646 ($\frac{11}{64}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100 Contact finger with spring
$37939 \\ 50428$	Contact finger with spring Screw fastening finger to contact base (14-24, ½" R. H. Blued), per 100
40479	Terminal for cables, per 100
40480	Terminal for cables, per 100 Finger shield Screw fastening shield to contact block (No. 8, §" F. H.), per 100
14192	Screw fastening shield to contact block (No. 8, $\frac{1}{8}$ F. H.), per 100 · · · · · ·
	40483 40483 40483
	40484 - 20° -
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	0 40481 0 40482 00
	00 40482
	00 40482
	Ø 40481 Ø 40482 ØØ
	<u>0 40481 0</u> 40482 <u>00</u>

40481	Contact Segment	•	•				-		•		•	•		•	•	•		•		
40482	Contact Segment		• •		•	•	•	•	·		•	-	·	·						•
40483	Contact Segment	•			•		•	•	·	•	-	•	•	•	-	•				•
40484	Screw for Segment.	, p	er 1	.00	•	•	•	•	•	•	·	•	•	•	•	•			•	•

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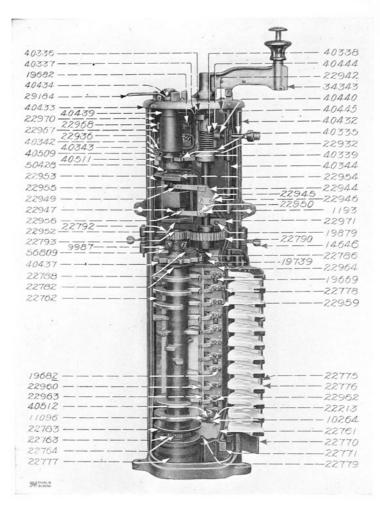
4513-6 Parts of Type C Controllers

C-28-C Controller

Description

- Cat. No. 34343
- Operating handle
- 29184 *Reversing handle .

- 40432
- *Not included in complete controller. Must be ordered separately.
 Following are the interchangeable parts:
 FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) .



9987	Cap screw fastening bearing cap to frame $(\frac{3}{8}$ -16, 2" Hex. H. Slot.)		
22761	Soft rubber packing for frame		
22762	Washer strip for packing		
1288	Screw fastening Nos. 22761, 22762 to frame (10-24, ³ / ₄ F. H.), per 100 .		
22763	Binding nut with set screw for magnet spool (13"-18, 1" thick, Hex. Brass S	Sp'l)	
22764	Set screw for No. 22763 (4"-20, 3" Headless Sp'l), per 100		
14646	Hinge bolt with pin and nut for fastening cover to frame		
4030	Spring cotter for pin $(\frac{3}{32}'' \times \frac{5}{8}'')$, per 1000		
40433	CAP for top of controller		
56716	Long screw fastening cap to frame (3"-16, 1" R. H. Brass), per 100		
22767	Short screw fastening cap to frame (3"-16, 3" R. H. Brass), per 100		
22980	Washer for Nos. 56716, 22767 ($\frac{257}{64}$ x $\frac{11}{16}$ x $\frac{1}{16}$ thick fiber), per 100		
40434	Water cap, with set screw, for reversing cylinder shaft		

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Parts of Type C Controllers 4513-7

Cat. No.	Description
22769	Set screw for water cap $(\frac{1}{4}$ "-20, $\frac{3}{16}$ " Sp'l Blued), per 100
40435	SHEET IRON COVER, complete
14645	Slotted lug for cover, with rivets
$22770 \\ 22771$	SHEET IRON COVER, complete Slotted lug for cover, with rivets HINGED POLE PIECE, complete, with hinge brackets and hinge pins
22772	Spring catch, complete, with two screws for pole piece
22773	ARC DEFLECTOR, complete
19628	ARC DEFLECTOR, complete Screw fastening arc deflector to pole piece (No. 10, 1½" R. H. Blued), per 100
19630	Insulating bushing used with No 22774
22775	Insulating bushing used with No. 22774 Arc deflector back Division plate for arc deflector
22776	Division plate for arc deflector
- 1188	Division plate for arc deflector Screw fastening back to division plates (No. 10, 1" F. H.), per 100
22777	MAIN MAGNET SPOOL, wound, complete, with terminal
22778	Terminal, per 100
22779	Terminal, per 100 Binding screw (14-24, $\frac{5}{16}$ " R. H. Blued), per 100 Lock washer ($\frac{14}{4}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100 CONTROLLING CYLINDER, complete, with shaft, insulation disks, collar and
22780	Lock washer (11" x 4" x .060" Ph. Brz.), per 100
40436	star wheel
22782	
22783	Insulation disk (upper)
22784	Collar with pin $(14'' \times 14'' \times 4'' thick)$
40437	Star wheel with pin. Must be fitted
22786	Check pawl with roller for controlling cylinder
19739	Roller with pin
22787	Pivot pin for pawl
40438	Washer for pin $(\frac{14}{27} \times \frac{1}{27} \times .125'')$, per 100
16118	Spring cotter for pin ($\frac{1}{2}$ " x $\frac{1}{2}$ "), per 1000
22788	star wheel Insulation disk (upper) Insulation disk (lower) Collar with pin $(1\frac{1}{2}^{"} \times 1\frac{1}{2}^{"} \times \frac{1}{2}^{"}$ thick) Star wheel with pin. Must be fitted Check pawl with roller for controlling cylinder Roller with pin Pivot pin for pawl Washer for pin $(\frac{1}{2}^{"} \times \frac{1}{2}^{"})$, per 100 Spring cotter for pin $(\frac{1}{2}^{"} \times \frac{1}{2}^{"})$, per 1000 Tension spring for pawl ($\frac{3}{2}$ turns .072" Ph. Brz. wire, $\frac{1}{2}^{"}$ diam. closed) Pin fastening spring to frame
$\begin{array}{r} 56809 \\ 40334 \end{array}$	Pin fastening spring to frame OPERATING SHAFT, complete, with gear, interlocking cam and collar Operating gear with pin (22 teeth, 10 pitch)
22790	Operating gar with bin (22 tests 10 ritch)
40335	Interlocking can with pin
40336	Collar with pin for operating shaft
22792	Operating gear with pin (22 teeth, 10 pitch) Interlocking cam with pin Collar with pin for operating shaft Pinion for operating gear and controlling cylinder (20 teeth, 10 pitch)
22793	Retaining washer for pinion ($\frac{1}{4}$ " x 1" x .125" Brass Sp'1), per 100
56743	Retaining washer for pinion ($\frac{1}{4}$ x 1 ["] x .125 ["] Brass Sp'1), per 100
0070 (
22794	Key for pinion (1" x 1") SAFETY BREAK CAM for operating shaft Spring for safety break and interlocking cams REVERSING CYLINDER, complete, with collar and star wheel
40337 40338	SAFEI BREAK CAM for operating shall
22931	PRVFRSING (VLINDER complete with collar and star wheel
22932	Star wheel with pin Must be fitted
40439	Star wheel with pin. Must be fitted Collar with pin Interlocking pawl with pin for spring Pin fastening tension spring to pawl, per 100 Pivot pin for pawl Washer for pin $(\frac{1}{3}^{"} \times \frac{3}{4}^{"} \times .060")$, per 100 Spring cotter for pin $(\frac{1}{3}^{"} \times \frac{3}{4}")$, per 1000 Tension spring for pawl $(\frac{1}{4}^{"} \times \frac{3}{4}")$, per 1000
40339	Interlocking pawl with pin for spring
40340	Pin fastening tension spring to pawl, per 100
40341	Pivot pin for pawl
21392	Washer for pin $(\frac{13}{12}^{"} \times \frac{3}{4}^{"} \times .060^{"})$, per 100
16118	Spring cotter for pin $(\frac{1}{4}^{"} \times \frac{1}{4}^{"})$, per 1000
22936	Tension spring for pawl (15 $\frac{1}{2}$ turns .091" steel wire, $\frac{1}{16}$ " diam. closed)
40342 40343	Spring cotter for pin $(\frac{3}{2}, \frac{7}{4}, \frac{7}{4}, \frac{7}{9})$, per 100 Tension spring for pawl $(15\frac{1}{2}$ turns .091" steel wire, $\frac{7}{16}$ " diam. closed) Spring holder Screw fastening spring holder in position $(\frac{3}{4}$ "-16, $\frac{3}{4}$ " Fill. H.), per 100 PILOT VALVE BODY with sliding bar, bell crank lever and link Screw fastening No. 40440 in position $(14-24, \frac{3}{4}$ " F. H.), per 100
40440	PULOT VALVE BODY with sliding has hell crank lever and link
10298	Screw fastening No. 40440 in position (14-24, $\frac{1}{4}$ " F. H.), per 100
40441	Pilot valve stem
40442	Washer for No. 40441 $\left(\frac{19}{19} \times \frac{1}{2} \times \frac{1}{16} \right)$ thick leather), per 100
40443	Pilot valve stem . Washer for No. 40441 ($\frac{19}{64}$ " x $\frac{1}{10}$ " thick leather), per 100 Pilot valve spring (10 turns .025" Ph. Brz. wire, $\frac{1}{16}$ " outside diam., open)
40444	Pilot valve cap (#"-24 thread)
40445	Pilot valve nipple with coupling and nut
40509	Pivot valve interlocking lever with bar
40510	Prvot pin for No. 40009, per 100 \ldots
- 21392 15519	Pivot pin for No. 40509, per 100
40344	SHAFT FOR SAFETY BREAK, complete, with lever arm and cam pawl
44605	Roller, with Pin for cam pawl
22941	Roller, with Pin for cam pawl Tension spring for No. 40344 (19½ turns .072" Ph. Brz. wire, ½" diam. closed)
22942	Spring post fastening tension spring to cap plate $(\frac{3}{4}^{\prime\prime}-16, \frac{1}{4}^{\prime\prime\prime})$ ong)
22943	CONTACT BLOCK complete, for safety break
22944	Contact block
22945	Contact block
22946	Wasner plate for screw
22947	Unreinforced contact inger, with spining

Cat. No.	Description
22949	Support for finger, per 100
1193	Support for finger, per 100 Screw fastening finger and support to contact block (8-32, ½" F. H.), per 100
22950	Washer plate for No. 1193, per 100
22951	Washer plate for No. 1193, per 100 Safety break blow-out box, complete, with pole piece, contact bases and magnet spool
22952	DIOW-OUT DOX
22953	Partition for box Screw fastening partition to box (No. 6, $\frac{3}{4}$ " F. H.), per 100
10305	Screw fastening partition to box (No. 6, $\frac{3}{4}$ " F. H.), per 100
22954	Pole piece for blow-out box
13848	Pole piece for blow-out box Screw fastening pole piece to box (No. 10, ² / ₄ F. H.), per 100 Screw fastening pole piece to from (14.24, ¹ / ₄ B. H. Plerd) and 100
50428	Server resoluting pole prece to manie $(14-24, \pi, K, H, Dimetric)$, per run
$22955 \\ 22956$	Contact base (upper)
13852	Contact base (lower) Screw fastening contact base to blow-out box (No. 10, 4" F. H.), per 100
19682	Binding screw for contact base (14, 3% B, H, Blue), per 100
22780	Binding screw for contact base (14-24, " R. H. Blued), per 100 Lock washer for No. 19682 (17 x 1" x .060" Phos. Brz.), per 100
22957	SAFETY BREAK MAGNET SPOOL, wound, complete, with terminal
22778	Terminal, per 100
22959	CONTROLLING CONTACT BLOCK complete with contact bases
19669	Screw fastening block to frame (14-24, $1\frac{1}{4}$ " R. H.), per 100 Washer for screw ($\frac{14}{64}$ " x $\frac{1}{2}$ " x .060" Brass), per 100
14426	Washer for screw $(\frac{14}{4}" \times \frac{1}{4}" \times .060"$ Brass), per 100
22960	Contact finger with spring
19682	Screw fastening finger to contact base (14-24, §" R. H. Blued), per 100
22780	Contact finger with spring Screw fastening finger to contact base (14-24, $\frac{3}{5}$ " R. H. Blued), per 100 Lock washer for No. 19682 ($\frac{11}{54}$ " x $\frac{1}{2}$ " x .060" Phos. Bronze), per 100 Copper connection strip for finger base per 100
22962	Copper connection strip for finger base, per 100 Terminal for cables, per 100 Finger shield
22778	Terminal for cables, per 100
22963	Finger shield
22964	Finger shield Trolley shield Screw fastening shields to block (No. 10, §" F. H.), per 100 Fiber insulation strip under controlling contact block REVERSING CONTACT BLOCK, complete, with contact bases Screw fastening block to frame (14-24, $1\frac{1}{4}$ " R. H.), per 100 Washer for screw ($\frac{1}{64}$ " x $\frac{1}{2}$ " x .060" Brass), per 100 Contact finger
$\begin{array}{r} 16282 \\ 22965 \end{array}$	Screw lastening shields to block (No. 10, §" F. H.), per 100
22965 22967	Piper insulation strip under controlling contact block
19669	Scrive fasting block to frame (14.24.11% P. H.) and 100
14426	Washer for screw $(H' \times I' \times 0.60"$ Brass) per 100
22968	Contact finger
22969	Connector for contact finger and contact base, per 100
19682	Contact finger Connector for contact finger and contact base, per 100 Screw fastening Nos. 22968, 22969 to contact base (14-24, 3" R. H. Blued), per 100 Lock washer for No. 19682 ($\frac{14}{14}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100 Terminal for cable. per 100
22780	Lock washer for No. 19682 (11" x 3" x .060" Ph. Brz.), per 100
22778	Terminal for cable, per 100
22970	Fiber shield
10214	Terminal for cable, per 100 Fiber shield Screw fastening shield to block (No. 8, $\frac{1}{2}$ " F. H.), per 100
22971	Large fiber cleat for holding wires to frame Small fiber cleat for holding wires to frame Screw fastening No. 22971 to frame (14-24, 1 ¹ / ₈ R. H. Blued), per 100 Screw fastening No. 40511 to frame (10-32, 1 ¹ / ₈ R. H. Blued), per 100 Lock washer for No. 40581 (¹ / ₈ x ¹ / ₃ x ¹ / ₃ x .050" Ph. Brz.), per 100 TERMINAL BLOCK. complete
40511	Small fiber cleat for holding wire to frame
$\frac{19879}{40581}$	Screw fastening No. 229/1 to frame (14-24, 1 ¹ / ₂ R. H. Blued), per 100
40582	Lock washing No. 40511 to frame (10-32, 14" R. H. Blued), per 100
40512	TERMINAL BLOCK, complete
10264	TERMINAL BLOCK, complete Screw for No. 40512 (14-24, 1" R. H. Blued), per 100 Nut for No. 10264 (14-24, Hex. Brass), per 100 Lock washer for No. 10264 ($\frac{11}{64}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100 Terminal for No. 40512, per 100
22213	Nut for No. 10264 (14-24 Hex Brass) por 100
22780	Lock washer for No. 10264 ($44'' \times 4'' \times 060''$ Pb. Brz.) per 100
22778	Terminal for No. 40512, per 100
11096	Terminal for No. 40512, per 100 Screw fastening No. 40512 to frame (14-24, $\frac{5}{4}$ " R. H. Blucd), per 100 Wire guard
44606	Wire guard
22760	Screw fastening wire guard in position (14-24, 3" F. H.), per 100
	Screw fastening wire guard in position (14-24, 3" F. H.), per 100 Connection wire for contact boards (No. 10 B. & S. rubber covered, requiring approxi-
	mately 4 ¹ / ₂ feet)

4513-8 Parts of Type C Controllers

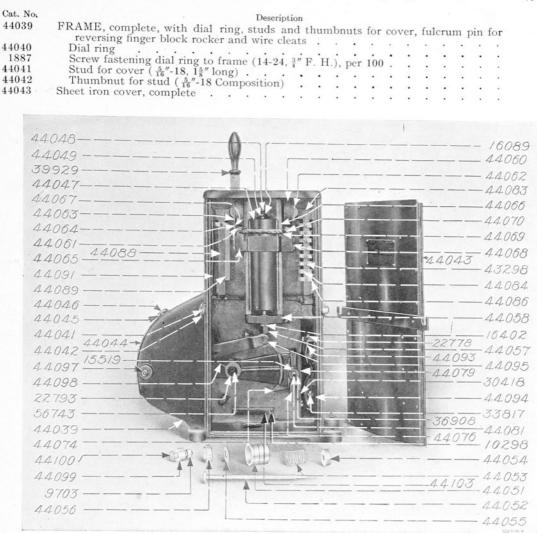
C-28-D Controller

34343	Operating handle	• •														
29184	*Reversing handle .						•	•	•	•	•	•	•	•	•	•
-	*Not included in complete Following are the intercho the C 28-C:	contro.	ucr.	Must	be or	dered	SPA	arat	ola							
$40513 \\ 40514$	SAFETY BREAK MAG Terminal block, complet	NET :	SPOO	L, wo	und,	com	plete	e, w	ith	ter	min	al	•	•		•
	, _F	• •	•	• •	•	• •	•	•	-	•	•	•	•	٠	•	•

C-29-B Controller

00000	Following are the interchangeable parts:
39929	Operating handle

Parts of Type C Controllers 4513-9



44044	Hand hole cover i
44045	Hinge pin for No. 44044 (¹ / ₄ " x 3 ¹¹ / ₁₆ ", Split), per 100
44046	Spring for No. 44044 (20 turns, .064" black steel wire)
44047	Dash pot cylinder, with lining, pipe plug, adjusting screw and nut
16089	Pipe plug, $(\frac{1}{2}''$ pipe), per 100
44048	Adjusting screw (14-24, ³ / ₄ " Hex. H. Blued, Sp'l cap screw), per 100
44049	Nut for No. 44048 (14-24, Hex. Blued cham. one side), per 100
44050	Cap screw fastening dash pot cylinder to frame, $(\frac{3}{8}''-16, \frac{3}{4}''$ Hex. H. Slot.), per 100
44051	Piston
44052	
44053	Piston rod . Compression spring for piston (8 turns, $.091''$ black steel wire, $1\frac{3}{4}''$ outside diam. open)
44054	Collar, with pin, for piston rod
44055	Leather washer for piston rod $(\frac{3}{4}'' \ge 1\frac{1}{2}'' \ge \frac{1}{8}''$ thick), per 100
44056	Retaining ring for No. 44055 $(1\frac{5}{8}"-18 \text{ thread})$
44057	Net for giving rol $(3'')$ is $(3'')$ in $(3'')$ or $($
	Nut for piston rod $(\frac{3}{8}''-16, \frac{3}{4}''$ thick, $\frac{7}{8}''$ across flats Hex. cham. one side), per 100
16402	Lock washer, for No. 44057, per 100
44058	Cross head, complete, with guide rods and supporting band
44059	BLOW-OUT SPOOL, complete, with spring, insulation and controlling contact shoe
44060	Blow-out spool, with lead and terminal
44061	Copper terminal, per 100
44062	Controlling contact shoe

4513-10 Parts of Type C Controllers

Cut. No.	Description
19669	Screw fastening No. 44062 to blow-out spool (14-24, $14''$ R. H.), per 100 Lock washer for No. 19669 ($\frac{11}{64}'' \times \frac{1}{2}'' \times .060''$ Ph. Brz.), per 100
22780	Lock washer for No. 19669 (#" x 4" x ,060" Ph. Brz.), per 100
44063	Spring for blow-out spool
44064	Insulation for spring
44065	Supporting block for No. 44059
44066	Spring for blow-out spool Insulation for spring Supporting block for No. 44059 Insulation between supporting block and supporting band and guide rods, per 100 Screw fastening Nos. 44066 in position (14.24, 14 P. H.) and 100.
19878	Screw fastening Nos. 44065, 44066 in position (14-24, ³⁷ / ₄ R. H.), per 100
38937	Washer for No. 19878 ($\frac{1}{44}$ " x $\frac{1}{2}$ " x .060"), per 100
44067	Washer for No. 19878 ($\frac{14}{5}$ " x $\frac{1}{2}$ " x $.060$ "), per 100 Insulation between supporting block and blow-out spool spring Cap screw fastening blow-out spool spring and insulation to supporting block (14-24,
48001	Cap screw fastening blow-out spool spring and insulation to supporting block (14-24,
44000	³ / ₄ " Hex. H.), per 100 Nut for No. 48001 (14-24, Hex. cham. both sides), per 100
44068	Nut for No. 48001 (14-24, Hex. cham. both sides), per 100
44069	Insulated connection bar for blow-out spools Screw fastening connection bar and blow-out spool terminal to supporting block (10-
44070	22 11% B H come 100
44071	32, 1 ¹ / ₂ R. H.), per 100 Washer for No. 44070 (1 ² / ₁ x ¹ / ₂ x . 044"), per 100 Nut for No. 44070 (10-32, Hex. cham. one side), per 100 REVERSING CONTACT FINGER BLOCK ROCKER, complete, with insulation, funger blocks and fungers
44072	W_{asher} for No. 44070 (10-32 Hay above non-cide) per 100
44073	REVERSING CONTACT FINGER BLOCK DOCKED complete with insulation
11010	finger blocks and fingers
44074	REVERSING CONTACT FINGER BLOCK ROCKER, complete, with insulation, finger blocks and fingers Rocker Finger block Insulation between finger block and rocker Screw fastening Nos. 44075, 44076 to rocker (10-32, ² / ₄ " F. H.), per 100
44075	Finger block
44076	Insulation between finger block and rocker
44077	Screw fastening Nos. 44075, 44076 to rocker (10-32, 4" F. H.), per 100
30418	Contact finger with contact tip
44078	Connection plate for contact fingers
44079	Insulation between connection plates and finger blocks
51745	Contact finger with contact fingers Connection plate for contact fingers Insulation between connection plates and finger blocks Screw fastening Nos. 30418, 44078, 44079 to finger block (14-24, ³ / ₄ " R. H. Blued), per 100
	per 100 . Anchor block for No. 51745, per 100
44080	Anchor block for No. 51/45, per 100
44081 36908	Fulctum bin for focker W_{0} (M_{0}) ($M_$
15519	Fulcrum pin for rocker Washer for No. 44081 ($\frac{11}{27}$ " x 1" x .062"), per 100 Spring cotter for No. 44081 ($\frac{3}{27}$ " x $\frac{4}{7}$), per 1000 CONTROLLING CONTACT BLOCK, right-hand, complete, with contact bases and spacing blocks
44082	CONTROLLING CONTACT BLOCK right-hand complete with contest have
	spacing blocks
44083	spacing blocks Contact block, with spacing blocks
44084	Contact base
44085	Contact base Screw fastening No. 44084 to contact block (10-32, 1" R. H. Blued), per 100
40582	
. 44086	Copper terminal for contact base, per 100 Screw fastening No. 44086 in position (10-32, ¹ / ₄ " R. H. Blued), per 100 CONTROLLING CONTACT BLOCK, left-hand, complete, with contact bases and
$\begin{array}{r} 43298 \\ 44087 \end{array}$	CONTROL LING CONTACT PLOCE 114 have a K. H. Blued), per 100
11001	spacing blocks
44088	spacing blocks Contact block with spacing blocks Contact base, small Contact base, large Screw fastening Nos. 44084, 44089 to contact block (10-32, 1" R. H. Blued), per 100 Lock washer for No. 44085 (13" x 13" x .050" Ph. Brg.), per 100
44084	Contact base, small
44089	Contact base, large
44085	Screw fastening Nos. 44084, 44089 to contact block (10-32, 1" R. H. Blued) per 100
40582	
44090	Connection strip for mos. 44084, 44089
44086	Connection strip for Nos. 44084, 44089 Copper Terminal for No. 44084, per 100 Screw fastening No. 44086 in position (10-32, ¹ / ₄ " R. H. Blued), per 100 Insulation shield under controlling contact blocks Screw fastening Nos. 44082, 44087 to frame (14-24, 1 ¹ / ₄ " F. H.), per 100 REVERSING CONTACT BLOCK, complete, with contact bases Contact bases per 100
43298	Screw fastening No. 44086 in position (10-32, 4" R. H. Blued), per 100
$44091 \\ 29423$	Insulation shield under controlling contact blocks
44092	DEVERSING CONTACT BLOCK constants (14-24, 14" F. H.), per 100
44093	Contact base per 100
- 22778	Contact base, per 100 Copper terminal for contact base, per 100 Saraw fastaning Non 44002 20778 to exclude the day of the D
13140	
44071	Washer for No. 13140 ($\frac{13}{14}$ " x $\frac{13}{142}$ " x .044"), per 100 . Screw fastening No. 44092 to frame (14-24, $\frac{3}{14}$ " R. H.), per 100
33817	Screw fastening No. 44092 to frame (14-24, 34" R. H.), per 100
38937	Washer for No. 33817 ($\frac{11}{11}$ " x $\frac{1}{3}$ " x .060"), per 100
44094	Washer for No. 33817 ($\frac{11}{54}$ " x $\frac{1}{2}$ " x .060"), per 100 Insulation shield under reversing contact blocks
\cdot 44095	Operating lever, with roller for piston rod
44096	Roller with pin
44097	Operating lever, with roller for piston rod Roller with pin Hinge pin with locking pin for No. 44095
44098	Operating cam
44099	Noner for operating cam
44100 9703	Nut for No. 44100 ($\frac{1}{2}$, 14 Hey Rough Cham and 14) are 100
44101	Operating cam Roller for operating cam Hinge bolt for No. 44009 ($\frac{1}{16}$ "-14, 2_8 " Sp'l) Nut for No. 44100 ($\frac{1}{16}$ "-14, Hex. Rough Cham. one side), per 100 Hinge pin for operating cam and operating handle Key for 44101 per 100
44102	Kev for 44101, per 100
22793	Key for 44101, per 100

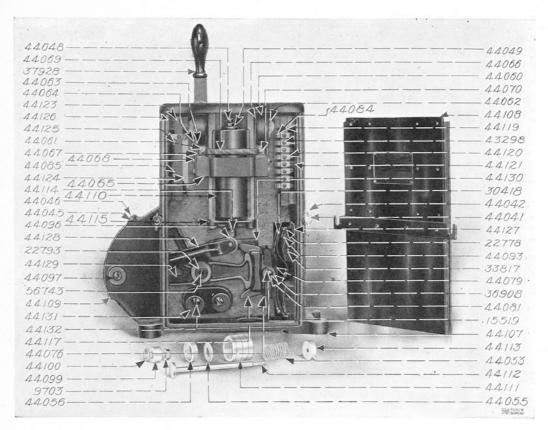
Parts of Type C Controllers 4513-11

Cat. No.	Description							
$56743 \\ 44103$	Screw for No. 22793 (14-24, $\frac{1}{2}"$ F. H.), per 100							
	Fiber cleat for holding wires to frame		2	÷.,				
10298	Screw fastening No. 44103 to frame (14-24, 3" F. H.), per	100		1.1	22	12	100	1.12

C-29-A Controller

	following are the interchangeable parts of the C 29-A Controller which differ from those of the C 29-B:
44104	Operating lever
44105	FRAME, complete, with studs and thumbnuts for cover, fulcrum pin for reversing
44106	finger block rocker and wire cleats
44100	Cleat for holding wires to frame

C-31-B Controller



Following are the interchangeable parts:

37928	Operating handle	
44107	FRAME, complete, with studs and thumbnuts for cover, fulcrum pin for revers	ng
	finger block rocker and wire cleats	
44041	Stud for cover $(\frac{5}{5}''-18, \frac{15}{5}'' \log)$	
44042	Thumbnut for stud $\left(\frac{5}{16}\right)^{-18}$, Composition)	
44108	Sheet iron cover, complete	
44109	Hand hole cover	
44045	Hinge pin for No. 44109 ($\frac{1}{4}$ x $3\frac{11}{16}$ Split), per 100	4
44046	Spring for No. 44109 (20 turns, .064" black steel wire)	
44110	Dash pot cylinder, with lining, pipe plug, adjusting screw and nut	
16089	Pipe plug, $(\frac{1''}{2})$ pipe), per 100	100
44048	Adjusting screw (14-24, ³ / ₄ " Hex. H. Blued, Sp'l Cap screw), per 100	
44049	Nut for No. 44048 (14-24, Hex. Blued Cham. one side), per 100	
44050	Cap screw fastening dash pot cylinder to frame (3"-16, 3" Hex. H. Slot.), per 100	

4513-12 Parts of Type C Controllers

Cat. No.	Description
44111	
44112	Piston rod
44053	Compression spring for piston (8 turns, .091" black steel wire, 12" outside diam. open)
44113	Collar, with pin for piston rod Leather washer for piston rod $(\frac{1}{4}'' \ge \frac{1}{4}'' \ge \frac{1}{4}''$ thick), per 100
44055	Leather washer for piston rod $(\frac{1}{4}^n \times \frac{1}{2}^n \times \frac{1}{4}^n$ thick), per 100
44056	Retaining ring for No. 44055 (1 $\frac{2}{5}$ "-18 thread)
44114	Nut for piston rod $(\frac{1}{16}, \frac{1}{26}, \frac{1}{27}, \frac{1}{16})$ thick, $\frac{1}{4}$ across flats, Hex. cham. one side), per 100 .
29059	Lock washer for No. 44114, per 100
44115	Cross head, complete, with guide rods and supporting band BLOW-OUT SPOOL, complete, with spring, insulation and controlling contact shoe
44059	BLOW-OUT SPOOL, complete, with spring, insulation and controlling contact shoe
44080	Blow-out spool with lead and terminal
44061	Copper terminal, per 100
44062	Controlling contact shoe Screw fastening No. 44062 to blow-out spool (14-24, 14" R. H.), per 100
19669	Screw fastening No. 44062 to blow-out spool (14-24, 14" R. H.), per 100
22780	Lock washer for No. 19669 ($\frac{11}{44}$ x $\frac{1}{2}$ x .060" Ph. Brz.), per 100 Spring for blow-out spool
44063	Spring for blow-out spool
44064	Insulation for spring
44065	Supporting block for No. 44059
44066	Insulation between supporting block and supporting band and guide rods
19878	Screw fastening Nos. 44065, 44066 in position (14-24, $\frac{2}{5}$ " R. H.), per 100
38937	Washer for No. 19878 ($\frac{1}{44}$ " x $\frac{1}{2}$ " x .060"), per 100
44067	Insulation between supporting block and blow-out spool spring
48001	Supporting block for No. 44059 Insulation between supporting block and supporting band and guide rods Screw fastening Nos. 44065, 44066 in position (14-24, $\frac{1}{4}$ " R. H.), per 100 Washer for No. 19878 ($\frac{1}{44}$ " x $\frac{1}{2}$ " x .060"), per 100 Insulation between supporting block and blow-out spool spring Cap screw fastening blow-out spool spring and insulation to supporting block (14-24,
	³ " Hex. H.), per 100
44068	Nut for No. 48001 (14-24, Hex. Cham. one side), per 100
44069	Insulated connection bar for blow-out spools, per 100 Screw fastening connection bar and blow-out spool terminal to supporting block (10-
44070	
44071	32, 1½" R. H.), per 100 Washer for No. 44070 (13" x 13" x .044"), per 100
44071	Washer for No. 44070 ($\frac{1}{10}$ x $\frac{1}{37}$ x $\frac{1}{37}$ x $\frac{1}{37}$ x $\frac{1}{37}$ characteristic sector $\frac{1}{37}$
44072	Nut for No. 44070 (10-32, Hex. Cham. one side), per 100 REVERSING CONTACT FINGER BLOCK ROCKER, complete, with insulation,
44116	REVERSING CONTACT FINGER BLOCK ROCKER, complete, with insulation,
4 + 1 1 7	finger blocks and fingers Rocker Finger block
44117	
$\begin{array}{r} 44075\\ 44076 \end{array}$	Finger block
	$\sim \Omega_{\rm max}$ for the New Mer. (1076 14076 to me line (10.00 7% The TL) $= 100$
44077 30418	Screw lastering Nos. 44073, 44076 to focker (10-32, $\frac{1}{5}$ F. H.), per 100 Contact finger with contact tip
44078	Connecting plate for contact the second
44079	Insulation between connection plates and finger blocks
51745	Insulation between connection plates and finger blocks Screw fastening Nos. 30418, 44078, 44079 to finger block (14-24, ³ / ₄ " R. H. Blued),
01112	per 100
44080	per 100
44081	Fulcrum pin for rocker
36908	Washer for No. 44081 ($\frac{147}{3}$ x 1" x .062"), per 100
15519	Spring cotter for No. 44081 ($\frac{3}{2}$ " x $\frac{3}{2}$ "), per 1000
44118	Fulcrum pin for rocker Washer for No. 44081 ($\frac{127}{32}$ " x 1" x .062"), per 100 Spring cotter for No. 44081 ($\frac{37}{32}$ " x $\frac{3}{4}$ "), per 1000 CONTROLLING CONTACT BLOCK, right-hand, complete, with contact bases and
1	spacing blocks
44119	Contact block with spacing blocks
44084	Contact boss
10075	Screw fastening No. 44084 to contact block, (10-32, 3" R. H. Blued), per 100.
40582	Lock washer for No. 10075 (12" x 12" x .050" Ph. Brz.), per 100
44120	Copper terminal for contact base
43298	Copper terminal for contact base Screw fastening No. 44120 in position (10-32, 4" R. H. Blued), per 100 Insulation shield under No. 44118
44121	Insulation shield under No. 44118
44122	Insulation shield under No. 44118 CONTROLLING CONTACT BLOCK, left-hand, complete, with contact bases and
	Spacing blocks Contact block, with spacing blocks Contact block, with spacing blocks Contact base, small Contact base, large
44123	Contact block, with spacing blocks
44084	Contact base, small
44124	Contact base, large
44085	Screw fastening Nos. 44084, 44124 to contact block (10-32, 1" R. H. Blued), per 100
40582	Lock washer for No. 44085 ($\frac{13}{4}$ " x $\frac{13}{2}$ " x .050" Ph. Brz.), per 100 Connection strip for Nos. 44084, 44124, per 100
44125	Connection strip for Nos. 44084, 44124, per 100
44120	
43298	Screw fastening No. 44120 in position (10-32, ¹ / ₄ " R. H. Blued), per 100
44126	Insulation shield under No. 44122
29423	Screw fastening Nos. 44118, 44122 to frame (14-24, 1 ¹ / ₄ " F. H.), per 100
44092	REVERSING CONTACT BLOCK, complete, with contact bases
44093	Contact base, per 100
22778	Copper terminal for contact base, per 100
13140	Copper terminal for contact base, per 100 . Screw fastening Nos. 44093, 22778 to contact block (10-32, §" R. H.), per 100 .

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Parts of Type C Controllers 4513-13

Cat. No.	Description
44071	Washer for No. 13140 ($\frac{13}{64}$ " x $\frac{13}{32}$ " x .044"), per 100
33817	Screw fastening No. 44092 to frame (14-24, 31" R. H.), per 100
38937	Washer for No. 33817 ($\frac{17}{47}$ x $\frac{1}{2}$ " x .060"), per 100
44127	Insulation shield under reversing contact blocks
44128	Operating lever, with roller for piston rod
44036	Roller with nin
44097	Roller with pin . Hinge pin with locking pin for No. 44128
44129	Operating cam
44099	Operating cam
44100	Roller for operating cam
9703	Hinge bolt for No. 44099 ($\frac{7}{16}$ "-14, $2\frac{1}{4}$ " Sp'l)
44101	Nut for No. 44100 (fr -14. nex. Kough, Cham, one side), per 100
	Hinge pin for operating cam and operating handle
44102	Key for No. 44101, per 100
22793	Retaining washer for No. 44101 ($\frac{1}{2}$ x 1" x .125" Brass. Sp(1), per 100
56743	Screw for No. 22793 (14-24, ¹ / ₄ " F. H.), per 100
44130	Fiber cleat for holding wires to frame
10298	Screw lastening No. 44130 to frame $(14-24, \frac{1}{2}^{"} F, H_{.})$, per 100
44131	Stop for operating cam
44132	Cap screw fastening No. 44131 to frame $(\frac{1}{2}^{"}-13, 1\frac{1}{2}^{"}$ Fill. H.), per 100

C-31-A Controller

Following is the only interchangeable part of the C 31-A Controller which differs from those of the C 31-B: Operating lever

44133

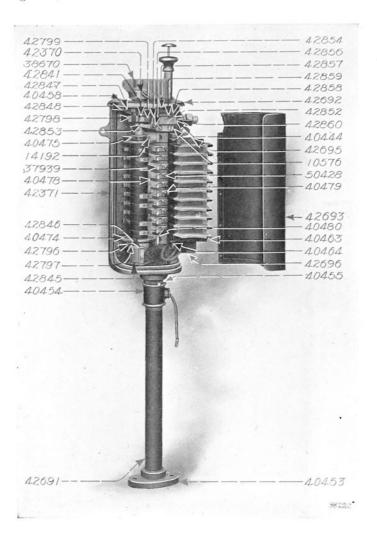
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C-35-A Controller

	Following are the interchangeable parts:
38670	Operating handle
42370	Operating handle Key for handle FRAME, complete, includes adjusting and set screws Wire tube Base for wire tube Coupler for tee and frame Set screw for No. 40455 (§"-16, §" Sq. H. Cup Point, Blued), per 100
42371	FRAME, complete, includes adjusting and set screws
42691	Wire tube
40453	Base for wire tube
40454	Tee for wire tube
40455	Coupler for tee and frame
40456	Set screw for No. 40455 (² / ₄ "-16, ² / ₄ " Sq. H. Cup Point, Blued), per 100
42692	CAP for top of controller
40458	CAP for top of controller Screw fastening cap to frame ($\frac{3}{4}$ " R. H. Brass), per 100
42693	Sheet iron cover, complete
40462	Sheet iron cover, complete ARC DEFLECTOR, complete, with pole piece, hinge pin and nuts
40463	Division plate for arc deflector
40464	Hinge pin for arc deflector
42694	Nut for hinge pin $(\frac{1}{16}''-18, \frac{1}{16}'')$ thick, Hex.), per 100
40465	Division plate for arc deflector Hinge pin for arc deflector Nut for hinge pin $(\frac{16}{16}^{\prime\prime}-18, \frac{2}{16}^{\prime\prime\prime}$ thick, Hex.), per 100 Nut with pin for hinge pin $(\frac{1}{16}^{\prime\prime}-18, \frac{2}{16}^{\prime\prime\prime}$ thick, Hex. Sp'l), per 100
40466	Adjusting screw for hinge pin (3"-13, 14" Headless Sp')
40467	Adjusting screw for hinge pin (1%-13, 1%" Headless Sp'l) Set screw for No. 40466 (14-24, 2" Headless Sp'l)
42695	Hinge bracket for pole piece (upper) Hinge bracket for pole piece (lower) Screw fastening hinge brackets to pole piece (14-24, §" F. H.), per 100
42696	Hinge bracket for pole piece (lower)
2028	Screw fastening hinge brackets to pole picce (14-24, 4" F. H.), per 100
42697	Latch for arc deflector
42698	Latch for arc deflector Spring for latch Blow-out coil, wound, complete with leads CONTROLLING CYLINDER, complete, with shaft, insulation disks, collars, pilot
40471	Blow-out coil, wound, complete with leads
42699	CONTROLLING CYLINDER, complete, with shaft, insulation disks, collars, pilot
	valve, operating cam and plunger
40473	Complete set of copper contact segments with screws, per set
	Contact segments and screws for same are listed on page 15
40474	Insulation disk Stop collar with pin for lower end of cylinder Collar with pin for upper end of cylinder Collar with pin for upper end of cylinder Operating cam, with stop piece for pilot valve Pin for operating cam and plunger $(\frac{1}{4}x \ 2'')$, per 100 Spring cotter for pin $(\frac{54}{54}x \ 2^{''}$ Blued), per 100 Spring collar with screw for No. 42708
42796	Stop collar with pin for lower end of cylinder
42797	Bushing for lower end of cylinder
40475	Collar with pin for upper end of cylinder
42798	Operating cam, with stop piece for pilot valve
42799	Pin for operating cam and plunger $(\frac{1}{4}^{n} \times 2^{n})$, per 100
42840	Spring cotter for pin $(\frac{1}{24}^{\prime\prime} \times \frac{2}{3}^{\prime\prime})$ Blued), per 100
42841	Stop collar, with set screw, for No. 42798
42842	Stop collar, with set screw, for No. 42798
42843	Plunger for No. 42798
42844	Spring for plunger
42845	Plunger for No. 42798
42846	Spring post

4513-14 Parts of Type C Controllers

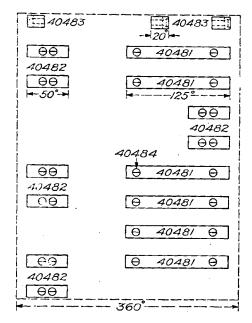
Cat. No.	Description	
42847	Cylinder stop	- 14 ⁻
42848	Hinge pin for No. 42847 $\left(\frac{5}{16}'' \times 1\frac{1}{8}''\right)$	1.022
42840	Spring cotter for pin $\left(\frac{3}{64}\right)$ x $\frac{3}{4}$, Blued, per 100	
42849	Spring for No. 42847	
10255	Screw fastening spring to cap plate (6-32, ¹ / ₄ " R. H., Blued), per 100	
42850	Stop plate	
1193	Screw fastening stop plate to cap plate (8-32, $\frac{1}{2}$ " F. H.), per 100	0.000
42851	PILOT VALVE, complete	e
42852	Body	1.1
42853	Operating lever, with catch	



42854	Catch with rivet								
42855	Hinge pin for operating lever $(4^{\circ} \times 24^{\circ})$, per 100								
42856	Spring cotter for pin $(\frac{2}{64}^{\prime\prime} \times \frac{1}{2}^{\prime\prime})$ Blued), per 100					1.1	20	12	
42857	Spring for operating lever and body, per 100 .						10	2.2	
42858	Latch with spring								
42859	Fulcrum pin for latch								
38937	Washer for No. 42859 $(\frac{17}{64}'' \ge \frac{17}{2}'' \ge .060'')$, per 100								
42856	Spring cotter for No. 42859 ($\frac{5}{64}$ " x $\frac{1}{2}$ " Blued), per 10	00 .							
40441	Pilot valve stem								
40442	Washer for No. 40441 ($\frac{19}{3}$ x $\frac{1}{3}$ x $\frac{1}{3}$ thick leather)	. per	- 100					- 8	

Parts of Type C Controllers 4513-15

Cat. No.		D	escr	iptic	n										
40443	Pilot valve spring														
	5 > Pilot valve cap (§"-24 thread)	•	•	•	•	•	•		•	•	•	•	•		
42860	Pilot valve nipple with coupling	and	nu	t	•		·	•				•			
10576	Screw fastening pilot valve in posi	tion	$(\frac{5}{16})$	/ ~-1	8,	1″ F	. н.	.),	per	100		•	•	•	·



Contact Segment			•	•	•	•
Contact Segment	٠	•	•	•	•	•
Contact Segment	•	•	•	•	·	•
Screw for Segment, per 100	•	•	٠	•	٠	•
Contact block, complete, with contact bases	•	•	•	•	٠	•
	•	•	•	٠	•	•
Lock washer for No. 19646 ($\frac{11}{64}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100	•	•	٠	٠	٠	•
Contact finger with spring	•	. :	•	•	•	•
Screw fastening finger to contact base (14-24, ½" R. H. Blued), pe	r 1	00	•	٠	·	·
Terminal for cables, per 100	•	·	•	٠	·	•
Finger shield	•	•	•	·	•	·
Screw fastening shield to contact block (No. 8 \$" F. H.) per 100						
	Contact Segment	Contact Segment Contact Segment Screw for Segment, per 100 Contact block, complete, with contact bases Screw fastening No. 40478 to frame (14-24, 1" R. H.), per 100 Lock washer for No. 19646 ($\frac{11}{64}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100 Contact finger with spring Screw fastening finger to contact base (14-24, $\frac{1}{2}$ " R. H. Blued), per 1 Terminal for cables, per 100 Finger shield	Contact Segment Contact Segment Screw for Segment, per 100 Contact block, complete, with contact bases Screw fastening No. 40478 to frame (14-24, 1" R. H.), per 100 Lock washer for No. 19646 ($\frac{14}{14}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100 Contact finger with spring Screw fastening finger to contact base (14-24, $\frac{1}{2}$ " R. H. Blued), per 100 Terminal for cables, per 100 Finger shield	Contact Segment Contact Segment, per 100 Contact block, complete, with contact bases Screw fastening No. 40478 to frame (14-24, 1" R. H.), per 100 Lock washer for No. 19646 ($\frac{14}{14}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100 Contact finger with spring Screw fastening finger to contact base (14-24, $\frac{1}{2}$ " R. H. Blued), per 100 Terminal for cables, per 100 Finger shield	Contact Segment Contact Segment Screw for Segment, per 100 Contact block, complete, with contact bases Screw fastening No. 40478 to frame (14-24, 1" R. H.), per 100 Lock washer for No. 19646 ($\frac{11}{12}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100 Contact finger with spring Screw fastening finger to contact base (14-24, $\frac{1}{2}$ " R. H. Blued), per 100 Terminal for cables, per 100 Finger shield	Contact Segment Contact Segment Screw for Segment, per 100 Contact block, complete, with contact bases Screw fastening No. 40478 to frame (14-24, 1" R. H.), per 100 Lock washer for No. 19646 ($\frac{14}{14}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100 Contact finger with spring Screw fastening finger to contact base (14-24, $\frac{1}{2}$ " R. H. Blued), per 100 Terminal for cables, per 100 Finger shield

C-36-A Controller

33560	*Operating handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 36-A Controller which differ from those of the C 26-A:
43757	Cap for top of controller CONTROLLING CYLINDER, complete, with shaft, insulation disks, collar, stop
43758	and releasing spring
43759	Cylinder stop with pin
	C-38-C Controller
34343	Operating handle \ldots

- 29184
- *Reversing handle
 *Roversing handle
 *Not included in complete controller. Must be ordered separately.
 Following are the interchangeable parts:
 FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) 40333

4513-16 Parts of Type C Controllers

Cat. No.	Description	
9987	Cap screw fastening bearing cap to frame (3"-16, 2" Hex. H. Slot.)	
22761	Soft rubber packing for frame, each	
22762	Washer strip for packing	
1288	Screw fastening Nos. 22761, 22762 to frame (10-24, ³ / ₄ " F. H.), per 100	
22763	Binding nut with set screw for magnet spool (1 ³ / ₄ ["] -18, ¹ / ₄ " thick, Hex. Brass Sp ⁽¹⁾	
22764	Set screw for No. 22763 ($\frac{1}{2}$ -20, $\frac{3}{2}$ Headless Sp'l), per 100	
14646	Hinge bolt with pin and nut for fastening cover to frame	
4030	Spring cotter for pin $(\frac{3}{32}'' \ge \frac{5}{32}'')$, per 1000	
44602	CAP for top of controller	
56716	Long screw fastening cap to frame (³ / ₈ "-16, 1" R. H. Brass), per 100	•

40439		m
40434		
2293/		# 40337
22968 — — — —		
29184		
44602		22942
22967		
22970		40339
22936		40335
40342		40344
40343		22950 22932
40511		
22954		22011 22940
22952		
22956 22793		
22792 56809	The second secon	
44604 -22782-		
44603		
22960		
22959		19682
22963		
1288		7
22762		7
22761		+
22213		22778
22783		
22763		
22764		40333
22777		
		(70 BARA

22767	Short screw fastening cap to frame $(\frac{3}{8}''-16, \frac{7}{8}'' R. H. Brass)$, per 100					
22980	Washer for Nos. 56716, 22767 ($\frac{25}{64}$ " x $\frac{11}{16}$ " x $\frac{1}{16}$ " thick fiber), per 100					
40434	Water cap, with set screw, for reversing cylinder shaft					
22769	Set screw for water cap $(\frac{1}{4}$ -20, $\frac{9}{16}$ Sp'l Blued), per 100					
22981	Sheet iron cover, complete					
14645	Slotted lug for cover with rivets					
22770	HINGE POLE PIECE, complete, with hinge brackets and hinge pu	IS				
22771	Spring catch, complete, with two screws, for pole piece			•		
22772	Screw fastening catch to pole piece stop (10-24, $\frac{7}{8}$ " F. H.), per 100					
22773	ARC DEFLECTOR, complete				•	
19628	Screw fastening arc deflector to pole piece (No. 10, 12" R. H. Elue	d),	per	100)	

Parts of Type C Controllers 4513-17

•	
Cat. No.	Description
19630	Insulating bushing used with No. 19698
22775	Arc deflector back
22776	Division plate for are deflector
1188	Insulating bushing used with No. 19628 Arc deflector back Division plate for arc deflector Screw fastening back to division plates (No. 10, 1" F. H.), per 100 MAIN MAGNET SPOOL, wound, complete, with terminal Terminal, per 100
22777	MAIN MACURE SPOOL would complete (No. 10, 17 F. H.), per 100
22778	Torminal and the second, wound, complete, with terminal
	Terminal, per 100
22779	Screw fastening terminal in position (14-24, 5" R H Blued) per 100
22780	Lock washer for No. 22779 ($\frac{17}{64}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100
44603	CONTROLLING CYLINDER, complete, with shaft, insulation disks, collar and
	star wheel
22782	Insulation disk (upper)
22783	Insulation disk (upper)
22784	Coller with sin
	Collar, with pin Star wheel, with pin. Must be ju.ed Check pawl, with roller, for controlling cylinder
44604	Star wheel, with pin. Must be fuel
22786	Check pawl, with foller, for controlling cylinder
19739	_ Roller, with pin
22787	Pivot Pin for pawl
40438	Washer for pin $(\frac{15}{7} \times \frac{7}{7} \times .125'')$, per 100
16118	Spring cotter for pin $(4'' \times 4'')$, per 1000
22788	Roller, with pin Pivot Pin for pawl Washer for pin $(\frac{1}{32}'' \times \frac{1}{3}'')$, per 100 Spring cotter for pin $(\frac{1}{32}'' \times \frac{1}{3}'')$, per 1000 Tension spring for pawl (32 turns, .072'' Ph. Brz, wire $\frac{1}{2}''$ Diam. closed) Pin fastening spring to frame
56809	Dia fostoria granda de farme a farme a farme a biam. closed)
40334	Pin fastening spring to frame OPERATING SHAFT, complete, with gear, interlocking cam and collar
	OFERATING SHAFT, complete, with gear, interlocking cam and collar
22790	Operating gear with pin (22 teeth, 10 pitch)
40335	Interlocking cam, with pin
40336	Collar, with pin, for operating shaft
22792	Pinion for operating gear and controlling cylinder (20 teeth, 10 pitch)
22793	Retaining washer for pipion $(\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2})^{n}$ Brass Sp ⁽¹⁾
56743	Screw fastening Nos 22792 22793 to controlling ordinder shoft (14.24.1/ D. L.)
, ,	Operating gear with pin (22 teeth, 10 pitch) Interlocking cam, with pin Collar, with pin, for operating shaft Pinion for operating gear and controlling cylinder (20 teeth, 10 pitch) Retaining washer for pinion ($\frac{1}{4}'' \ge 1'' \ge .125''$ Brass Sp'l) Screw fastening Nos. 22792, 22793 to controlling cylinder shaft (14-24, $\frac{1}{2}''$ F. H.), per 100
22794	
40337	SAFBIX BREAK CAM, for operating shaft
40338	Key for pinion SAFETY BREAK CAM, for operating shaft Spring for safety break and interlocking cams
22931	KISVERSINIT CVLUNTER complete with college and star wheel
22932	Star wheel with pin. Must be fitted
40439	Collar with pin
40339	Interlocking pawl, with pin for spring
40340	Star wheel with pin. Must be fitted Collar with pin . Interlocking pawl, with pin for spring Pin fastening tension spring to pawl, per 100
	Binet rain for power spring to pawi, per 100
40341	Pivot pin for pawl $\frac{1}{32}$ x $\frac{3}{4}$ x .060"), per 100 Washer for pin $(\frac{1}{32}$ x $\frac{3}{4}$ x .060"), per 100 Spring cotter for pin $(\frac{1}{3}$ x $\frac{3}{4}$ "), per 1000 Tension spring for pawl (15½ turns, .091" steel wire, $\frac{9}{16}$ " Diam. closed)
21392	wasner for pin $(\frac{1}{2}, \frac{1}{2}, 1$
16118	Spring cotter for pin $(\frac{1}{2}^{"} \times \frac{1}{2}^{"})$, per 1000
22936	Tension spring for pawl ($15\frac{1}{2}$ turns, $.091''$ steel wire, $\frac{9}{16}''$ Diam. closed)
40342	Spring holder
40343	Spring holder . Screw fustening spring holder in position $(\frac{2}{3}''-16, \frac{2}{3}''$ Fill. H.), per 100
40344	SHAFT FOR SAFETY BREAK, complete, with lever arm and cam pawl
44605	Roller with pin for cam pawl
22941	Roller with pin for cam pawl Tension spring for No. 40344 (191 turns, .072" Ph. Brz. wire, $\frac{1}{2}$ " diam. closed)
22941	Exclosed opting tot tot. $100 \pm 1(10)$ totals, 012 Fill Diz. wite, $\frac{1}{2}$ dialit. $closed$).
	Spring post, fastening tension spring to cap plate, $(\frac{3}{8}''-16, \frac{13}{16}'' \text{ long})$
22943	CONTACT BLOCK, complete, for safety break
22944	CONTACT BLOCK, complete, for safety break Contact block
22945	Screw fastening block to lever arm $(14-24, 1+7, 1+7)$ ber 100
22946	Washer plate for screw
22947	Washer plate for screw
22949	Support for finger, per 100
1193	Support for finger, per 100 Screw fastening finger and support to contact block (8-32, ½" F. H.), per 100
22950	Washer plate for No. 1193, per 100
	Associate plate for two integrations of the part of th
22951	Safety break blow-out box, complete, with pole piece, contact bases and magnet spool
22952	Blow-out box
22953	Partition for box Screw fastening partition to box (No. 6, $\frac{3}{4}$ " F. H.), per 100
10305	Screw fastening partition to box (No. 6, $\frac{3}{4}$ " F. H.), per 100
22954	
13848	Screw fastening pole piece to box (No. 10, $\frac{2}{7}$ " F. H.), per 100
50428	Screw fastening pole piece to frame (14-24 4" R H Blued) per 100
	Contract base (upper) to frame (11 =1, 2 to 11 Diacu), per 100
22955	Contact base (upper)
22956	Contact Dase (lower)
13852	Screw fastening contact base to blow-out box (No. 10, 3" F. H.), per 100 .
19682	Binding screw for contact base (14-24, 3" R. H. Blued), per 100 Lock washer for No. 19682 (43" x 1" x .060" Phos. Bronze), per 100
22780	Lock washer for No. 19682 ($\frac{12}{14}$ " x $\frac{1}{2}$ " x .060" Phos. Bronze), per 100
22957	SAFETY BREAK MAGNET SPOOL, wound, complete, with terminal
22778	Terminal, per 100
22959	Terminal, per 100 CONTROLLING CONTACT BLOCK, complete, with contact bases
44909	Contraction of the brook, complete, with contact bases

Cat. No.	
19669	DescriptionScrew fastening block to frame (14-24, $1\frac{1}{4}$ " R. H.), per 100Washer for No. 19669 ($\frac{1}{24}$ " x $\frac{1}{2}$ " x.060" Brass), per 100Contact finger with springScrew fastening finger to contact base (14-24, $\frac{3}{4}$ " R. H. Blued), per 100Lock washer for No. 19682 ($\frac{1}{24}$ " x $\frac{1}{2}$ " x.060" Phos. Bronze), per 100Copper connection strip for finger base, per 100Terminal for cables, per 100Terminal for cables, per 100Finger shieldTrolley shieldScrew fastening shields to block (No. 10, $\frac{4}{5}$ " F. H.), per 100Fiber insulation strip under controlling contact blockREVERSING CONTACT BLOCK, complete, with contact bases
14426	Washer for No. 19669 ($\frac{13''}{x} \frac{1}{x} \frac{1}{x} . 060''$ Brass), per 100
22960	Contact finger with spring
19682	Screw fastening finger to contact base (14-24, 3" R. H. Blued), per 100
22780	Lock washer for No. 19682 ($\frac{1}{4}$ " x $\frac{1}{4}$ " x .060" Phos. Bronze), per 100
$\begin{array}{r} 22962 \\ 22778 \end{array}$	Copper connection strip for linger base, per 100
$\begin{array}{r} 22778 \\ 22963 \end{array}$	Finance shield
22964	Trolley shield
16282	Screw fastening shields to block (No. 10, §" F. H.), per 100
22965	Fiber insulation strip under controlling contact block
22967	
19669	Screw fastening block to frame (14-24, $1\frac{4''}{4}$ R. H.), per 100
14426	Washer for No. 19669 ($\frac{14}{17} \times \frac{1}{27} \times .060^{\circ}$ Brass), per 100
22968 22969	Contact finger
19682	Screw fastening Nos 22060 to contact base, per 100
22780	Lock washer for No. 19682 ($\frac{17}{14}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100
22778	Terminal for cable, per 100
22970	Terminal for cable, per 100
10214	Screw fastening shield to block (No. 8, $\frac{1}{2}$ " F. H.), per 100
22971	Large liber cleat for holding wire to frame
$40511 \\ 19879$	Sprain neer cleat for holding wire to frame
40581	Screw fastering No. 40511 to frame (14-24, 1% R. H. Blued), per 100
40582	Large fiber cleat for holding wire to frame Small fiber cleat for holding wire to frame Screw fastening No. 22971 to frame (14-24, $1\frac{1}{3}$ " R. H. Blued), per 100 Screw fastening No. 40511 to frame (10-32, $1\frac{1}{3}$ " R. H. Blued), per 100 Lock washer for No. 40581 ($1\frac{13}{3}$ " x $\frac{13}{3}$ " x .050" Ph. Brz.), per 100
40512	TERMINAL BLOCK, complete Screw for No. 40512 (14-24, 1" R. H. Blued), per 100 Nut for No. 10264 (14-24, Hex. Brass), per 100 Lock washer for No. 10264 ($\frac{14}{14}$ " x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100 Terminal for No. 40512, per 100 Screw fastening No. 40512 to frame (14-24, $\frac{1}{2}$ " R. H. Blued), per 100 Wire mard
10264	Screw for No. 40512 (14-24, 1" R. H. Blued), per 100
22213	Nut for No. 10264 (14-24, Hex. Brass), per 100
$\begin{array}{r} 22780\\ 22778\end{array}$	Lock washer for No. 10264 ($\frac{11}{10}$ x $\frac{1}{2}$ " x .060" Ph. Brz.), per 100
11096	Screw fastening No. 40512 to frame (14.24.5" P. H. Blued) por 100
44606	
22760	Screw fastening wire guard in position (14-24, 3" F. H.), per 100 Connection wire for contact boards (No. 10 B. & S. rubber covered, requiring approxi-
	Connection wire for contact boards (No. 10 B. & S. rubber covered, requiring approxi-
	mately 4½ feet)
	mately $4\frac{1}{2}$ leet)
34343	mately $4\frac{1}{2}$ leet)
34343 29184	mately $4\frac{1}{2}$ leet)
	mately 4½ leet) C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately.
	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those
29184	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C:
	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder
29184	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder
29184	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position)
29184 40432 40435 40440	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position)
29184 40432 40435 40440 10298	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position)
29184 40432 40435 40445 10298 40441	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position)
29184 40432 40435 40440 10298 40441 40442	 C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete PILOT VALVE BODY, with sliding bar, bell crank lever and link Screw fastening No. 40440 in position (14-24, §" F. H.), per 100 Pilot valve stem Washer for No. 40441 (k%" x k" x k" thick leather) per 100
29184 40432 40435 40440 10298 40441 40442 40443	mately 4½ feet) C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete
29184 40432 40435 40440 10298 40441 40442 40443 40444	mately 4½ feet) C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete PILOT VALVE BODY, with sliding bar, bell crank lever and link Screw fastening No. 40440 in position (14-24, 3" F. H.), per 100 Pilot valve stem Washer for No. 40441 (14" x 1" x 1" thick leather), per 100 Pilot valve spring Pilot valve nipple, with coupling and nut
29184 40432 40435 40440 10298 40441 40442 40443	mately 4½ feet) C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete PILOT VALVE BODY, with sliding bar, bell crank lever and link Screw fastening No. 40440 in position (14-24, 3" F. H.), per 100 Pilot valve stem Washer for No. 40441 (14" x 1" x 1" thick leather), per 100 Pilot valve spring Pilot valve nipple, with coupling and nut
29184 40432 40435 40440 10298 40441 40442 40443 40443 40444 40445 40509 40510	mately 4½ feet) C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete PILOT VALVE BODY, with sliding bar, bell crank lever and link Screw fastening No. 40440 in position (14-24, 3" F. H.), per 100 Pilot valve stem Washer for No. 40441 (14" x 1" x 1" thick leather), per 100 Pilot valve spring Pilot valve nipple, with coupling and nut
29184 40432 40435 40440 10298 40441 40442 40443 40444 40445 40509 40510 21392	mately 4½ feet) C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C. FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete
29184 40432 40435 40440 10298 40441 40442 40443 40443 40444 40445 40509 40510	mately 4½ feet) C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete PILOT VALVE BODY, with sliding bar, bell crank lever and link Screw fastening No. 40440 in position (14-24, 3" F. H.), per 100 Pilot valve stem Washer for No. 40441 (14" x 1" x 1" thick leather), per 100 Pilot valve spring Pilot valve nipple, with coupling and nut
29184 40432 40435 40440 10298 40441 40442 40443 40444 40445 40509 40510 21392	mately 4½ feet) C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C. FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete
29184 40432 40435 40440 10298 40441 40442 40443 40444 40445 40509 40510 21392	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C. FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole picce stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete PILOT VALVE BODY, with sliding bar, bell crank lever and link Screw fastening No. 40440 in position (14-24, 3" F. H.), per 100 Pilot valve stem Washer for No. 40441 (14" x 1" x 1" thick leather), per 100 Pilot valve spring Pilot valve spring Pilot valve spring Pilot valve cap Pilot valve nipple, with coupling and nut Pilot valve cap Pilot valve ping (142" x 1" x .060"), per 100 Washer for pivot pin (142" x 1" x .060"), per 100 Washer for pivot pin (142" x 1" x .060"), per 100 Washer for pivot pin (142" x 1" x .060"), per 100 Washer for pivot pin (142
29184 40432 404435 40440 10298 40441 40442 40443 40443 40445 40509 40510 21392 15519	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C. FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole picce stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete PILOT VALVE BODY, with sliding bar, bell crank lever and link Screw fastening No. 40440 in position (14-24, 3" F. H.), per 100 Pilot valve stem Washer for No. 40441 (14" x 1" x 1" thick leather), per 100 Pilot valve spring Pilot valve spring Pilot valve spring Pilot valve cap Pilot valve nipple, with coupling and nut Pilot valve cap Pilot valve ping (142" x 1" x .060"), per 100 Washer for pivot pin (142" x 1" x .060"), per 100 Washer for pivot pin (142" x 1" x .060"), per 100 Washer for pivot pin (142" x 1" x .060"), per 100 Washer for pivot pin (142
29184 40432 40435 40440 10298 40441 40442 40443 40444 40445 40509 40510 21392 15519 34343	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete
29184 40432 40435 40440 10298 40441 40442 40443 40444 40445 40509 40510 21392 15519 34343	mately 4½ feet) C-38-A Controller *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete PILOT VALVE BODY, with sliding bar, bell crank lever and link Screw fastening No. 40440 in position (14-24, ½" F. H.), per 100 Pilot valve stem Washer for No. 40441 (½" x ½" x ½" x ½" thick leather), per 100 Pilot valve spring Pilot valve spring Pilot valve spring Pilot valve cap Pilot valve interlock lever, with bar Pivot pin for No. 40509, per 100 Washer for pivot pin (½" x ¾" x 060"), per 100. Spring cotter for pivot pin (½" x ¾" x 0.06"), per 100. Spring cotter for pivot pin (½" x ¾" x 0.06"), per 100. C-38-B Controller Operating handle *Reversing handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interc
29184 40432 40435 40440 10298 40441 40442 40443 40444 40445 40509 40510 21392 15519 34343 29184	mately 44 feet) C-38-A Controller *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole pice stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete PILOT VALVE BODY, with sliding bar, bell crank lever and link Screw fastening No. 40440 in position (14-24, $\frac{2}{5}$ " F. H.), per 100 Pilot valve stem Washer for No. 40441 ($\frac{1}{12}$ " x $\frac{1}{2}$ " x $\frac{1}{16}$ " thick leather), per 100 Pilot valve spring Pilot valve interlock lever, with bar Pivot pin for No. 40509, per 100 Washer for pivot pin ($\frac{1}{12}$ " x $\frac{3}{4}$ " x .060"), per 100 Washer for pivot pin ($\frac{1}{12}$ " x $\frac{3}{4}$ " x .060"), per 100 Spring cotter for pivot pin ($\frac{1}{12}$ " x $\frac{3}{4}$ " x .060"), per 100 Washer for pivot pin ($\frac{1}{12}$ " x $\frac{3}{4}$ " x .060"), per 100 Spring cotter for pivot pin ($\frac{1}{12}$ " x $\frac{3}{4}$ " x .060"), per 100 Spring cotter for pivot pin ($\frac{1}{12}$ " x $\frac{3}{4}$ " x .060"), per 100 *Reversing handle *Not included in complete controller. Must be ordered
29184 40432 40435 40440 10298 40441 40442 40443 40444 40445 40509 40510 21392 15519 34343	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole picce stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete PILOT VALVE BODY, with sliding bar, bell crank lever and link Screw fastening No. 40440 in position (14-24, ‡" F. H.), per 100 Pilot valve stem Washer for No. 40441 (½" x ½" x 16" thick leather), per 100 Pilot valve spring Pilot valve spring Pilot valve spring Pilot valve nipple, with coupling and nut P
29184 40432 40435 40440 10298 40441 40442 40443 40444 40445 40509 40510 21392 15519 34343 29184	C-38-A Controller Operating handle *Not included in complete controller. Must be ordered separately. *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole picce stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Screw fastening No. 40440 in position (14-24, ² / ₈ " F. H.), per 100 Pilot valve stem Washer for No. 40441 (¹ / ₁₄ " x ¹ / ₁₄ " thick leather), per 100 Pilot valve cap Pilot valve nipple, with coupling and nut
29184 40432 40435 40440 10298 40441 40442 40443 40444 40445 40509 40510 21392 15519 34343 29184	C-38-A Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole piece stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Sheet iron cover, complete PILOT VALVE BODY, with sliding bar, bell crank lever and link Screw fastening No. 40440 in position (14-24, ½" F. H.), per 100 Pilot valve stem Washer for No. 40441 ($\frac{19}{12}$ " x ½" x $\frac{1}{16}$ " thick leather), per 100 Pilot valve spring Pilot valve apple, with coupling and nut Pilot valve apple, with coupling and nut Pilot valve interlock lever, with bar Pivot pin for No. 40509, per 100 Washer for pivot pin ($\frac{12}{32}$ " x $\frac{3}{3}$ ", per 100 Spring cotter for pivot pin ($\frac{12}{32}$ " x $\frac{3}{3}$ ", per 100 C-38-B Controller Operating handle *Reversing handle *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-B Controller which differ from those of the C 38-C: FRAME, complete, fitt
29184 40432 40435 40440 10298 40441 40442 40443 40444 40445 40510 21392 15519 34343 29184 40432	C-38-A Controller Operating handle *Not included in complete controller. Must be ordered separately. *Not included in complete controller. Must be ordered separately. Following are the interchangeable parts of the C 38-A Controller which differ from those of the C 38-C: FRAME, complete, fitted with bearing cap and cap screws for controlling cylinder shaft. (Includes pole picce stop, magnet core, binding nut for magnet spool, soft rubber packing and all spring and fulcrum pins riveted in position) Screw fastening No. 40440 in position (14-24, ² / ₈ " F. H.), per 100 Pilot valve stem Washer for No. 40441 (¹ / ₁₄ " x ¹ / ₁₄ " thick leather), per 100 Pilot valve cap Pilot valve nipple, with coupling and nut

4513-18 Parts of Type C Controllers

PRICE SUPPLEMENT

TO ACCOMPANY BULLETIN NO. 4513 PARTS OF TYPE C CONTROLLERS

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1887-9	. per 100 1.50 . per 100 ' .50 per 1,000 2.00	22782-2, 7, 17 22783-2, 7, 17 22784-2, 7, 17	.20 .25 .55	32557-1, 4	20.00 7.50 per 100 5.00
9703-10, 13 9891-2 9987-1, 6, 16	. per 100 2.50 . per 100 .65 . .10	22785-2 22786-2, 7, 17 22787-2, 7, 17	3.00 .75 .04	34343-3, 6, 8, 15, 18, 19 . 36908-10, 12 3792S-11	20.00 per 100 .50 4.85
10075-12 10214-3, 8, 18 10255-14	. per 100 .50 . per 100 .25 . per 100 .25	22788-2, 7, 17 22789-2 22790-2, 7, 17	.20 16.00 10.00	37939-5, 15 38670-13 38937-10, 12, 13, 14 .	.26 19.00 per 100 .25
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13852-3, 8, 17 14192-5, 15 14426-3, 8, 18	. per 100 . 50 . per 100 . 50 . per 100 . 1.00	22930-2	.50 . 6.00 .45	40341-4, 7, 17 40342-4, 7, 17 40343-4, 7, 17	.08 .10 per 100 [™] 4.00
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43298-10, 12 43757-15 43758-15	. per 100 .75 . 27.50	44092-10, 12 . 44093-10, 12 . 44094-10 .	2.75 per 100 4.00 		

Parts of Type C Controllers 4513-19

Cat. No.	Description	
10298	Screw fastening No. 40440 in position (14-24, ¹ / ₈ " F. H.), per 100	
40441	Pilot valve stem Washer for No. 40441 ($\frac{19}{64}$ x $\frac{1}{2}$ x $\frac{1}{16}$ thick leather), per 100	•
40442	Washer for No. 40441 ($\frac{14}{12}$ x $\frac{1}{2}$ x $\frac{1}{16}$ thick leather), per 100	٠
40443	Pilot valve spring	•
40444	Pilot valve cap	
40445	Pilot valve nipple, with coupling and nut	
40509	Pilot valve interlock lever with bar	
40510	Pivot pin for No. 40509, per 100	
21392	Washer for pivot pin $(\frac{13}{2}^{"} \times \frac{3}{2}^{"} \times .062^{"})$, per 100	
15519	Spring cotter for pivot pin $(\frac{3}{32}^n \times \frac{3}{2}^n)$, per 1000	
44607	CONTROLLING CONTACT BLOCK, complete, with contact bases	
40514	Terminal block, complete	
	C-38-D Controller	
0 10 10	Operating handle	
34343	*Reversing handle	•
29184	*Not included in complete controller. Must be ordered separately.	•
	Following are the interchangeable parts of the C 38-D Controller which differ from th	ose
44607	of the C 38-C: CONTROLLING CONTACT BLOCK, complete, with contact bases	•
40514	Terminal block, complete	•

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22768-2	22959-3, 8, 17	40458-5, 13	42849-14	44083-10	48001-10, 12
22769-2, 7, 16	22960-3, 8, 18	40459-5	42850-14	44084-10, 12	50428-3, 5, 8, 15, 17
22770 - 2, 7, 16	22962-3, 8, 18	40460-5	42851-14	44085-10, 12	51728-
22771-2, 7, 16	22963-3. 8, 18		42852-14	44086-10	51745-10, 12
22772-2 , 7, 16	22964-3, 8, 18	40461-5	42853-14	44087-10	56716-2, 6, 16
22773-2, 7, 16	22965-3, 8, 18	40462-5, 13	42854-14	44087-10	56743-2, 7, 11, 13, 17
22775-2, 7, 17	22967-3, 8, 18	10463-5, 13 10464-5, 13	42855-14	44089-10	56809-2, 7, 17
	22968-3, 8, 18		1 34000-13	71/00-10	1 7 0 0 0 0 44 4 4 4 4 4

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FOREIGN DEPARTMENT Schenectady, N. Y., and 44 Broad St., New York, N. Y. LONDON OFFICE 83 Cannon Street, London, E. C., England

For all CANADIAN Business Canadian General Electric Company, Ltd., Toronto, Ont.

General Electric Company Schenectady, N.Y.

SUPPLY DEPARTMENT

June, 1907

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No. 4514

THOMSON INCLINED COIL PORTABLE INDICATING INSTRUMENTS-TYPES P AND P-2

Portable Indicating Instruments that can be relied upon under the severe usage to which testing instruments may be subjected, are very necessary in maintaining economi-



VOLTMETER-TYPE P

cal and satisfactory operation of electric lighting and power systems.

The portable instruments described and listed in this Bulletin are primarily designed for use on alternating current circuits, but may be used with good results on direct current circuits, by making reversed readings and taking the mean as the true indication.

CONSTRUCTION

Voltmeters and wattmeters are constructed on the dynamometer principle, and ammeters are constructed on the magnetic vane principle. The electrical and mechanical design insures retention of accuracy and sensitiveness under the most exacting operating conditions.

SUSPENSION OF MOVING ELEMENTS

The very light moving elements of all instruments are mounted on a vertical bronze shaft which terminates in hardened and highly polished pivots. The pivots are suspended in selected sapphire jewels of the highest grade, thus reducing bearing friction and jewel wear to a minimum.

CONTROLLING FORCE

A thoroughly reliable and permanent controlling or restraining force is obtained by the use of a highly-tempered, phosphor bronze spring.



VOLTMETER, TYPE P-INTERIOR

SHIPPING CLAMP

To prevent damage to the moving elements or bearings during transportation, or when the instruments are not in use, a clamping device, operating from the front of the base, lifts the moving element from its bearings and holds it securely.

4514-2 Thomson Inclined Coil Portable Indicating Instruments—Types P and P-2.

CONTACT KEY

The voltmeters and wattmeters are provided with a contact key which may be locked



AMMETER-TYPE P

in position, enabling the instruments to be left constantly in circuit.

DAMPING DEVICES

The movements of the pointer are damped by means of an air vane.

Excessive oscillation of the pointer may



INDICATING WATTMETER-TYPE P

be checked by a friction damping device operated by a small button. The combination of these two systems is very effective and enables rapid and accurate reading.

ACCURACY

Variations of frequency, waveform, or power factor do not affect the accuracy of the instrument indications. Errors due to parallax are eliminated by the use of a small mirror under the scale.

SCALES

As will be seen from the illustrations on pages 6 to 8, the scales are very satisfactory as to length, legibility and distribution. No



AMMETER-TYPE P-INTERIOR

particular law of deflection is assumed in making these scales, each instrument being carefully calibrated by comparison with a laboratory standard.

TORQUE

The Thomson Inclined Coil Portable Instruments are so designed that the torque



INDICATING WATTMETER-TYPE P-INTERIOR

or turning moment is sufficiently high to insure the indicating pointer taking up a definite position with each change in current value. Thomson Inclined Coil Portable Indicating Instruments-Types P and P-2 4514-3

FINISH

The cover and other metal parts are finished in polished black oxide. The base is polished mahogany.

CARRYING CASES

All instruments are supplied with neatly finished wooden carrying cases, which are provided with leather handles.

VOLTMETERS

Voltmeters are made in capacities up to and including 600 volts for use without multipliers. The normal operating point is located at the most open part of the scale.

VOLTMETERS-TYPE P

Cat. No.	Capacity in Volts	List Price
3335 3336 3344 3337	$\begin{array}{r} 65\\ 130\\ 300\\ 600 \end{array}$	\$50.00 50.00 50.00 50.00

AMMETERS ,

Ammeters are made in capacities up to and including 200 amperes. For use on alternating current circuits of higher capacities, current transformers must be used.

When current transformers are supplied the ammeter scale is marked in the actual capacity of the winding, thus enabling the use of the instrument without current transformer on circuits not exceeding the capacity of the instrument.

Ammeters cannot be furnished for use on direct current circuits of more than 200 amperes.

Cat. No.	Capacity in Amps.	List Price
6461	2	\$40.00
28789	5	40.00
6456	10	40.00
3332	15	40.00
40683	20	40.00
40684	30	40.00

AMMETERS-TYPE P

Cat. No	Capacity in Amps.	List Price
40685	40	\$40.00
40686	60	40.00
40687	80	50.00
6459	100	50.00
40688	150	50.00
6460	200	50.00

AMMETERS-TYPE P-Cont'd

WATTMETERS-TYPE P

Wattmeters are made self-contained in capacities up to and including 200 amperes, and 100-125 volts normal. They may be used, however, at any voltage up to 150, and the maximum permissible current is plainly marked on the scale of each instrument.

Wattmeters for use on circuits from 200 to 600 volts are provided with multipliers. When required on alternating current circuits, the voltage of which exceeds 650, or in capacities in excess of 200 amperes, current transformers are used. In this case the scale is marked in secondary values, or in other words the actual capacity of the instrument itself. Wattmeters cannot be furnished for use on direct current circuits above 200 amperes.

Wattmeters of 40-ampere capacity and above are provided with larger bases and have larger covers than those of lower ratings.

WATTMETERS-TYPE P-100-125 VOLTS

Catalogue No.	Capacity		List Price
	Ampere	Watt	List Price
7986	1.5	150	\$75.00
7981	3	300	75.00
30527	5	500	75.00
28860	10	1000	75.00
7982	15	1500	75.00
40689	20	2000	75.00
40690	30	3000	75.00
40691	40	4000	110.00
40692	60	6000	110.00
40693	80	8000	115.00
8093	100	10000	115.00
8094	150	15000	120.00
8095	200	20000	125.00

4514-4 Thomson Inclined Coil Portable Indicating Instruments-Types P and P-2

MULTIPLIERS FOR PORTABLE VOLT-METERS AND WATTMETERS

In order that the portable voltmeters and wattmeters may be used on circuits of higher voltage than that for which they are wound, a line of potential multipliers has been designed.



MULTIPLIER FOR PORTABLE VOLTMETERS AND AMMETERS

The multipliers are mounted in a ventilated wooden case and provided with binding posts for making the proper connections.

When ordering multipliers for instruments, the ratios desired must be given, and when multipliers are ordered separately from the instruments, the serial number of the instrument with which the multiplier is to be used must be specified. For circuits above 750 volts potential transformers should be used instead of multipliers.

If transformers are ordered for use in connection with instruments, the frequency of the circuit must be given.

Capacity of Instrument	List Price		
in Volts	Ratio 2-1	Ratio 4-1	Ratio 5-1
$\begin{array}{r} 65\\130{-}150\\300\end{array}$	\$20.00 25.00 25.00	\$25.00 25.00	\$30.00

LAMP INSPECTORS' WATTMETER-TYPE P-2

A special form of wattmeter for testing

incandescent lamps and other devices of small current capacity has been developed and is known as the Lamp Inspectors' Wattmeter.

CONSTRUCTION

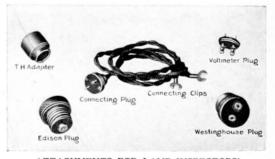
This instrument is of the Thomson Inclined Coil type, permanently inclosed in a wooden carrying case. In the electrical element of this instrument a compensating coil is introduced, so that the wattmeter indicates the consumption of energy in the lamps only, and is in no way influenced by the losses in either the potential or current coil of the instrument.

LOCKING DEVICE

To prevent damage to the pivots or jewels during transportation, or when not in use, the instrument is provided with an automatic clamping device, which, when the cover is closed, holds the armature free from the jewels. Upon opening the cover the device releases and the instrument is ready for use.

CONNECTIONS AND METHOD OF OPERATION

With each Lamp Inspectors' Wattmeter are furnished an Edison plug with a T.-H.



ATTACHMENTS FOR LAMP INSPECTORS' INDICATING WATTMETER

adapter, and a Westinghouse plug, thus providing means for connection to the three forms of sockets most generally used.

Lead wires are provided which are suitably tipped at one end for insertion into the plugs and at the other end for connection to the binding posts of the instrument.

Thomson Inclined Coil Portable Indicating Instruments—Types P and P-2 4514-5

A small secondary plug arranged to fit the regular plugs and provided with two small binding posts is also supplied with every instrument. With this convenient device the power required by small motors or other apparatus may be conveniently measured.

In the base of the instrument are the sockets, one an Edison, and the other a Westinghouse. To measure the energy taken by a lamp, it is only necessary to connect

CAPACITY

The capacity of the indicating wattmeter is 150 watts. Lamps of any candle-power up to 32 and of any voltage up to 150 can be tested, as can also any device, the consumption of energy in which is not over 150 watts at any voltage not exceeding 150, or current not exceeding 2 amperes.

By the use of a potential multiplier the



LAMP INSPECTORS' INDICATING WATTMETER

the wattmeter to the source of potential and insert the lamp to be tested in the proper socket in the instrument base. Lamps with T.-H. bases may be tested by using the adapter.

INTERCHANGEABILITY

The fact that the instrument is equally well adapted to direct and alternating currents, necessitates the use of only one instrument in stations using both systems.

On direct current circuits reverse readings should be taken to eliminate the possibility of any slight error which the presence of local fields may introduce in instruments of this class. For convenience, a special reversing key is provided to reverse the current in the instrument and lamp, without the usual inconvenience of reversing the leads attached to the terminals.

When reversed readings are made the mean of the two readings is taken as the correct reading. instrument may be used on circuits of voltage higher than 150; but when multipliers are ordered at a date later than the instrument, the latter must be returned to the factory for attaching the necessary connection plugs.

FINISH

The instrument is very light and exceedingly compact, the external dimensions being $7\frac{3}{8}'' \ge 7\frac{3}{8}'' \ge 4\frac{1}{2}''$. It is provided with a finelypolished carrying case, with snap lock.

The terminals, reversing and damping buttons are mounted on a polished vulcanite support, and all metal parts of the instrument are finished in black oxide.

Cat. No.	Capacity in Watts	Normal Voltage	List Price
7987	150	100-125	\$100.00

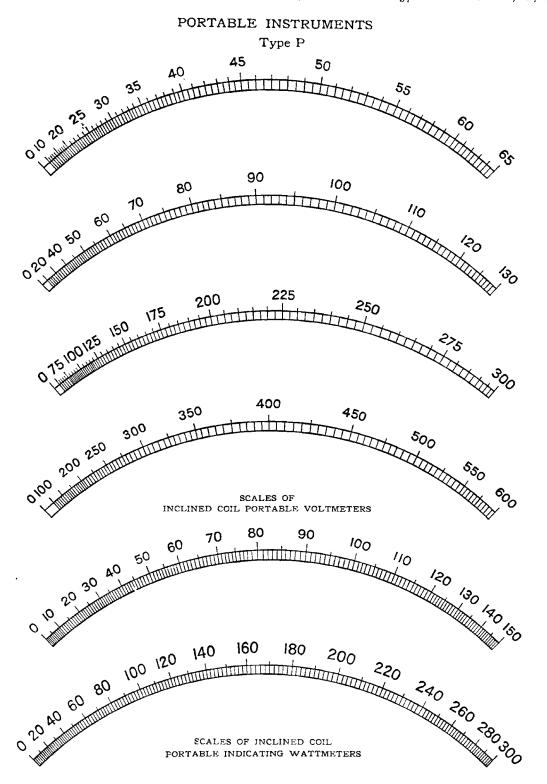
45146 Thomson Inclined Coil Portable Indicating Instruments-Types P and P-2

PORTABLE INSTRUMENTS

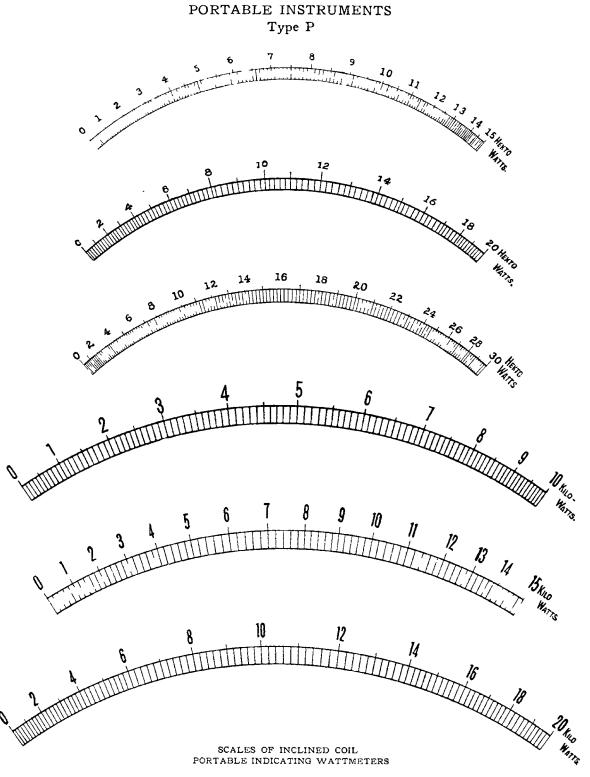
> SCALES OF INCLINED COIL PORTABLE AMMETERS

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Thomson Inclined Coil Portable Indicating Instruments Types P and P-2 4514-7



4514.8 Thomson Inclined Coil Portable Indicating Instruments Types P and P 2



PORTABLE INDICATING WATTMETERS

General Electric Company Schenectady, N.Y.

RAILWAY DEPARTMENT

June, 1907

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Bulletin No. 4515

A. J. W

AUXILIARY CONTACTOR EQUIPMENTS FOR CYLINDER CONTROLLERS

The increased power and higher voltages now being used on many electric railways have imposed new requirements in the design of control apparatus for railway motors, mainly owing to the more destructive character of the arcing in case of a grounded motor or derange-

ment of other apparatus. To meet these requirements the General Electric Company has developed an auxiliary equipment adapted for use with practically all standard cylinder controllers, consisting essentially of two standard Sprague General Electric 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.

By this means all heavy arcing is elimin-

ated from the controller as the power circuit is opened by the contactors, and consequently the wear and tear on the controller fingers and contact surfaces is diminished, repairs minimized, and the possibility of burnt-out controllers practically prevented.

In addition, this equipment includes overload

devices known as MU tripping switches which interrupt the energizing circuit of the contactor coils in case of an overload, causing the contactors to open the main circuit. These tripping switches perform the functions of circuitbreakers and may be substituted for them,

preventing arcing in the vestibule.

The equipment also includes a combined switch and fuse for opening and protecting the circuit of the contactor operating coils.

The complete equipment as designed for use on cars equipped with standard cylinder controllers includes the following :

Two sets of Controller Auxiliary Contact Attachments.

The necessary new Cylinder Segments. One Contactor Box with Contactors assembled.

Two Overload Trip-

K-28-F Controller

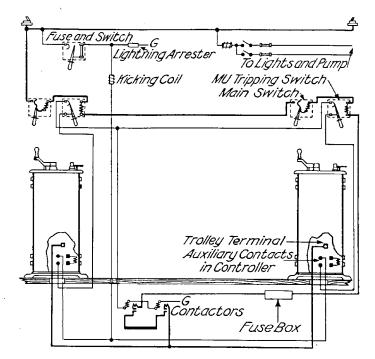
ping Switches.

One Combined Switch and Fuse for Contactor Operating Circuit.

The control connections are as shown in the wiring diagram below, which gives the proper sequence and circuits in which the MU tripping switch contacts, auxiliary controller

4515-2 Auxiliary Contactor Equipments for Cylinder Controllers

attachments, contactor energizing coils, overload coil of tripping switch and contactor contacts are located. Only a small space is taken up under the car by the contactors, and the auxiliary controller attachments can be fitted to the following controllers: K-6, K-10, K-11, K-12, K-14, K-28 and L-4, with but slight change. The automatic MU tripping switch which replaces the usual platform circuitbreaker is smaller and more compact; in fact, the additional devices required add little to the total two contact fingers operated through a pivoted arm by a cam secured to the controller shaft, except in the case of the L-4 controller, as explained below. The auxiliary contacts are connected in series with the contacts of the MU tripping switch and the energizing coils of the contactors; and, therefore, when the controller auxiliary contacts are broken by the cam projections, the power circuit of the contactors is opened. The cam projections are located so that they break the auxiliary contact



Wiring Diagram for Contactor Equipment

weight of the equipment and can be readily fitted to any type of car.

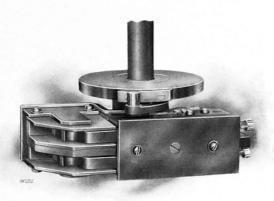
The combination control which is the subject of this bulletin is designed for a single car equipment and must not be confused with the standard Sprague-General Electric Type M multiple unit control for operating several motor cars together.

CONTROLLER ATTACHMENTS

The controller auxiliary attachments as shown in the illustration, page 3, consist of circuit just before the controller segments leave the fingers and also during the period when the controller cylinder is passing from series to parallel connections, or vice versa. In the L-4 controller, two of the existing controller segments and fingers are used for making and breaking the contactor coil circuit. When the controller is in any of the ON positions (except as mentioned above) the auxiliary contacts are closed and a circuit is completed through the contacts of the MU tripping switch and energizing coils of the contactors,

Auxiliary Contactor Equipments for Cylinder Controllers 4515-3

closing the main power circuit through the contactors. From the above it is clear that the power circuit is opened at the main contacts of the contactors when an excessive current passes through the tripping switch overload coil, when the controller is moved to the OFF position or passes from series to parallel connections.



Auxiliary Attachment for K-28 Controller

The two controller auxiliary contacts are separated from one another by fire-proof insulating barriers so shaped as to form arc chutes. A blowout coil is provided to extinguish arcs when breaking circuit. As the current carried by the contact fingers is only that required to energize the operating coils of the contactors it has a small value and no serious arcing can therefore occur.

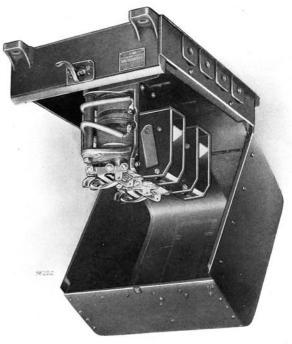
CONTACTORS

Two contactors are used similar to those employed with Sprague-General Electric Type M control. They are assembled in a substantial sheet-iron box which can be placed in any convenient position under the car. A very effective magnetic blowout is provided for extinguishing arcs between the contacts of the contactors and currents far in excess of those usually encountered during short circuits, can be satisfactorily broken.

MU TRIPPING SWITCHES

This switch as shown in the illustration, page 4, is fitted in a box made of insulating material divided into front and back compartments closed by suitable covers. The front compartment contains the single pole contact of the tripping switch with its tripping device and adjusting screw and the operating handle; the back compartment contains a small blowout coil to extinguish the arc when the single pole contact is opened, and the tripping coil which actuates the switch when excessive current flows through the power circuit.

As the current interrupted by the switch is only that required to energize the contactor coils the moving parts have little inertia so that the circuit is broken immediately the current in the tripping coil reaches a predetermined value which can be varied by the adjusting screw provided for that purpose. By moving the handle to the OFF position, the auxiliary circuit is opened, the contactors drop out and the power is completely cut off.

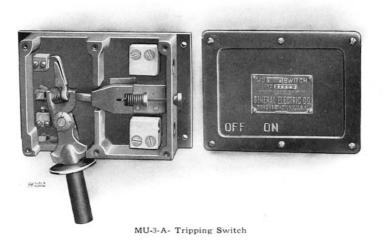


Contactors Assembled in Iron Box

4515-4 Auxiliary Contactor Equipments for Cylinder Controllers

CONTROLLER CAPACITIES

By the addition of the auxiliary contactor equipment the arc disrupting capacity of controllers is increased, and therefore it has been possible to enlarge the size of the wiring and blowout magnet winding and thereby obtain a greater current capacity for controllers in a few cases. The rated capacities of various controllers have therefore been increased as shown in the following table.



CONTROLLERS FITTED WITH ATTACHMENTS

When new controllers are to be installed, the General Electric Company can furnish the following controllers which have the auxiliary contacts assembled in them before shipment:

CONTROLLER	RATING WITH CONTACTOR EQUIPMENT	CONTROLLER	RATING WITHOUT CONTACTOR Equipment	POINTS
K- 6-H	4- 50 H. P. motors	K- 6-A	4- 40 H. P. motors	6 series 5 parallel
K-10-H	2-40 H. P. motors	K-10-A	2-40 H. P. motors	5 series 4 parallel
K-11-H	2- 60 H. P. motors	K-11-A	2- 60 H. P. motors	5 series 4 parallel
K-12-D	4- 30 H. P. motors	K-12-A	4- 30 H. P. motors	5 series 4 parallel
K-14-E	4- 75 H. P. motors	K-14-A	4- 60 H. P. motors	7 series 6 parallel
K-28-F	4- 50 H. P. motors	K-28-B	4- 40 H. P. motors	5 series 5 parallel
L- 4-C	4-100 H. P. motors	L- 4-A	4-100 H. P. motors	4 series 4 parallel

GENERAL ELECTRIC COMPANY

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

General Electric Company Schenectady, N.Y.

June, 1907

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MR CIRCUIT BREAKERS

The General Electric Company is manufacturing a complete new line of car circuit breakers known as the MR-10, 11, 12 and 13, which have advantages over the old types MR-3, 4 and 5, and MQ, due to improved contacts, arc chutes and other details. These cir-

The circuit breaker is provided with an extension arc chute located at the top of the casing which practically conceals the arc ruptured on breaking circuit, so that it

ARC CHUTE



cuit breakers are especially designed for electric railway cylinder controller equipments up to 300 HP. capacity, and are used for two purposes, viz., as a device to automatically break the main trolley circuit in case of excessive overloads or short circuits, and as a hand operated main circuit switch. They are small, compact and thoroughly reliable, and the parts are surrounded by a fibre lining enclosed in a non-magnetic box with a hinged iron cover which prevents accidental contact with live parts. can be located in any convenient position in the car vestibule without objectionable arcing or flashing. The extension arc chute is also so inserted that it can be removed and replaced by one of larger proportions if it is found necessary to completely conceal the arc.

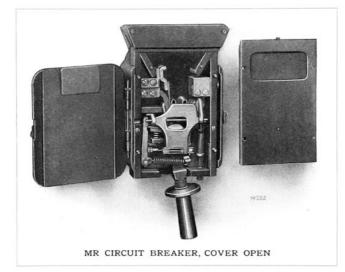
CONTACTS

Two contacts are provided in these MR circuit breakers — a main current carrying contact and an auxiliary circuit breaking con-

4516-2, MR Circuit Breakers

tact. The main moving contact is a laminated metal brush, and the auxiliary contact consists of two metal fingers located above the main contact and arranged so as to open the circuit after the main brush contact has moved away about $\frac{1}{4}''$, thereby effectually protecting the main contact from burning or injury from the arc. Both main and auxiliary switches are designed so as to make a face to face wiping contact, thus the number of spare parts required.

The iron cover forms part of the magnetic circuit of the blowout and tripping mechanism, thus economizing material and providing the most compact form of breaker possible. It is hinged to the box and is closed by a convenient thumb latch so that all parts can be immediately inspected and renewals readily made if required, the various parts being so disposed as to be entirely accessible.



preventing dust or grit from binding the contact surfaces when making or breaking circuit and effectually preventing sticking.

As full contact area is obtained with but small sliding action, scoring and wear and tear of the contact surfaces are minimized and good electrical connection is always obtained even in dusty locations.

UNIFORMITY OF PARTS

In all capacities of these MR circuit breakers the corresponding parts are made of uniform size, the only exception being in the blowout coils which are wound to suit the various current ratings required for tripping circuit breakers of different capacities. The mechanism and working parts are therefore identical in all sizes insuring interchangeability, facilitating repairs, and minimizing

BLOWOUT COIL AND TRIPPING CURRENT

The blowout coil is of ample capacity, and so proportioned as to properly extinguish the arc formed when breaking any current up to the maximum possible current on short circuit.

The tripping current can be adjusted between two values for each size of breaker by means of a thumb screw and spring. The lower value represents the safe continuous current carrying capacity of the breaker, the higher, the maximum tripping current for which the tripping coil is designed. A brass plate is provided close to the adjusting spring on which three lines are ruled and the corresponding current values stamped; the top line indicating the position of the top of the cap nut of the adjusting screw for

MR Circuit Breakers, 4516-3

the minimum tripping current; the bottom line the position of this nut for the maximum tripping current; and the intermediate line the position of the nut for a tripping current half way between these limits. By opening the cover, therefore, the proper tension adjustment of the spring can be at once made for any tripping current between these limits.

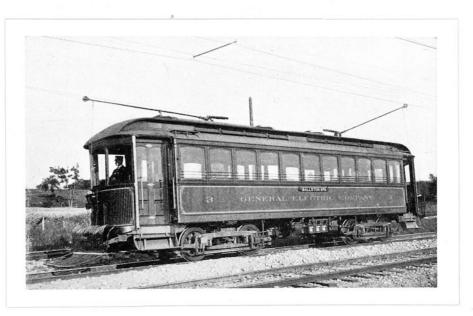
HAND OPERATION

As previously mentioned, the circuit breaker can be used as a hand operated main trolley circuit switch, the handle provided being used for both opening and closing circuit. The words "on" and "off" are cast on the cover to clearly indicate whether the switch is open or closed.

RATINGS AND PRICES

The following are the various circuit breakers manufactured for 600 volts, the current ratings given representing the minimum and maximum tripping currents for which they are severally designed, the lower value representing the continuous current carrying capacity.

Cat. No.	TYPE	CALIBRAT	ION LIS	ST PRICE
44185	MR-10-A	50 to 150	Amps.	\$35.00
44186	MR-11-A	100 to 300	**	35.00
44187	MR-12-A	200 to 600	"	40.00
44188	MR-13-A	300 to 900	" "	40.00



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General Electric Company Schenectady, N.Y.

POWER AND MINING DEPARTMENT

February, 1908

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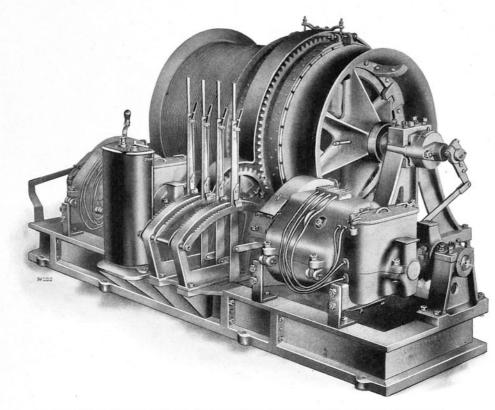
*Bulletin No. 4518A

ELECTRIC HOISTS

The extensive adoption of electric hoists is very largely due to the facility with which electric power can now be obtained and to the increased efficiency, compactness and

chief characteristics obtained by the use of the electric drive.

Electric hoists are now extensively used for the erection of buildings and for general



SINGLE FRICTION DRUM ELECTRIC HOIST DRIVEN BY TWO CONTINUOUS CURRENT MOTORS

durability inherent in motor driven hoists, which are self-contained and can be readily and quickly located where most efficient operation is secured. Neither coal, water nor pipes are required and the heavy heat losses incidental to steam driven hoists are obviated, simplicity of construction being one of the

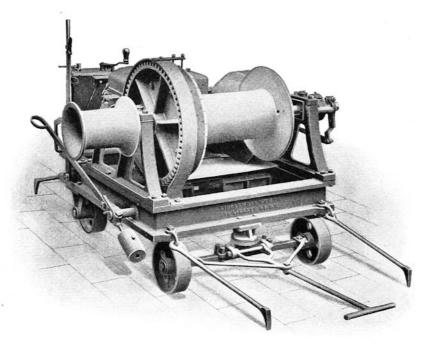
* Supersedes Bulletin No. 4412. Second Edition. hoisting work in docks, ferries, warehouses, mines, quarries, coal yards and for many other purposes too numerous to mention. In order to meet the increasing demand for these machines, the General Electric Company is manufacturing a complete line of both alternating and direct current standard

4518A-2 Electric Hoists

motor equipments which are specially designed for every class of hoist service.

Pages 5 to 20 give the class and rating of the motors, dimensions of drums, bedplates, pounds lift, and approximate shipping weight of the various hoists equipped by the General Electric Company. The accompanying illustrations give the general arrangement adopted for each class of service and clearly bring out the compactness and consequent ease of operation of the hoists. of the double cone type and is composed of segments of hard wood turned off conically to suit the flanges of the friction drum with which it engages when in gear. A small horizontal movement of the drum along the shaft throws the friction band into gear. This movement is obtained by means of a screw steel pin and cross key operated by a hand lever.

The band brake is of the differential type. It is lined with blocks of wood whose wear



ELECTRIC HOIST MOUNTED ON TRUCK

HOISTS

The hoists are of the friction drum type equipped with a mechanical brake. They are provided with one or more drums according to service conditions. The friction drum is made in one complete casting turned true. It is usually mounted loose on the shaft and driven by a friction clutch operated by means of hand levers. In some forms, however, it is desirable, especially in damp or wet locations, to operate the drum by gearing which is thrown by a jaw clutch. The friction is can be taken up by shortening the band and which can be readily replaced when worn out. The brake acts directly on the drum and is controlled by levers located in convenient positions. All material used in these hoists is carefully selected and special attention has been given to the accurate mesh and cut of the gears, and to the proper lubrication of all moving parts so as to reduce friction, promote smooth running and increase efficiency.

As durability is one of the most important points in connection with these hoists, every part has been made as strong as possible consistent with weight and cost, and thousands have been in constant operation for several years all over the country.

MOTORS

The direct current motors used for the hoists are of the General Electric Company's armoured or enclosed type similar to those employed in railway work, and can be used on 220, 250 or 550 volt circuits. The motors are simple, efficient and compact, and all the electrical parts are thoroughly insulated and protected from dust and moisture. Every motor is thoroughly and completely tested both electrically and mechanically before shipment and will stand any kind of weather without injury to running parts.

For alternating current circuits, the Gen eral Electric Company's induction motors are used which can operate on both twoand three-phase circuits for 220, 440 or 550 volts. The motors are of specially rugged construction due to the simplicity inherent in this type of motor, for which no commu tator is required. Form M motors are usu ally employed and the necessary speed chan ges are obtained by means of a resistance exterior to the motor which is provided with collector rings and brushes for this purpose.

Proper speed reduction is effected through cut steel gears, and motor speeds are low so as to reduce the gear speeds as much as possible, minimize noise and wear, and obtain smooth running for the hoist gears and drums. In no case are high armature speeds recom mended for hoists.

CONTROLLERS

For ordinary conditions of service, the standard cylinder type of controller is used, but for large hoists where the requirements are specially exacting, type M control is recommended. Controllers have been de signed for both direct and alternating current operation. They can be supplied either with a single handle for both forward running or reversing, or with two handles one for operating the main controller cylinder and the other for changing the motor connections to reverse the motion of the hoist. These controllers have from 5 to 9 control points, the number depending on the nicety of speed regulation desired. Controllers for alternating current motors only have a single operating handle.

Full information on these controllers will be found in a separate bulletin entitled "Controllers for Power and Mining Service."

RESISTANCES

The General Electric Company's cast grid rheostat is used for both alternating current and direct current hoist equipments. It is well adapted for severe service as it has large current capacity and is practically indestructible, having proved the most suitable type of resistance for electric railways for many years.

This resistance is generally mounted on the hoist platform, but in the larger sizes of mine hoists, it is usually located in a con venient position nearby.

PARTIAL LIST OF HOIST INSTALLATIONS

The following are a few of the hoist installations using General Electric motors:

The North German Llovd Steamship Company employ 36 electric hoists on three of their piers at Hoboken, N. J. The hoists are used for loading and unloading cargo and coaling vessels from lighters and are equipped with 25 and 40 h.p. direct current 500 volt series motors.

The Delaware, Lackawanna & Western R. R. Company employ 40 electric hoists at their coal mines in Scranton and the vicinity. The hoists are equipped with direct current motors and also a number with induction motors.

The American Argicultural Company use a number of alternating and direct current hoists on their docks for unloading fertilizer material.

4518A-4 Electric Hoists

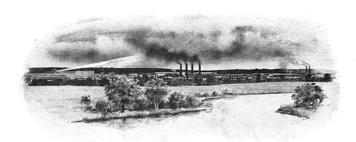
The O'Rourke Engineering and Construction Company use electric hoists almost exclusively for their extensive building operations in New York City. Twenty-eight hoists are in operation at the Church St. Terminal of the Hudson & Manhattan Railroad Company, New York, and in constructing the City Investment Building, Cortlandt and Church Sts., New York.

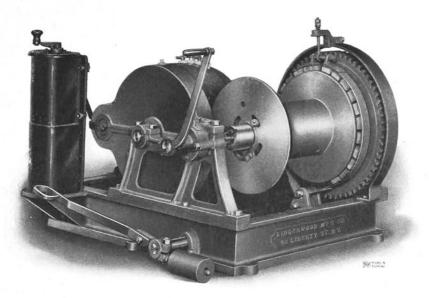
The Bush Terminal Company and the New York Dock Company use a large number of electric hoists.

The Boston Edison Company, Atlantic Street Station employ two-motor double friction drum, direct connected high speed coal hoists for dock work, which will lift 8,000 lbs. of coal 800 ft. per minute. The hoist is equipped with two MP-6-100-150 r.p.m. 250 volt series GE motors operated by a foot controller on the Ward-Leonard System. When the load has been hoisted, a double friction drum hoist equipped with two MP-6-40-200 r.p.m. 250 volt motors with standard series parallel controller, trolleys it in along the boom. The Boston Elevated Railroad Company use two combination hoists and traveling coal bridges on the dock at their Albany St. Station, which are equipped with General Electric motors. This equipment is used for hoisting coal from lighters and also to convey it to the storage over the coal loading sheds.

The United Railway & Electric Company, Pratt St. Station, Baltimore, Md., use electric hoists operating on the Ward-Leonard System each of which is equipped with an MP-6-100-200 r.p.m. 250 volt motor. The load is trollied in by a 25 h.p. 635 r.p.m. 550 volt series enclosed motor using rheostatic control. The dynamic brake used for lowering the coal buckets is an interesting feature of this installation. The mechanical brake is dispensed with by operating the motor as a generator with its field separately excited, resistance being inserted in the armature circuit.

The City of Boston employs a number of alternating current and direct current hoists for assisting teams up the gangways at the docks at low tide.





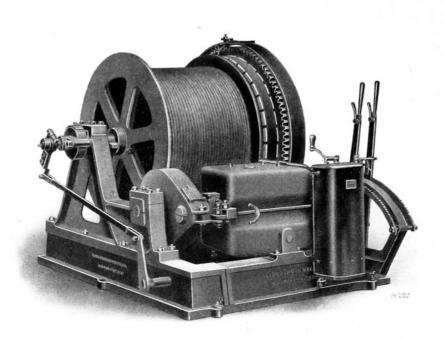
SINGLE FRICTION DRUM ELECTRIC HOISTS WITH CONTINUOUS CURRENT 500, 250 OR 220 VOLT MOTORS

Number	1	MOTORS		DIMENSIONS OF DRUM		Rope speed in ft.	Approx. dimensions of	Estimated shipping weight
of Hoist	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	per min.	Bed-plate Inches	complete Lbs.
400	1.5	CO-2502	8	9	300	100	$31 \ge 24$	1260
401	2	CO-2503	8	12	500	100	$34 \ge 27$	1375
402	3	CO-2503	8	12	500	150	$34 \ge 27$	1380
403	5	CO-2504	12	15	1000	100	$45 \ge 34$	2350
404	7.5	CO-2504	12	15	1000	150	$43 \ge 34$	2220
405	10	CO-2505	12	15	1000	250	$43 \ge 34$	2610

SINGLE FRICTION DRUM ELECTRIC HOISTS WITH ALTERNATING CURRENT 550, 440 OR 220 VOLT VARIABLE SPEED INDUCTION MOTORS

Number		MOTORS		DIMENSIONS OF DRUM		Rope	Approx. dimensions of	Lbs. 1260 1400 1500 2250
of Hoist	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	speed in ft. per min.	Bed-plate Inches	complete
420	1	ITC-5001	8	9	300	100	$31 \ge 24$	1260
421	2	ITC-5002	8	12	500	100	$34 \ge 27$	1400
422	3	ITC-5003	8	12	500	150	$34 \ge 27$	1500
423	4	ITC-5004	12	15	1000	100	$45 \ge 34$	2250
424	6	ITC-5006	12	15	1000	150	$43 \ge 34$	2240
425	11	ITC-5008	12	15	1000	250	43 x 34	2720

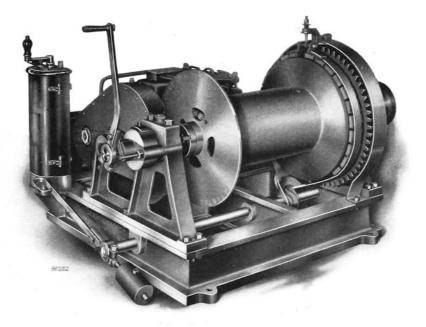
4518A-6 Electric Hoists



SINGLE FRICTION DRUM MINE HOISTS WITH CONTINUOUS CURRENT 500, 250 OR 220 VOLT MOTORS

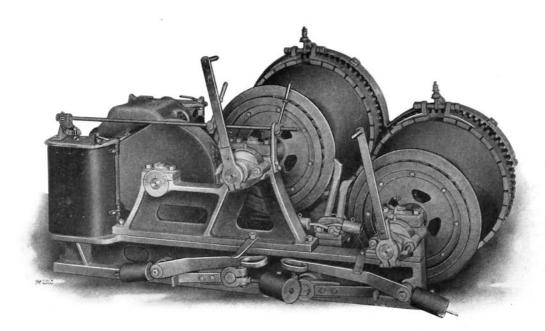
Number of Hoist H.P.	Ν	IOTORS	DIMENSIONS OF DRUM		Hoist in lbs. for single	Rope speed in ft.	Approx. dimensions of	Estimated shipping weight
	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	per min.	Bed-plate Inches	complete Lbs.
502	15	CO-2506	24	24	1500	250	$54 \ge 49$	4495
503	24	CO-2002	30	24	2000	300	$66 \ge 55$	7420
504	38	CO-2004	42	30	2500	400	$78 \ge 61$	10450
505	53	CO-2006	48	30	2500	500	$94 \ge 66$	14465
506	76	CO-2001	54	36	4000	500	$99 \ge 74$	17725
507	91	CO-2003	54	36	4000	600	$99 \ge 74$	19950
508	114	CO-2003	60	36	5000	600	$111 \ge 80$	24635
509	114	CO-2003	60	36	6000	500	$111 \ge 80$	24635

These hoists are now furnished with drum and motor gears on the opposite side from that shown above.



SINGLE FRICTION DRUM ELECTRIC HOISTS WITH CONTINUOUS CURRENT 500, 250 OR 220 VOLT MOTORS

Number	Ν	Motors		DIMENSIONS OF DRUM		Rope	Approx. dimensions of	Estimated shipping
of Hoist	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	speed in ft. per min.	Bed-plate Inches	weight complete Lbs.
510	10	CO-2505	12	16	1500	150	47 x 39	3150
511	15	CO-2506	12	16	2000	175	$54 \ge 39$	3750
512	20	CO-2506	12	20	2500	175	$52 \ge 46$	4450
513	25	CO-2002	14	27	3500	175	$54 \ge 54$	5375
514	40	CO-2004	16	24	5000	200	$67 \ge 55$	1775
515	50	CO-2006	16	30	7000	200	$69 \ge 60$	8775

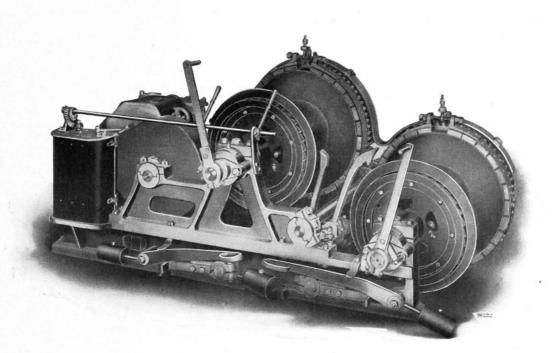


DOUBLE FRICTION DRUM ELECTRIC HOISTS WITH CONTINUOUS CURRENT 500, 250 OR 220 VOLT MOTORS

Number	Ν	Motors		DIMENSIONS OF DRUM		Rope speed in ft.	Approx. dimensions of	Estimated shipping weight
of Hoist	Н.Р.	Class	Diam. Inches	Face Inches	line Lbs.	per min.	Bed-plate Inches	complete Lbs.
516	15	CO-2506	12	16	2000	175	74 x 41	5275
517	20	CO-2506	12	20	2500	175	71 x 46	5950
518	25	CO-2002	14	27	3500	175	$75 \ge 54$	7325
519	40	CO-2004	16	24	5000	200	$87 \ge 55$	9775
520	50	CO-2006	16	30	7000	200	$93 \ge 60$	11650

Foot brake levers will be placed forward as shown on page 10 illustrating the 516S class. Solenoid brakes may be furnished with all hoists and further information will be given

on application.



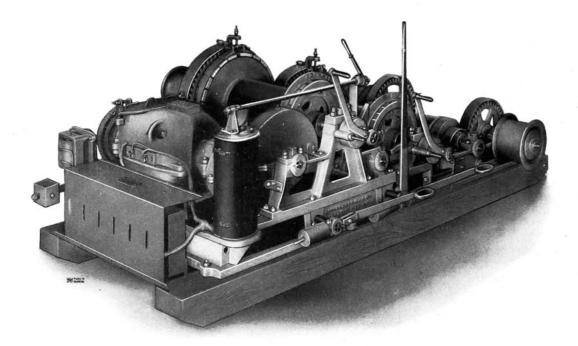
DOUBLE FRICTION DRUM ELECTRIC HOISTS WITH CONTINUOUS CURRENT 500, 250 OR 220 VOLT MOTORS

Number	Ν	Motors		DIMENSIONS OF DRUM		Rope	Approx. dimensions of	Estimated
of Hoist	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	speed in ft. per min.	Bed-plate Inches	weight complete Lbs.
516P	15	CO-2506	12	16	2000	175	80 x 41	5475
517P	20	CO-2506	12	20	2500	175	$78 \ge 46$	6175
518P	25	CO-2002	14	27	3500	175	$81 \ge 54$	7600
519P	40	CO-2004	16	24	5000	200	$92 \ge 55$	10075
520P	50	CO-2006	16	30	7000	200	$98 \ge 60$	12000

These hoists have pinion between drum gears. Both drums rotate in the same direction allowing rope clearances where swinging gear is used.

Foot brake levers will be placed forward as shown on page 10 illustrating the $516\,\mathrm{S}$ class.

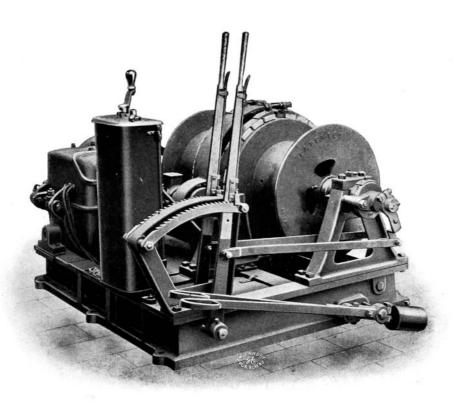
4518A-10 Electric Hoists



DOUBLE FRICTION DRUM ELECTRIC HOISTS WITH CONTINUOUS CURRENT 500, 250 OR 220 VOLT MOTORS

Number	1	AOTORS	DIMENSIONS OF DRUM		Hoist in lbs. for single	Rope	Approx. dimensions of	Estimated
of Hoist	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	speed in ft. per min.	Bed-plate Inches	weight complete Lbs.
516S	15	CO-2506	12	16	2000	175	124 x 41	7075
517S	20	CO-2506	12	20	2500	175	122 x 46	7775
518S	25	CO-2002	14	27	3500	175	125 x 54	9200
519S	40	CO-2004	16	24	5000	200	$136 \ge 55$	11675
520S	50	CO-2006	16	30	7000	200	$142 \ge 60$	12600

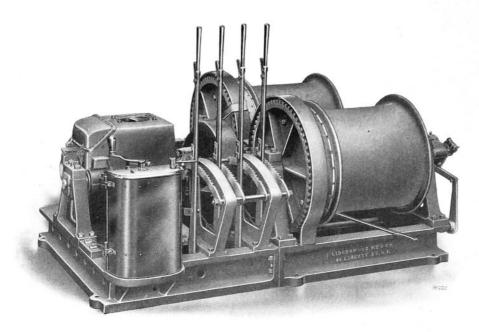
These are the same as the 516P class except that a boom swinging gear is connected and mounted on the front.



DOUBLE SIDE BY SIDE DRUM ELECTRIC HOISTS WITH CONTINUOUS CURRENT 500, 250 OR 220 VOLT MOTORS

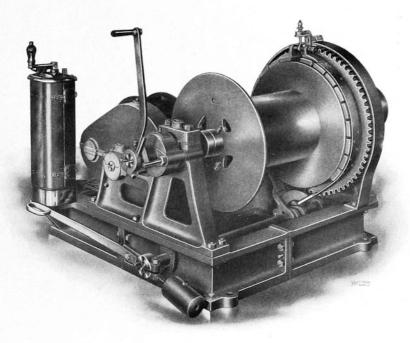
Number	1	MOTORS		DIMENSIONS OF DRUM		Rope speed in ft.	Approx. dimensions of	Estimated shipping weight
of Hoist	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	per min.	Bed-plate Inches	complete Lbs.
$516\frac{1}{4}$	15	CO-2506	12	15	2000	175	63 x 49	5175
$517\frac{1}{4}$	20	CO-2506	12	15	2500	175	$63 \ge 57$	6290
$518\frac{1}{4}$	25	CO-2002	14	15	3500	175	$63 \ge 57$	7275
5191	40	CO-2004	16	16	5000	200	$73 \ge 65$	9550
5201	50	CO-2006	16	18	7000	200	$77 \ge 65$	10775

4518A 12 Electric Hoists



SPECIAL DOUBLE DRUM ELECTRIC HOISTS WITH CONTINUOUS CURRENT 500, 250 OR 220 VOLT MOTORS

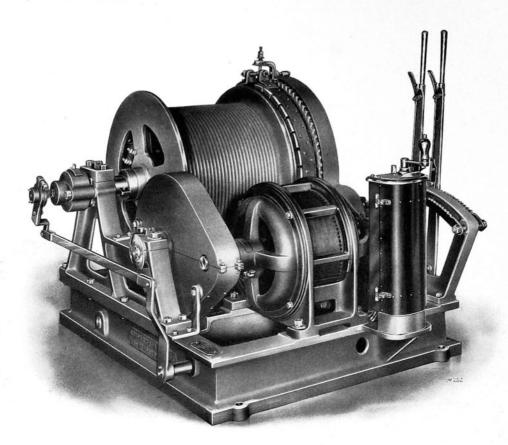
Number	1	Motors		DIMENSIONS OF DRUM		Rope	Approx. dimensions of	Estimated shipping
of Hoist	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	speed in ft. per min.	Bed-plate Inches	weight complete Lbs.
$516\frac{1}{2}$	15	CO-2506	12	16	2000	175	75 x 57	5610
$517\frac{1}{2}$	20	CO-2506	12	22	2500	175	91 x 60	7045
$518\frac{1}{2}$	25	CO-2002	14	22	3500	175	91 x 60	8015
$519\frac{1}{2}$	40	CO-2004	16	24	5000	200	$91 \ge 74$	10670
$520\frac{1}{2}$	50	CO-2006	16	30	7000	200	$98 \ge 74$	12220



SINGLE FRICTION DRUM ELECTRIC HOISTS WITH ALTERNATING CURRENT 550, 440 OR 220 VOLT VARIABLE SPEED INDUCTION MOTORS

Number		Motors		DIMENSIONS OF DRUM		Rope speed in ft.	Approx. dimensions of	Estimated
of Hoist	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	per min.	Bed-plate Inches	weight complete Lbs.
521	11	ITC-5008	12	16	1500	150	47 x 39	3230
522	15	ITC-5009	12	16	2000	175	$55 \ge 39$	3420
523	18	ITC-5010	14	27	2500	175	$54 \ge 54$	4430
524	22	ITC-5011	14	27	3000	175	$54 \ge 54$	4725
525	37 .	ITC-5012	16	24	4500	200	$67 \ge 55$	6615
5253	52	ITC-5013	16	30	6000	200	$69 \ge 60$	7760

4518A-14 Electric Hoists



SINGLE FRICTION DRUM ELECTRIC MINING HOISTS WITH ALTERNATING CURRENT 550, 440 OR 220 VOLT, VARIABLE SPEED INDUCTION MOTORS

Number	Motors		DIMENSIONS OF DRUM		Hoist in lbs. for single	Rope	Approx. dimensions of	Estimated shipping
of Hoist	H.P.	Class	Diam. Inches	Face Inches	Lbs.	speed in ft. per min.	Bed-plate Inches	weight complete Lbs.
532	15	ITC-5009	24	24	1500	250	54 x 49	4180
533	22	ITC-5011	30	24	2000	300	66 x 55	6770
534	37	ITC-5012	42	30	2500	400	78 x 61	9990
535	52	ITC-5012	48	30	2500	500	$94 \ge 66$	13090
536	75	ITC-5013	54	36	4000	500	$99 \ge 74$	16175
537	112	ITC-5014	54	36	4000	600	$105 \ge 74$	18190
538	150	ITC-5015	60	36	6500	575	121 x 80	23720

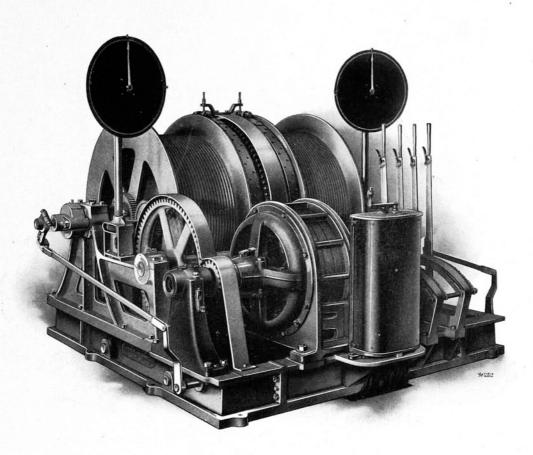
Motor and drum gears will be mounted on the opposite side from that shown in the above illustration.

ADDENDA

-

To Accompany Bulletin No. 4519 Parts of GE 87-A and B Railway Motors Page 6 Armature Heads

		ARMA		
Cat. No.	Location	No. of Turns	Cat. No.	List Price
59179	Pinion End	2	46064	\$13.40
59180	Com. End	2	46064	27.00

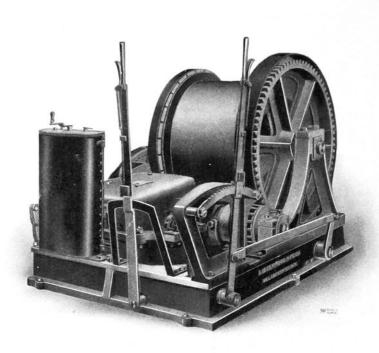


DOUBLE FRICTION DRUM ELECTRIC MINING HOISTS WITH ALTERNATING CURRENT 550, 440 OR 220 VOLT, VARIABLE SPEED INDUCTION MOTORS

Number	Motors		DIMENSIONS OF DRUM		Hoist in lbs. for single	Rope	Approx. dimensions of	Estimated
of Hoist	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	speed in ft. per min.	Bed-plate Inches	weight complete Lbs.
541	15	ITC-5009	24	24	1500	250	54 x 84	6785
542	22	ITC-5011	30	24	2000	300	67 x 90	10120
543	37	ITC-5012	42	30	2500	400	$78 \ge 106$	15165
544	52	ITC-5012	48	30	2500	500	$94 \ge 110$	20110
545	75	ITC-5013	54	36	4000	500	99 x 129	25395
546	112	ITC-5014	54	36	4000	600	$105 \ge 129$	27380
547	150	ITC-5015	60	36	6500	575	121 x 131	33840

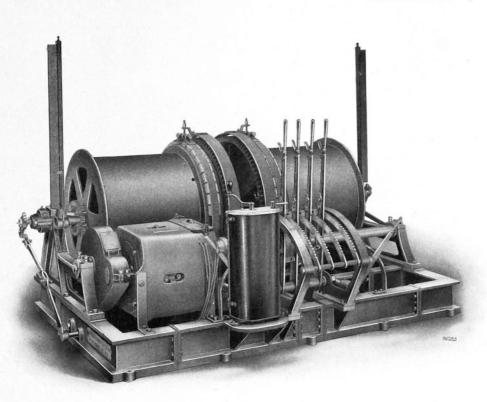
Motor gears will be mounted on the opposite side to that illustrated above. Solenoid brakes may be furnished with all hoists and further information will be given on application.

EXTRA PRICES FOR DIAL INDICATORS WILL BE FURNISHED ON APPLI-CATION.



JAW CLUTCH AND BRAKE REVERSIBLE ELECTRIC MINING HOISTS WITH CONTIN-UOUS CURRENT, 500, 250 OR 220 VOLT MOTORS

Number	Motors		DIMENSIONS OF DRUM		Hoist in lbs. for single	Rope	Approx. dimensions of	Estimated shipping
of Hoist	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	speed in ft. per min.	Bed-plate Inches	weight complete Lbs.
549	7.5	CO-2504	12	15	1000	150	46 x 42	2225
550	15	CO-2506	24	24	1500	250	$57 \ge 54$	4495
551	24	CO-2002	30	24	2000	300	$67 \ge 56$	7425
552	38	CO-2004	42	30	2500	400	$82 \ge 62$	10450
553	53	CO-2006	48	30	2500	500	$91 \ge 70$	14475
554	76	CO-2001	54	36	4000	500	$98 \ge 76$	17725
555	91	CO-2003	54	36	4000	600	$96 \ge 76$	19950
556	114	CO-2003	60	36	5000	600	$111 \ge 85$	24650
557	114	CO-2003	60	36	6000	500	$111 \ge 85$	24650



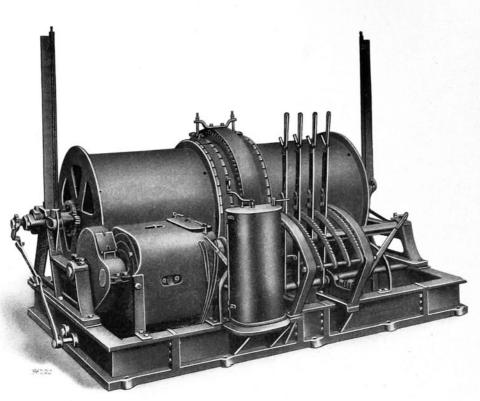
DOUBLE FRICTION DRUM ELECTRIC MINING HOISTS WITH CONTINUOUS CURRENT 500, 250 OR 220 VOLT MOTORS

Number	Motors		DIMENSIONS OF DRUM		Hoist in lbs. for single	Rope	Approx. dimensions of	Estimated shipping weight
of Hoist	Н.Р.	Class	Diam. Inches	Face Inches	Lbs.	speed in ft. per min.	Bed-plate Inches	complete Lbs.
558	24	CO-2002	30	24	2000	300	$66 \ge 107$	11340
559	38	CO-2004	42	30	2500	400	78 x 120	16675
560	53	CO-2006	48	30	2500	500	$94 \ge 126$	22875
561	76	CO-2001	54	36	4000	500	$99 \ge 142$	28375
562	91	CO-2003	54	36	4000	600	$99 \ge 142$	30600
563	114	CO-2003	60	36	5000	600	111 x 151	38050
564	114	CO-2003	60	36	6000	500	111 x 151	38050
565	114	CO-2003	72	60	8000	750	$118 \ge 204$	64620

These hoists have bearing between drum gears. Motor will be mounted on opposite side of hoist than that shown above. Solenoid brakes may be furnished with all hoists and further information will be given on application.

EXTRA PRICES FOR VERTICAL INDICATORS WILL BE FURNISHED ON APPLICATION.

4518A-18 Electric Hoists



DOUBLE FRICTION DRUM ELECTRIC MINING HOISTS WITH CONTINUOUS CURRENT 500, 250 OR 220 VOLT MOTORS

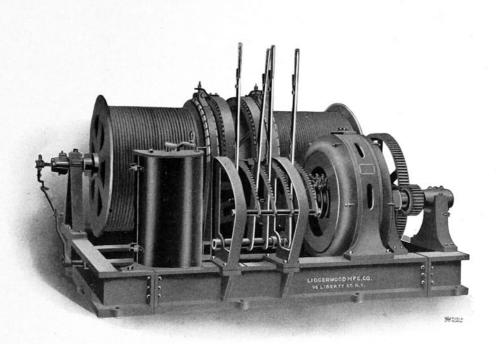
Number	Motors		DIMENSIONS OF DRUM		Hoist in lbs. for single	Rope	Approx. dimensions of	Estimated shipping weight
of Hoist	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	speed in ft. per min.	Bed-plate Inches	complete Lbs.
566	24	CO-2002	30	24	2000	300	66 x 90	10775
567	38	CO-2004	42	30	2500	400	$78 \ge 106$	15725
568	53	CO-2006	48	30	2500	500	$94 \ge 110$	21475
569	76	CO-2001	54	36	4000	500	$99 \ge 129$	26950
570	91	CO-2003	54	36	4000	600	$99 \ge 129$	29175
571	114	CO-2003	60	36	5000	600	111 x 131	34650
572	114	CO-2003	60	36	6000	500	111 x 131	34650
573	114	CO-2003	72	60	8000	750	$120 \ge 191$	61240

These hoists are similar to the 558-565 class inclusive except that single gear is used between drums and the center bearing is omitted.

The motor will be mounted on the opposite side of hoist to that illustrated above.

Solenoid brakes may be furnished with all hoists and further information will be given on application.

EXTRA PRICES FOR VERTICAL INDICATORS WILL BE FURNISHED ON APPLICATION.



DOUBLE FRICTION DRUM ELECTRIC MINING HOISTS WITH ALTERNATING CURRENT 550, 440 OR 220 VOLT, VARIABLE SPEED INDUCTION MOTORS

Number	Motors		DIMENSIONS OF DRUM		Hoist in lbs. for single	Rope	Approx. dimensions of	Estimated shipping
of Hoist	H.P.	Class	Diam. Inches	Face Inches	line Lbs.	speed in ft. per min.	Bed-plate Inches	weight complete Lbs.
576	15	ITC-5009	24	24	1500	250	54 x 94	6570
577	22	ITC-5011	30	24	2000	300	$66 \ge 107$	10605
578	37	ITC-5012	42	30	2500	400	$78 \ge 120$	15990
579	52	ITC-5012	48	30	2500	500	$94 \ge 126$	21340
580	75	ITC-5013	54	36	4000	500	$99 \ge 142$	26680
581	112	ITC-5014	54	36	4000	600	$105 \ge 142$	28610
582	150	ITC-5015	60	36	6500	575	$121 \ge 151$	37080

These hoists are similar to 541-547 class except that two drum gears are provided and a middle bearing between drums; also the style of motor will be similar to that shown in illustration, page 15.

4518A-20 Electric Hoists

Number	•	Motors .		SIONS OF	Hoist in lbs. for single	Rope speed in ft.	Approx. dimensions of	Estimated shipping weight
of Hoist	H.P.	Class	Diam. Inches	Face Inches	Lbs. speed in it.	Bed-plate Inches	complete Lbs.	
526	15	ITC-5009	12	16	2000	175	74 x 41	4970
527	18	ITC-5010	12	20	2500	175	71 x 46	6350
528	22	ITC-5011	14	27	3000	175	75 x 54	6680
529	37	ITC-5012	16	24	4500	200	87 x 55	9225
530	52	ITC-5013	16	30	6000	200	93 x 60	10635
526P	15	ITC-5009	12	16	2000	175	79 x 41	5150
527P	18	ITC-5010	12	20	2500	175	78 x 46	6585
528P	22	ITC-5011	14	27 ·	3000	175	81 x 54	6950
529P	37	ITC-5012	16	24	4500	200	92 x 55	9535
530P	52	ITC-5013	16	30	6000	200	98 x 60	10995
526S	15	ITC-5009	12	16	2000	175	41 x 123	6750
527S	18	ITC-5010	12	20	2500	175	46 x 123	8185
· 528S	22	ITC-5011	14	27	3000	175	54 x 125	8550
529S	37 ·	ITC-5012	16	24	4500	200	55 x 136	11135
530S	52	ITC-5013	16	30	6000	200	$60 \ge 142$	12595

DOUBLE FRICTION DRUM ELECTRIC HOISTS WITH ALTERNATING CURRENT 550, 440 OR 220 VOLT, VARIABLE SPEED INDUCTION MOTORS

These hoists may be furnished in type P with pinion between drum gears so that both drums will operate in the same direction, and also in type S with swinging gear connected on the front the same as shown on page 10, illustrating continuous current hoists 516-520S class.

Solenoid brakes may be furnished with all hoists and further information will be given on application.

GENERAL ELECTRIC COMPANY

Principal Offices, SCHENECTADY, N. Y.

SALES OFFICES

BOSTON, MASS., 84 State Street.
NEW YORK, N. Y., 44 Broad Street.
SYRACUSE, N. Y., Sedgwick, Andrews & Kennedy Bidg.
BUFFALO, N. Y., Ellicott Square Building.
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PHILADELPHIA, PA., Witherspoon Bidg.
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FOREIGN

FOREIGN DEPARTMENT,

Schenectady, N. Y., and 44 Broad St., New York, N. Y. LONDON OFFICE, 83 Cannon St., London, E. C., England.

For all CANADIAN Business,

Canadian General Electric Company, Ltd.,

Toronto, Ontario.



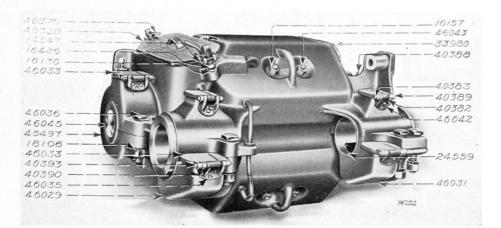
SUPPLY DEPARTMENT

June, 1907.

Bulletin No. 4519

AAW

PARTS OF GE 87-A AND B RAILWAY MOTORS



GE 87-A RAILWAY MOTOR

Weights

	Motor, complete, without axle gear and case, GE 87-A	2953 Lbs.
	Motor, complete, without axle gear and case, GE 87-B	3079 "
	Armature and pinion (16 teeth)	768 "
	Axle gear (71 teeth)	265 ''
	Gear case	166 ''
AT. NO.	DESCRIPTION	LIST PRICE
45356	FRAME, complete, for GE 87-A motor, includes upper and lower field castings, lids, pole pieces, bearing caps and linings, and all bolts, pins, etc., fastening parts together	
15357	Frame, complete, for GE 87-B motor, includes upper and lower field castings, lids, pole pieces, bearing caps and linings, and all bolts, pins, etc., fastening parts together	
15358	Lid with felt packing, for upper casting, commutator end, for GE 87-A motor .	\$2.25
15359	Lid with felt packing, for upper casting, commutator end, for GE 87-B motor .	3.00
10376	Cam with eye-bolt, fastening lid in position	.45
6426	Nut for cam eye-bolt $(\frac{3}{4}''-10, \frac{1}{2}''$ thick, Hex. Rough), per 100	5.00
6136	Lock washer for cam eye-bolt	.05
4547	Spring cotter for lid $(\frac{1}{4}'' \ge 2\frac{1}{2}'')$, per 1000	10.00
3980	Lid with rope packing, for upper casting, pinion end	.60
3981	Lid with rope packing, for lower casting, commutator end	.75
33982	Lid with rope packing, for lower casting, pinion end, for GE 87-A motor	.50
5325	Lid with rope packing, for lower casting, pinion end, for GE 87-B motor	.20
1295	Cap screw fastening lids in position $(\frac{5}{8}''-11, 1\frac{5}{8}''$ Hex. H.)	.15

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4519-2 The GE 87-A and B Railway Motors

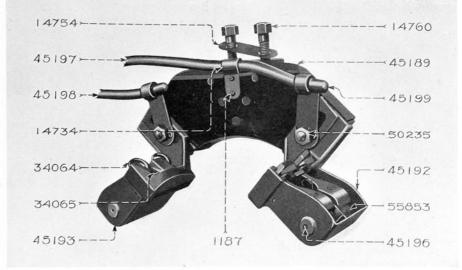
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	· ·	
саг. no. 16137	DESCRIPTION Lock washer for No. 11295, per 100	LIST PRICE
	Soft rubber bushing for use with cables (long)	\$4.00
45360		.15
45496	Soft rubber bushing for use with cables (short)	.15 20.00
45497	*Armature bearing cap, commutator end, for GE 87-B motor	20.00 27.50
45498	*Armature bearing cap, commutator end, for GE 87-A motor	27.50 19.00
45499	*Armature bearing cap, pinion end, for GE 87-A motor	
46028		28.00
46029	*Axle bearing cap, commutator end, for GE 87-A motor	23.50
46030	*Axle bearing cap, commutator end, for GE 87-B motor	30.00
46031	*Axle bearing cap, pinion end, for GE 87-A motor	24.00
46032	*Axle bearing cap, pinion end, for GE 87-B motor	29.00
24559	Dowel pin for axle bearing cap $(\frac{8}{7}'' \times \frac{18}{18}'')$.06
46033	Lid for axle bearing cap grease chamber, for GE 87-A motor	.65
35150	Lid for axle bearing cap grease chamber, for GE 87-B motor	.45
40390	Spring for No. 46033 (17 turns, .102" steel wire)	.06
35151	Spring for No. 35150 (17 turns, .102" steel wire)	
40393	Hinge pin for No. 46033 ($\frac{2}{3}$ " x 4 $\frac{16}{16}$ " R. H.), per 100	3.00
35152	Hinge pin for No. 35150, pinion end $(\frac{2}{3}'' \times 5\frac{1}{2}'' R. H.)$.04
46034	Hinge pin for No. 35150, commutator end, $(\frac{3}{2}" \times 5\frac{3}{2}" R. H.)$.	.05
4030	Spring cotter for Nos. 40393, 35152, 46034, $(\frac{3}{32}" \times \frac{5}{32}")$, per 1000	2.00
46035	Hinge bracket with rivets, for No. 46033	.20
46036	Bolt fastening upper and lower field castings for GE 87-A & B motors together,	
	and bearing caps for GE 87-A motor, in position (11/2"-7, 51/" Sq. H. Sp'l drilled	
	for cotter)	.60
46037	Stud fastening axle caps to frame, for GE 87-B motor, (11"-7, 6" Sp'l drilled for	
	cotter)	.40
46038	Stud fastening gear case to frame, for GE 87-B motor, (1 ¹ / ₈ "-7, 4 ³ / ₄ " Sp'! drilled for	
	cotter)	.35
46039	Hinge bolt for GE 87-A motor $(1\frac{1}{6}\pi^{-7}, 5\frac{1}{2}\pi^{-7})$ Sp'l drilled for cotter)	.65
18106	Nut for Nos. 46036, 46037, 46038, 46039, $(1\frac{1}{8}''-7, \text{Hex. Rough})$.	.15
50218	Lock washer for No. 18106	.08
46040		.15
16323	Spring cotter for Nos. 46036, to 46040 inclusive, $(\frac{3}{16}'' \times 1\frac{1}{2}'')$, per 1000	3.00
46041	Dowel stud for upper field casting $(1''-8, 6\frac{1}{2}'' \log)$.20
46033	Lid for armature bearing grease chamber, for GE 87-A motor	.65
40387	Lid for armature bearing grease chamber, for GE 87-B motor	1.50
40389	Lid for axle bearing grease chamber, for GE 87-A motor	1.00
40388	Lid for stand pipe for armature bearing grease chamber, for GE 87-A motor	.50
45330	Lid for stand pipe for armature bearing grease chamber, for GE 87-B motor	.30
40390	Spring for Nos. 46033, 40387 (17 turns, .102" steel wire)	.06
40382	Spring for No. 40389 (9 turns, .102" steel wire)	.06
40391	Spring for Nos. 40383, 45330 (8 turns, .091" steel wire)	.06
40393	Hinge pin for Nos. 46033, 40387 (≩″ x 4 ⅔″ R.H.), per 100	3.00
40383	Hinge pin for No. 40389 ($\frac{37}{8}$ x 3 $\frac{1}{16}$ R.H.), per 100	3.00
40394	Hinge pin for Nos. 40388, 45330 ($\frac{2}{3}$ " x 3 $\frac{5}{13}$ " R.H.), per 100	3.00
4030	Spring cotter for hinge pins $(\frac{3}{32}'' \times \frac{5}{8}'')$, per 1000	2.00
46035	Hinge bracket, with rivets, for No. 46033	.20
40396	Hinge bracket, with rivets, for No. 40387	.25
46042	Hinge bracket, with rivets, for No. 40389	.20
33984	Socket pipe plug for lower casting $(1'' \text{ pipe})$.08
46043	Bolt fastening pole piece to frame $(\frac{1}{2}''-9, 5\frac{1}{2}''$ Sq. H.)	.25
16157	Nut for No. 46043 (j'' -9, Hex. Rough)	.10
16135	Lock washer for No. 16157, per 100	5.00
46044	Suspension bolt $(1\frac{1}{2}^{"}-7, 4\frac{1}{2}^{"}$ Sq. H., drilled for cotter)	.35

*Must be fitted.

The GE 87-A and B Railway Motors 4519-3

CAT. NO.	DESCRIPTION	LIST PRICE
18106	Nut for No. 46044, (1 ⁴ / ₈ "-7, Hex. Rough)	\$0.15
50218	Lock washer for No. 18106	.08
9704	Spring cotter for No. 46044 $\left(\frac{3}{16}'' \ge 1\frac{3}{4}''\right)$, per 1000	4.00
42996	AXLE BEARING LINING, malleable iron and babbitt, for GE 87-A motor (2	•
	halves, 4" bore)	20.10
42997	Axle bearing lining, malleable iron and babbitt, for GE 87-A motor (2 halves,	
	$4\frac{1}{4}$ " bore)	20.45
42998	Axle bearing lining, malleable iron and babbitt, for GE 87-A motor (2 halves,	
	$4\frac{1}{2}$ " bore)	20.45
42999	Axle bearing lining, malleable iron and babbitt, for GE 87-A motor (2 halves,	
	5" bore)	20.80
45412	Axle bearing lining, Brass, for GE 87-A motor, (2 halves, 5 ¹ / ₂ " bore)	27.00
43090	Axle bearing lining, Brass, for GE 87-B motor, (2 halves, 5½" bore)	30.60
43093	ARMATURE BEARING LINING, commutator end, brass and babbitt	18.15
43094	Armature bearing lining, pinion end, brass and babbitt (2 halves)	22.00
		1.4

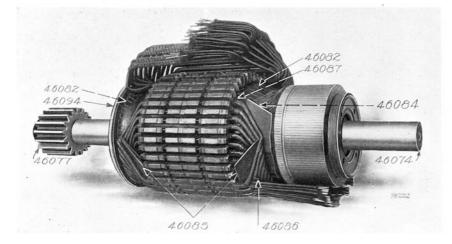


BRUSH HOLDERS AND BRUSH HOLDER YOKE

46045	Plug for No. 43093	.10
45188	BRUSH-HOLDER YOKE, complete, with holders and cables	28.50
45189	Brush-holder yoke, with end plates, bracket and cap screws	4.50
45190	Right-hand brush-holder, complete	8.50
45191	Left-hand brush-holder, complete	8.50
45192	Right-hand body, with pins	4.50
45193	Left-hand body, with pins	4.50
34064	Pressure arm, with contact spring, tip and flexible pigtail connector	1.50
34065	Contact spring, with conductor, tip and rivets	.75
55852	Flexible pigtail connector for No. 34064	.20
24591	Side washer for pressure arm $\left(\frac{17}{12}'' \times 1\frac{3}{8}'' \times .031''$ brass)	.02
55853	Tension Spring (10 turns, .091" steel music wire)	.25
45194	Pin for tension spring $(\frac{3}{16}'' \ge 4\frac{1}{16}'')$, per 100	1.50
45195	Sleeve for No. $45194 \left(\frac{3}{16}'' \ge \frac{5}{16}'' \ge 1\frac{3}{4}'' \text{ long fiber} \right)$.05
45163	Washer for No. 45195 $(\frac{2}{5}1'' \times \frac{5}{8}'' \times \frac{1}{6}''$ thick fiber), per 1000	1.00

4519-4 The GE 87-A and B Railway Motors

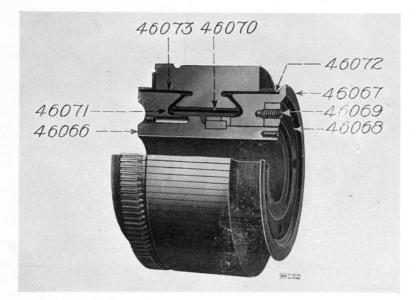
CAT, NO.	DESCRIPTION						LIST PRICE
45196	Hinge pin for pressure arm $(\frac{1}{4}'' \ge 4\frac{1}{4}''$ Pin H.), per 100						\$4.00
10110	Spring cotter for No. 45196 $(\frac{5}{64}" \ge \frac{1}{2}")$, per 1000						2.00
14760	Cap screw fastening yoke to frame $(\frac{5}{8}''-11, \frac{17}{8}''$ Hex. H.), per 100						10.00
14754	Washer plate for No. 14760, per 100						3.00
50235	Crown nut for bolt fastening body to yoke, (12"-13, Hex. Sp'l), per	100					4.00
50236	Cotter pin for No. 50235, per 1000						2.00
45197	Right-hand cable with tip (59" long, 150 No. 25 B & S wire) .						2.00
45198	Left-hand cable, with tip (47" long, 150 No. 25 B & S wire) .						1.65
45199	Tip for cables			÷			.40
14734	Clip for right-hand cable		2				.04
1187	Screw for clip (No. 10, $\frac{7}{8}''$ R.H.), per 100						1.00
42911	CARBON BRUSH $(2\frac{1}{4}" \text{ long}, 2" \text{ wide}, \frac{1}{2}" \text{ thick})$, 2 required for each	ch h	nold	er,	4 f	or	
	each motor, per 100						14.00
43100	FIELD COIL, complete, for 2 turn armature						66.15
46046	Outside terminal, with connection strip and screws for No. 43100						.60
46047	Inside terminal, with connection strip and screws for No. 43100	12					.60
46048	Screw for terminal (14-24, ⁷ / ₁₆ " R.H.), per 100						.85



46049	Flange for held coil	55
46050	Oiled Canvas pad for field coil	.20
46051	Inside connection cable for field coils (9" long, 150 No. 25 B & S wire)	.25
46052	Long cable for field coil, for GE 87-A motor (57" long, 150 No. 25 B & S wire)	1.20
46053	Long cable for field coil, for GE 87-B motor (671" long, 150 No. 25 B & S wire)	1.40
46054	Short cable for field coil, for GE 87-A motor (54" long, 150 No. 25 B & S wire)	1.15
46055	Short cable for field coil, for GE 87-B motor (601/2" long, 150 No. 25 B & S wire) .	1.25
46056	Upper field cable, axle side, for GE 87-A motor (30" long, 150 No. 25 B & S wire)	.65
46057	Upper field cable, axle side, for GE 87-B motor (311/2" long, 150 No. 25 B & S wire)	.70
46058	Lower field cable with connector, axle side, (22" long, 150 No. 25 B & S wire)	.65
46059	Two-way connector with screws, for No. 46058	.20
6081	Screw for connector (10-24, 3/ R.H. Blued), per 100	.50
46060	Ground cable, with terminal, for GE 87-A motor (32" long, 150 No 25 B & S wire)	1.45
46061	Ground cable, with terminal, for GE 87-B motor (36" long, 150 No 25 B & S wire)	1.50
46062	Ground terminal	.80
11295	Cap screw fastening ground terminal to frame, $(\frac{5}{8}"-11, 1\frac{5}{8}"$ Hex. H.)	.15
16137	Lock washer for No. 11295, per 100	4.00

The GE 87-A and B Railway Motors 4519-5

CAT. NO.				ESCH														LIST PRICE
34075	AXLE KEY, $(1'' \ge 1'' \ge 6\frac{3}{8}'' \log 6\frac{3}{8})$	<u>д,</u> г	our	nd e	nds)	÷.,	S				34			92			\$0.40
30102	SPLIT GEAR, 64 teeth, 4" bore																	32.15
30103	Split Gear, 64 teeth, 44" bore																2	32.25
30104	Split Gear, 64 teeth, $4\frac{1}{2}''$ bore																	31.65
30105	Split Gear, 64 teeth, 5" bore																	32.00
30106																		32.50
28459	*Pinion, grade "D," 23 teeth, 3																	
	30105, 30106																	16.55
	i finion grade C. (Identical			abo	ve.	exc	cept	qu	alit	V C	of n	nate	ria	l er	npl	ove	d).	
	[†] Pinion grade "C," (Identical same catalogue number																	9.80
30097	same catalogue number	÷	•		·											8		9.80 33.00
30097 30098	same catalogue number Split Gear, 67 teeth, 4" bore	:	•		·	•	•			:	•	:	:		÷	а 8 9	•	33.00
	same catalogue number Split Gear, 67 teeth, $4''$ bore Split Gear, 67 teeth, $44''$ bore	•	•	•			• • •	•	5 2 5					•	•		•	



COMMUTATOR

30101	Split Gear, 67 teeth, $5\frac{1}{2}''$ bore					•												33.20
28458	*Pinion, grade "D," 20 teeth, 3 30100, 30101	31"	tap	per 1	oore	, fo	r use	e w	ith	No	s. 3	3009	7, 3	009	8, 3	3009	99,	10.00
	†Pinion, grade "C," (Identical	W	rith	abo	ove,	ex	cept	q	uali	ty	of	mat	eria	l e	mpl	loye	d)	12.00
	same catalogue number																	7.70
30094	Split Gear, 69 teeth, 4" bore																	33.90
30095	Split Gear, 69 teeth, 44" bore																	34.00
30096	Split Gear, 69 teeth, $4\frac{1}{2}''$ bore																	33.25
28586	Split Gear, 69 teeth, 5" bore																	33.75
28573	Split Gear, 69 teeth, $5\frac{1}{2}$ " bore																	34.00
28457	*Pinion, grade "D," 18 teeth, 3	$\frac{1}{8}''$	tap	er l	oore,	, for	r use	e w	ith	No	s. 3	009	4, 3	009	5, 3	3009	96,	01100
	28586, 28573																	11.00
	†Pinion, grade "C," (Identical	W	ith	abo	ove,	ex	cept	qu	uali	ty	of	mat	eria	1 e	mpl	loye	d)	
	same catalogue number																	6.70
26607	Split Gear, 71 teeth, 4" bore		22															35.20
30065	Split Gear, 71 teeth, $4_4^{1''}$ bore																	35.25

*Grade "D" pinion furnished with all original equipments. †Unless otherwise designated, supply orders will be filled with grade "C."

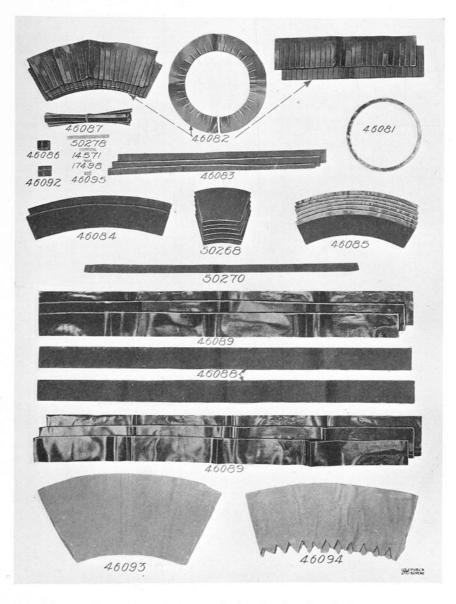
4519-6 The GE 87-A and B Railway Motors

CAT. NO.	DESCRIPTION	LIST PRICE
30050	Split Gear, 71 teeth, 4½" bore	\$34.65
26681	Split Gear, 71 teeth, 5" bore	35.00
26682	Split Gear, 71 teeth, 5½" bore	35.35
28441	*Pinion, grade "D," 16 teeth, 3 ¹ / ₈ " taper bore, for use with Nos. 26607, 30065, 30050, 26681, 26682	9.20
	†Pinion, grade "C," (Identical with above except quality of material employed)	5.60
42973	same catalogue number	9.00
	diameter (Max. gear 71 teeth, Max. pinion 28 teeth (Malleable Iron), for GE $87-\Lambda$ motor	39.50
42974	Gear Case (D.L. 37928) complete, adapted for use with gear having 8" hub diam- eter (Max. gear 65 teeth, Max. pinion 28 teeth (Malleable Iron), for GE 87-A	39.50
40075	motor	99.90
42975	(Max. gear 67 teeth, Max. pinion 28 teeth (Malleable Iron) for GE 87-B motor	38.00
34099	Lid for oil hole, with spring and hinge pin	1.25
34078	Spring for lid (151 turns, .102" steel wire)	.15
34079	Hinge pin for hd $(\frac{3}{2}'' \times 5'')$.04
46036	Bolt fastening halves of gear case together and fastening to frame (1 ¹ / ₈ "-7, 5 ¹ / ₂ " Sq. H. Sp'l drilled for cotter), for GE 87-A & B motors	.60
46063	Bolt fastening gear case to frame, for GE 87-B motor, (11/-7, 31/ Hex. H.)	.30
18106	Nut for Nos. 46036, 46063 (1 ¹ / ₂ "-7, Hex. Rough)	.15
50218	Lock washer for No. 18106	.08
16323	Spring cotter for No. 46036 $(\frac{3}{15}'' \times 1\frac{1}{2}'')$, per 1000	3.00
46064	°ARMATURE, 2 turn, complete, with thrust collars and pinion (No. 10 B. & S	
10007	E.D.C.C. wire)	550.00
43097	‡Armature coi ¹ , 2 turn (No. 10 B & S E.D.C.C. wire), per set of 43	78.90
46065	COMMUTATOR, complete	200.00
46066	Shell	26.00
46067		15.50
46068	Nut	5.70
46069	Set screw for nut (g"-16, 1g" Pointed, Headless)	.05
55891	Key for shell $(\frac{3}{2}'' \times \frac{3}{2}'' \times 1''$ round ends)	.10
44501	Pipe plug for commutator shell ($\frac{1}{8}''$ pipe), per 100	3.50
43104	Set of copper and mica segments, finished and bound, (129 segments)	90.75
46070	Mica collar under segments	1.20
46071	Inner mica cone	1.65
46072	Wide outer mica cone $(3\frac{1}{4})$ wide)	2.00
46073	Narrow outer mica cone (2§" wide)	1.60
46074	Shaft, bare	21.50
46075	Key for shaft (§" x §" x 193" Sq. ends)	.25
46076	Key for pinion $(\frac{1}{2}'' \times \frac{3}{4}'' \times 4\frac{3}{4}''$ Round end)	.15
46077	Pinion nut	.55
46078	Lock washer for nut $(2\frac{1}{5}'' \times 4\frac{3}{15}'' \text{ thick, Sp'l.})$.06
46079	Thrust collar, commutator end	2.75
46080	Thrust collar, pinion end	2.75
46081	Mica ring, back of commutator segments, $(8\frac{1}{4}'' \times 10'' \times \frac{1}{16}'' \text{ thick})$	1.40
46082	Set of insulations for armature core, includes 5 thicknesses . 010" red paper, 4 thick-	1,10
	nesses .008" oiled cotton $(5\frac{1}{2})$ wide for commutator end, 5 thicknesses .010"	
	red paper and 4 of .008" oiled cotton $(4\frac{1}{4})$ wide for pinion end and 5 thick-	
	nesses .010" red paper 4 of .008" oiled cotton (47) while for philon end and 5 thek-	
		1 40
	inside diameter), for core head flange, pinion end	1.40

*Grade "D" pinion furnished with all original equipments. †Unless otherwise designated, supply orders will be filled with grade "C." °Number of teeth in pinion must be specified. ‡43 Coils in complete set for one armature, Cat. No. is for one coil.

The GE 87-A and B Railway Motors 4519-7

CAT. NO.	DESCRIPTION	LIST PRICE
46083	Set of oiled asbestos insulations over layer of rope, just back of commutator $(36'')$	
	long, one strip each, $\frac{1}{3}$ ", $1\frac{1}{2}$ " and $1\frac{1}{3}$ " wide, 3 in set), per 100 sets	\$6.50
46084	Set of japanned canvas and oiled cotton insulations over short leads under coils	
	(2 thicknesses of canvas, 1 of oiled cotton, $19\frac{7}{8}''$ long, $3\frac{3}{8}''$ wide, 2 in set) .	.25
46085	Set of japanned canvas and oiled cotton insulations, between inner and outer turns of coils, commutator and pinion ends $(16\frac{1}{2}" \log, 3\frac{1}{2}" wide for pinion end,$	
	$3\frac{1}{8}''$ wide for commutator end, 6 in set, 3 at each end)	.65



46086 50268 .20

4519-8 The GE 87-A and B Railway Motors

CAT. NO.	DESCRIPTION	LIST PRICE
50270	Strip of japanned canvas and oiled cotton insulation over ends of short leads,	
	just back of commutator (34" long, $1\frac{1}{2}$ " wide)	\$0.08
46087	Set of japanned pressboards for coils in slots $(11\frac{1}{2}" \times \frac{7}{16}" \times .015", 86$ in set) .	.20
46088	Set of japanned canvas strips over coils, commutator and pinion ends (54" long,	
	$3\frac{1}{2}$ wide, 2 in set)	.15
46089	Set of varnished cambric dressings, commutator and pinion ends (6 pieces in set,	
	3 at each end, one strip each $3\frac{1}{2}$, $4\frac{1}{4}$ and $5\frac{1}{2}$ wide, 52 long, for commutator	
	end and one strip each, $3\frac{1}{2}''$, $3\frac{3}{4}''$ and $4\frac{3}{4}''$ wide, $52''$ long, pinion end)	.65
46090	Horn fiber center band under binding wire and band over commutator end dress-	
	ing (50" long, §" wide, .020" thick), per 100	3.65
46091	Horn fiber band over pinion end dressing (50" long, §" wide, .010" thick, per 100	.75
46092	Set of horn fiber strips under long binding clips, commutator end $(1\frac{1}{2}'' \ge 2'' \ge .010'')$,	
	8 in set), per 100 sets	.35
46093	Outside dressing, commutator end	.30
46094	Outside dressing, pinion end, slotted edge	.30
50278	Binding clip (6" x §" x .020" tin), per 1000	10.00
14571	Binding clip $(2\frac{1}{2}'' \times \frac{1}{2}'' \times .010'' \text{ tin})$, per 1000	2.00
17498	Binding clip $(1\frac{3}{16}" \times \frac{3}{4}" \times .010"$ tin), per 1000	2.00
46095	"T" shaped binding clip ($\frac{1}{5}$ " x $\frac{15}{32}$ " x .020" tin), per 1000	3.50
	Acme tape used in connection and binding armature ($\frac{3}{4}$ wide) cord for filling ($\frac{3}{16}$	

Acme tape used in connection and binding armature ($\frac{4''}{4''}$ wide) cord for filling ($\frac{4''}{4''}$ diam. hemp); cord for dressing No. 7; binding wire is .057" tinned steel, requiring approximately 425 feet.

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General Electric Company Schenectady, N.Y.

July, 1907

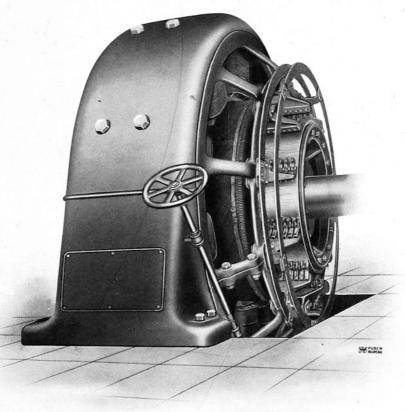
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Bulletin No. 4520

ENGINE TYPE CONTINUOUS CURRENT GENERATORS FORM R

The General Electric Company is manufac- Owing to the slow speed that can be obtained

turing a new line of multipolar direct current with the multipolar type of generator, these



MP 10-400-120-250 VOLTS 400 KW. DIRECT CURRENT GENERATOR

two- and three-wire generators in sizes from 25 Kw. and upwards known as Form R and RO, respectively, the smaller Form R generators being usually wound for 125 and 250 volts-the Form RO for 250 volts and the larger sizes of both types for 250 and 275 volts. machines are specially adapted for direct connection to engines, with which they form a very compact unit.

Direct driven generators have important advantages over belt driven machines as they require less floor space per Kw. output, and thus

4520-2 Engine Type Continuous Current Generators, Form R

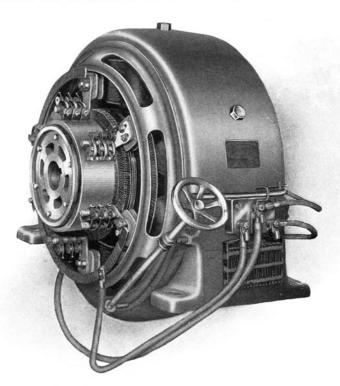
effect a saving in the cost of land and buildings. Higher efficiencies can also be obtained and economies in fuel due to the elimination of belts and shafting and the losses incidental thereto. They have moreover a further advantage of running practically without noise, enabling them to be used in residences and other places where quiet operation is a necessity.

In these generators are incorporated all the

of pole piece is also used on all Form R generators to reduce the eddy current losses and at the same time to obtain a more uniform flux distribution with improved commutation.

COMPOUND WOUND MACHINES

Form R generators are usually compound wound, in which case a German silver shunt is



MP-6-50-290-250 VOLTS 50 KW. GENERATOR, FORM R

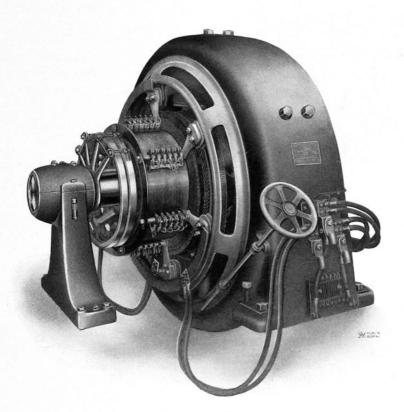
improvements in design and construction which have been suggested to the Company in its long experience in the manufacture of this type of machine. Only the highest class of material and approved modern machinery is used in their construction, and they embody all the best features of the old Form L, together with numerous improvements, chiefly relating to a more thorough ventilation of the field coils and armatures, as well as a more effective distribution of the active material. A laminated form provided for the series winding so that the compounding can be accurately adjusted for all ordinary service conditions; shunt wound generators will, however, be supplied if desired. The maximum range of compounding from no load to full load, for which these machines can be supplied if so required, is 110 to 125 volts and 220 to 250 volts. While this range can be obtained, over-compounding of about 5% is all that is usually necessary for ordinary service conditions. Engine Type Continuous Current Generators, Form R 4520-3

SPEEDS AND VOLTAGES

In order to adapt these machines to suit the speeds used by various engine manufacturers, standard Form R generators are designed for both standard and slow speeds. The standard speed machines can be run 5% above or below standard speed, and the slow speed machines

LARGE MACHINES

A full line of machines above 200 Kw. is being manufactured, an illustration of which appears on the front page. These generators comprise machines from 300 Kw. up to 1600 Kw. at 250 and 275 volts; the speeds ranging from 150 RPM, for the smallest size, to 100



MP-6-150-225-250 VOLTS 150 KW. GENERATOR, FORM RO

5% above slow speed at rated voltage and output. A reasonable variation of full load voltage can be obtained with these machines, but if lower voltages than standard are required, the Kw. output must be proportionately reduced. Further information on this point can be obtained on application.

The ratings, weights and dimensions for the standard generators, Forms R and RO will be found on page 7, up to 200 Kw. RPM, for the largest size. The dimensions, ratings, etc., of these sizes will be furnished on application.

THREE-WIRE GENERATORS

The Form RO three-wire generators are the same as the Form R type with the addition of collector rings. Machines up to and including 200 Kw. are provided with two collector rings, mounted at the commutator end of the machine, which are connected to the proper points in the armature winding.

The brush rigging for the collector rings is supported from the end of the pillow block, as shown in the illustration, and is connected through copper brushes to a compensator which is furnished with these machines. These compensa-



COMPENSATOR

tors are similar in construction to the wellknown General Electric Company's type H transformers, and consist essentially of two or more insulated coils wound on a laminated iron core, the whole being enclosed in an iron case, thus providing a reliable, compact and efficient balancing device. Standard compensators are designed for a neutral current of 25% of full load generator current, as this value has been found ample for practically all conditions of service.

The compensator carries an alternating current and serves to maintain a neutral potential at its middle point which can therefore be used for connection to the middle wire or neutral of a three-wire system. The variations of potential between the two sides will be slight, even with considerable differences of load between them.

Form RO machines are usually wound for 250 volts, so that 125 volts can be obtained on either side of the three-wire system. They can be either flat or over-compounded to compensate for line losses.

FRAME

The frame is cast from a specially selected soft iron of high magnetic permeability, and the pole pieces are securely bolted to the frame and can be readily removed when required. Feet are provided on the bottom half of the frame to give ample bearing surface for bolting the generator to the engine bedplate, and liners can be supplied between the frame and bedplate if required.

Provision is made in the magnet frame for the reception of the brushholder yoke so as to permit the proper shifting of brushes, a hand wheel being supplied for this purpose.

FIELD COILS AND POLE PIECES

The field coils are rectangular in shape as shown in the illustration, and are held firmly in position by the tips of the pole pieces when the latter are bolted to the frame. The end flanges on the field coils are ventilated and ducts are formed in the coils so as to allow free circulation of air through the windings. In the larger size



FIELD COIL

machines, the series and shunt windings are wound on separate parts of the bobbin, but in the smaller machines, the shunt winding is wound over the series.

The magnet cores are laminated in order to minimize eddy currents and are of rectangular shape. Engine Type Continuous Current Generators, Form R 4520-5

ARMATURE

The armature is built up of soft steel laminations so as to minimize eddy currents and consequent heating of the core and to increase the efficiency of the machine. The laminations are punched with dies so as to ensure perfectly uniform stampings and when assembled form a rigid core with smooth slots in which the conductors are embedded.

The armature is drum wound and, in addition to the usual ventilating ducts through the core, an open type flange is used which allows free air circulation between the end windings. securely soldered into the segments. Loose joints and imperfect contact between the armature and commutator are thus avoided and perfect electrical connection is obtained.

EQUALIZING RINGS

Equalizing rings are provided on generators having multiple wound armatures. These rings are used to connect the armature windings between points of equal potential so that any unbalancing that may occur will be equalized by the alternating currents which will flow through the rings



ARMATURE

The armature is very carefully constructed so as to practically eliminate any danger from short circuits or grounds. The armature windings consist of separately insulated straight copper bars, and each coil is so formed as to be easily removed from the slots for repairs if required. The slotted armature core thoroughly protects the windings from mechanical injury during assembly or transportation. The end connections are supported by flanges fastened to the armature spider and the windings are securely held in the slots against centrifugal force, fibre wedges being used in the majority of machines for this purpose.

The armature is connected to the commutator by carefully selected copper strips which are between the sections. These currents equalize the pole strengths all around the armature and cause an equal division of the direct current in the several paths. Thus if an armature should settle out of center, due to the difference of air gap above and below, the magnetic strength of all the poles will remain the same. For the same reason unbalanced magnetic pull tending to bend the shaft and increase the bearing friction will be eliminated. Commutation will also be improved, as the distribution of the magnetism is equalized under all of the poles. These equalizer rings are mounted on the end flange on the back of the armature, where they are readily accessible.

4520-6 Engine Type Continuous Current Generators, Form R

COMMUTATOR

The commutator segments are made with liberal depth of the highest grade of hard drawn copper insulated from the shell and from one another by selected mica gauged to a uniform thickness and of such hardness as to wear evenly with the copper. The care taken in the construction of the commutator and the good electrical constants of the generators insure practically sparkless operation from no load to one and one-half full load without requiring any shifting of the brushes, thus minimizing the wear of the commutator and ensuring a long life to the latter.

The commutator shell is of cast iron and is pressed on the armature spider so that the commutator is supported independently of the shaft.

BRUSH-HOLDER, YOKE AND BRUSHES

The brush-holder yoke, as already mentioned, is supported by the magnet frame so as to allow the brushes to be readily rotated when required. The brushes are made of the highest grade carbon and can readily be adjusted or removed for inspection without altering the adjustment of the brushholders or the tension of the spring pressing the brushes on the commutator.

The brushholders are known as the General Electric Company's type CS holder which is of light but strong construction. The brushes slide in finished ways and are pressed against the commutator by springs which give a practically uniform pressure throughout the working range of the brushes. This type of spring has no hinge joints, common to other holders, and variable friction is not therefore introduced tending to change the pressure on the brush in operation. The holder is designed so that the brush can be readily removed by simply throwing the spring out of notch.

A flexible, braided copper wire pigtail or

shunt, is provided to insure proper electrical connection between the brushes and studs and to prevent current passing through the tension spring.



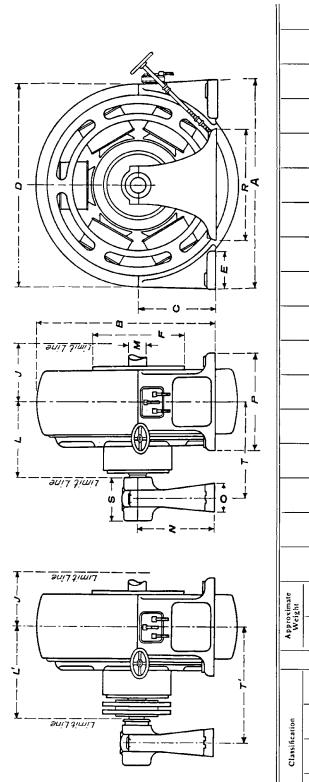
CS BRUSH-HOLDER

HEATING

Standard Forms R and RO generators up to and including 200 Kw. are rated for heating on the following basis:

After a continuous full load run of 24 hours at rated volts and amperes the rise in temperature of armature or field windings will not exceed 35° C, nor the commutator 40° C above the surrounding air. With the load then increased to 25% above rated amperes at rated volts for two hours the rise in temperature of no part of the machine will exceed 55° C above the surrounding air. The machines may also be operated at 50% overload for one hour without injury. The machines will stand 100% overload momentarily without flashing over or injurious sparking.

The above temperatures are taken by thermometers and are based on a room temperature of 25° C. If the room temperature differs from 25° C, the observed rise of temperature should be corrected $\frac{1}{2}$ % for each degree C difference. This is in accordance with the standard rules of the American Institute of Electrical Engineers.



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cation	brendard Speed	310	300	290	275	260	250	225	200	150	110
Classification	K. W.	25	35	50	25	100	125	150	200	200	200
	Pole	9	9	9	9	9	9	9	8	x	×
	Type	МР	MP	MP	МР	МР	MP	МР	MP	MP	МР

L' and T' refer to 250 Volt Three-wire Form RO Generators. Dimensions are approximate, and subject to change without notice.

Engine Type Continuous Current Generators, Form R 4520-7

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General Electric Company Schenectady, N.Y.

DEPARTMENT SUPPLY

July, 1907

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Bulletin No. 4521

D.D.W GE FLOOR OUTLET BOXES ADJUSTABLE WATER-TIGHT OUTLET BOXES

`HE GE Floor Outlet Boxes are intended primarily for use in offices or other places where, for various reasons, ceiling or bracket outlets would be



GE Adjustable Floor Outlet Box Cat. No. 76453

The threaded portion is designed to give an adjustment of one inch.

The floor plate is made of heavy brass and is fastened to the iron col-

lar by screws; a

rubber gasket is

tight joint.

The exposed sur-

faces of the plate and nozzle have a

polished brass fin-

ish, and the steel

body is heavily ja-

panned inside and

out. It is substan-

tially built and will

when subjected to

provided to ensure a water-

Section of Adjustable Box showing not sink in the floor Receptacle, Cat. No. 42453 and Attaching Plug. Cat. No. 42455 in place

undesirable. The body of the box is drawn in one piece from oneeighth inch cold rolled steel of the best grade, and the adjustable collar with which the box is provided, is made in one piece of the same material.

moved and the box closed by means of a brass. flush, sealing plug. Both nozzle and sealing plug are provided with rubber gaskets to ensure a watertight joint. The conduit holes can also be

closed, when

can be readily re-



Adjustable Box with Sealing Plug Cat. No. 76467 Inserted

necessary, by brass plugs.

heavy weight. It is not necessary to remove

the floor plate when inserting or removing the

plug. When not in use, both nozzle and plug

The boxes are furnished with

either round or square floor plates. The

adjustable iron collars to which the plates are secured are also furnished with round or square flanges to fit the plates. If boxes are purchased separately from the plates. care should be taken to specify



Adjustable Box Cat. No. 76461 Including Receptacle and Plug

Plug for Conduit Hole

4521.2 G.E. Floor Outlet Boxes

whether the flanges on the adjustable collars should be round or square to fit the plates.

Installation of Box

The box or lower part (the collar and plate being removed) should be set level from 1 to $1\frac{1}{2}$ inches below the upper surface of the floor. This should be done when the conduit is run. The box should be filled with excelsior or paper to prevent the entrance of plaster or rubbish before the floor is laid.

The adjustable collar with floor plate attached, can be set in place either before or after the floor is laid. The thread of the steel collar should be well leaded before screwing it into place so as to make the joint thoroughly water-tight. If set in marble or tile floor, the rough edges around the brass floor plate should be filled with cement. The socket or receptacle can be connected either before or after the floor plate is set.

Dimensions of Box

Diameter across floor plate, 5 inches.

Diameter lower body, 4 inches.

Height adjustable from $3\frac{3}{5}$ inches to $4\frac{3}{5}$ inches.

Weight complete with outlet nozzle 3¹/₄ lbs.

Conduit holes threaded with $\frac{1}{2}$ inch standard pipe tap for $\frac{5}{8}$ inch conduit, can be tapped larger if so ordered.

PRICE	LIST	OF	GE	WATER-TIGHT	FLOOR	OUTLET	вох
				(ADJUSTABLE))		

Cat. No.	Description	Package Quantity	List Price Each
76459	Box complete with round brass floor plate with either single or double outlet nozzle	25	\$4.00
76460	Box complete with square brass floor plate with either single or double outlet nozzle	25	4.50
76461	Cat. No. 76459 complete with Plug Cat. No. 33442 and Receptacle Cat. No. 38298	25	5.30
76462	Cat. No. 76460 complete with Plug Cat. No. 33442 and Receptacle Cat. No. 38298	25	5.80
76465	Single Outlet Nozzle	25	1.40
76466	Double Outlet Nozzle	25	1.40
76467	Flush Sealing Plug (for floor plate)	25	.40
76468	Sealing Plug (for conduit hole in box)	25	.10

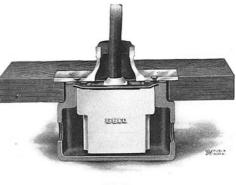
NOTE.—The hole in the floor plate of either Cat. No. 76459 or 76460 is large enough to admit any standard Edison base attaching plug. Receptacle Cat. No. 28795 or 42453, and the separable attaching plug Cat. No. 42456 will be found most satisfactory for use in GE Outlet Boxes, if the receptacle and plug listed above are not desired.

TYPE PR OUTLET BOXES

The Type PR Floor Outlet Box has all the advantages of the Adjustable Box with the exception of the adjustment feature. Two conduit holes, one in each end of box, threaded with $\frac{1}{2}$ inch standard pipe tap for $\frac{5}{8}$ inch conduit are regularly provided. Any other arrangement must be specially ordered.
The box has the following dimensions:
Length of box 4¼ inches.
Width of box 2¾ inches.
Depth under face plate 2¼ inches.
Floor plate 4¼ inches by 3 inches.



Exterior





PRICE LIST OF TYPE PR FLOOR OUTLET BOXES

Cat. No.	Description	Package Quantity	List Price Each
76470	Box complete, with standard brass floor plate, with either single or double outlet nozzle, and including receptacle		
	Cat. No. 38298 and attaching plug Cat. No. 33442	25	\$4.20
76465	Single Outlet Nozzle	25	1.40
76466	Double Outlet Nozzle	25	1.40
76467	Flush Sealing Plug (for floor plate)	25	.40
76468	Sealing Plug (for conduit hole in box)	25	.10

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General Electric Company

SUPPLY DEPARTMENT

lugust, 1907.

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ELECTRIC HEATING AND COOKING DEVICES FOR MARINE USE



HE great advantages of electricity in the way of simplicity, safety and flexibility have led to its almost universal adoption as a means of illumination on shipboard, so that today even the smallest tug

boat has its own electric plant; but ship owners and builders have not as yet fully appreciated its equal superiority as a producer of power and heat. On land the use of the electric motor for power purposes is now as general as electric lighting and the last few years have seen the beginning of a widespread movement to adopt electricity for heating and cooking as well.



Luminous Radiator

Recognizing the vast possibilities in this new application of electricity, the General Electric Company has developed a variety of special devices which have already won such favor that it seems certain they will be as commonly used as the incandescent lamp. As this Company has been closely identified from the first with the introduction and growth of electric lighting on shipboard, and has constantly recommended electric power for ship auxiliaries, it now desires to call attention to the very special advantages of electric heating and cooking devices on board ship.

A ship's lighting plant, usually of more than ample capacity for its intermittent load, offers at once an available source of supply, which, utilized for cooking in the galley or heating in the staterooms, would provide numerous real and profitable conveniences with small increase in cost.

RADIATORS

The electric heater is ideal for stateroom use. It is compact and neat in

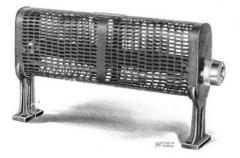


Air Heater

appearance and easily turned on and off, thus admitting of regulation of temperature for each individual room. It is connected by simple wiring which is more flexible than steam piping. The wires take little space and can be run anywhere, while steam pipes are bulky and apt to leak, and necessarily heat the spaces through which they pass. It is safe to say that the electric radiator, although deriving its heat indirectly from steam, is no less efficient when the losses due to leakage and radiation are taken into consideration.

4-4523 Electric Heating and Cooking Devices for Marine Use

Two types of electric heater have been made, the Luminous, consisting of large incandescent bulbs, or glowers, in front of a copper reflector, and the Non-luminous air heater, in which heat is distributed by natural



Stateroom Heater

circulation of air through special resistance coils. The Luminous type gives quick heat by means of radiation, and with its pleasant glow would be an attractive substitute for an open fire in the smoking room, saloon, or writing room of a passenger steamer.

The Non-luminous heaters are, however, better adapted to continuous service in heating rooms or spaces.

WATER HEATER

Another service to which electricity may be put is in furnishing hot water in the state-



Wash Bowl with Heater

room, and the convenience of the electric shaving mug, one or two-quart water heater,

or the electric washbowl fed from a small tank in which a heating unit is immersed, will readily be appreciated. The washbowl is



Parts of One-Quart Heater

primarily designed simply to take the chill off the water on boats running through t he winter in



Shaving Mug

northern waters, but the shaving mug and small water heaters will furnish boiling water in a few minutes.

COOKING AND LAUNDERING

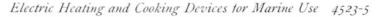
For cooking and laundry work a large line of standard devices is offered. There is the chafing dish, disk stove, egg boiler and coffee percolator for the cabin or wardroom,



Iron with Indicating Switch

and various grids, broilers, frying pans, combination cookers, teakettles, water urns, and continuous flow water heaters for the galley, as well as several sizes of ovens which, with the absence of live coals and the facility of temperature regulation, at once commend themselves as safer and more efficient

GENERAL ELECTRIC COMPANY





than any other form of stove for marine appliances mentioned above, special devices,

installation. To meet all requirements for ironing or pressing in the laundry, sizes of flatirons from three to twentyfour pounds can be supplied.



as electric soldering irons, gluepots, curling iron heaters, hospital sterilizers, heating pad, disk stoves for heating poultices, cigar lighters, etc., will all find their place

In addition to the heating and cooking in workshop, suite, smoking room, or sick bay.

6-4523 Electric Heating and Cooking Devices for Marine Use

CONSTRUCTION OF HEATING UNITS

Two distinct forms of heating elements are used by the General Electric Company: the Cartridge and Quartz Enamel units consist of a thin tape of special resistance metal, wound



edgewise, insulated with a fireproof cement and then inserted in a mica lined brass tube capped with a cement plug through which the leading-in wires are brought. The Quartz Enamel unit, is made up of a resistance wire wound in a coil of small diameter which is then coiled into the form of a flat spiral with mica insulating strips

Cartridge Unit

between its convolutions and held against a layer of Quartz grains imbedded in



Quartz Enamel Unit

enamel on the bottom of the heater. Both heating units are practically infusible and

indestructible, but can be readily replaced if damaged by accident. Great care has been taken in the design of the heating devices to insure the most efficient application of the heat and at the same time to give proper radiating surface so that nearly all the apparatus may be left in circuit indefinitely without fear of burnout.

All the smaller devices are portable and fitted with flexible cord and plug by which they may be connected to any lighting circuit in the same way as a portable lamp. They are regularly carried in stock and samples may be seen and full information regarding them obtained, at any of the branch offices of



Cigar Lighter

the General Electric Company. The larger appliances, such as heaters, washbowls and ovens are made on a special order and can be supplied within a reasonable time. The Company invites correspondence in regard to heating and cooking outfits for any type or size of vessel.



Electric Heating and Cooking Devices for Marine Use 4523-7

LIST OF APPLIANCES FOR CIRCUITS OF 105 TO 125 VOLTS AND 200 TO 250 VOLTS

Air Heater: 2000 watts.

Broiler: 3 heat, 400 to 1200 watts.

Chafing Dish: 2 heat, 220 and 575 watts.

Coffee Percolator: 300 and 500 watts.

Cigar Lighter: table or pendant type, 75 watts.

- Combination Cookers: 1 qt., 500 watts; 2 qt., 3 heats, 275 to 1000 watts; 4 qt., 3 heats, 300 to 1050 watts; 6 qt., 3 heats, 350 to 1300 watts.
- Frying Pans: 5", 500 watts; 7", 2 heats, 220 and 575 watts; 10", 3 heats, 350 to 1300 watts.
- Flatirons: 3 lb., 250 watts; 6 lb., 500 watts; 8 lb., 600 watts; 12 lb., 750 watts; 15 lbs., 750 watts; 18 lb., 750 lbs., 24 lb., 1000 watts.

Grid: 3 heats, 225 to 900 watts.

Glue Pots: 1 qt., 85 watts; 2 qt., 3 heats, 360 watts; 4 qt., 3 heats, 140 to 560 watts.

Heating Pad: 55 watts.

Luminous Radiator: oxidized or nickel finish, 750 and 1500 watts.

Ovens: small size, 3 heats, 500 to 1500 watts.

Soldering Iron: 3 lb., 200 watts.

Sterilizer, Hospital: 3 heats, 200 to 800 watts.

Stove: 6" disk, single heat, 600 watts; 8" disk, 3 heats, 225 to 900 watts; 10" disk, 3 heat, 400 to 1200 watts.

Teakettle: 2 qt., 2 heat, 160 and 575 waits; 4 qt., 3 heat, 300 to 1050 watts.

Water Heaters: 1 pt., 300 watts; 1 qt. heater and egg boiler, 2 heat, 300 and 500 watts; 4 qt. heater, 3 heats, 500 to 1050 watts; 6 qt. heater, 3 heats, 350 to 1300 watts.

Water Urn: 2 gal., 3 heats, 180 to 720 watts.

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

SALES OFFICES:

BOSTON, MASS., 84 State Street NEW YORK, N. Y., 44 Broad Street SYRACUSE, N. Y., Sedgwick, Andrews & Kennedy Building BUFFALO, N. Y., Ellicott Square Building NEW HAVEN, CONN., Malley Building PHILADELPHIA, PA., Witherspoon Building BALTIMORE, MD., Continental Trust Building PITTSBURG, PA., Park Building ATLANTA, GA., Empire Building NEW ORLEANS, LA., Hennen Building CINCINNATI, OHIO, Perin Building, Fifth and Race Sts. COLUMBUS, OHIO, Columbus Savings & Trust Building CLEVELAND, OHIO, Citizens Building NASHVILLE, TENN., Stahlman Building CHICAGO, ILL., Monadnock Building DETROIT, MICH., Majestic Building ST. LOUIS, MO., Wainwright Building KANSAS CITY, MO., 2114 Central Street OKLAHOMA CITY, OKLA., Culbertson Building DALLAS, TEXAS, Scollard Building HELENA, MONTANA, Power Block DULUTH, MINN., Providence Building MINNEAPOLIS, MINN., Phœnix Building DENVER, COLO., Kittredge Building SALT LAKE CITY, UTAH, Dooly Building SAN FRANCISCO, CAL., Union Trust Building LOS ANGELES, CAL., Delta Building PORTLAND, ORE., Worcester Building SEATTLE, WASH., Alaska Building

FOREIGN :

FOREIGN DEPARTMENT, Schenectady, N. Y., and 44 Broad Street, New York, N. Y.

LONDON OFFICE, 83 Cannon Street, London, E. C., England.

For all CANADIAN BUSINESS, Canadian General Electric Company, Ltd., Toronto, Ontario.

x

General Electric Company Schenectady, N.Y.

SUPPLY DEPARTMENT

July, 1907

Cat. No.

*Bulletin No. 4525

ALW

PARTS OF GE 57-A AND H RAILWAY MOTORS

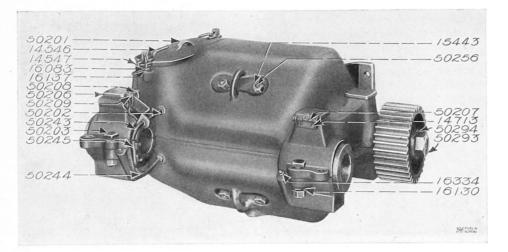


Table of Weights

Motor, complete, without axle gear and case	2632 lbs.
Armature and pinion (16 teeth)	704 lbs.
Axle gear (69 teeth)	
Pinion (16 teeth)	$22\frac{1}{2}$ lbs.
Gear case	140 lbs.

Description

50200	FRAME, complete, for GE-57-A Motor. Includes upper and lower field castings, lid for upper casting, lid for lower casting, pole shoes, bearing caps and linings, oil feeders, hinge bracket and all bolts, pins, etc., fastening parts together
47569	Frame, complete, for GE-57-H Motor. Includes upper and lower field castings, lid for upper casting, lid for lower casting, pole shoes, bearing caps and linings, oil feeders, hinge
	bracket and all bolts, pins, etc., fastening parts together
50201	Lid for upper casting
14546	Cam, with eye bolt fastening lid in position
16083	Nut for cam eye bolt (5"-11, 3" thick Hex. Rough)
16137	Lock washer for cam eye boltper 100

* Supersedes Supply Catalogue No. 7521.

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4525-2 Parts of GE 57-A and H Railway Motors

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Cat. No.	Description
14547	Spring cotter for lid ($\frac{1}{4}'' \ge 2\frac{1}{2}''$)
50202	Soft rubber bushing for use with cables
50203	Bolt fastening upper and lower castings together and bearing caps in position $(1''-8)$
	4¾″ Sq. H. Sp'l)
50204	Hinge bolt (1"-8, 3 ² / ₄ " Sp'l)
50256	Bolt fastening pole shoes in position (1"-8, 4 ⁷ / ₈ " Sq. H.)
15443	Nut for Nos. 50203, 50204, 50256 (1"-8, 1" thick Hex. Rough)
16130	Lock washer for No. 15443
50205	Hinge pin for frame (1" x 4§")
16323	Spring cotter for hinge pin $\left(\frac{3}{16}'' \ge 1\frac{1}{2}''\right)$
50206	Lid for grease chamber
50207	Large spring for lid (18 turns .055" steel wire)
50208	Small spring for lid (14 turns .055" steel wire)
50209	Hinge pin for lid (¼″ x 3⅛″)
50210	Hinge rivet for lid (4" x 2§" R.H.)
14713	Hinge for lid with rivets
50211	Lid for lower casting, with packing,
50212	Cap screw fastening lid to lower casting (§"-11, 2" Sq. H.)
16074	Nut for No. 50212 (§"-11, §" thick Hex. Rough)
16137	Lock washer for No. 16074
50213	*Armature bearing cap, commutator end
50214	*Armature bearing cap, pinion end
50215	*Axle bearing cap, commutator end, for GE-57-A Motor
50216	*Axle bearing cap, pinion end, for GE-57-A Motor
47570	*Axle bearing cap, commutator end. for GE-57-H Motor
47571	*Axle bearing cap, pinion end, for GE-57-H Motor
16334	Plug for oil holes in bearing caps (§" pipe)
14732	Oil feeder
50217	Suspension bolt (1 ⁴ /7, 4 ¹ /2, 4. H.)
18106	Nut for No. 50217 (1#"-7, 1#" thick, Hex. Rough)
50218	Lock washer for No. 18106
50219	AXLE BEARING LINING, brass (2 halves, $4\frac{1}{2}$ bore), for GE–57-A Motor
50220	Axle bearing lining, brass (2 halves, 4 ¹ / ₄ " bore), for GE-57-A Motor
50221	Axle bearing lining, brass (2 halves, 4" bore), for GE-57-A Motor
50222	Axle bearing lining, brass (2 halves, 3 ³ / ₄ " bore), for GE-57-A Motor
33427	Axle bearing lining, brass (2 halves, 5" bore), for GE-57-H Motor
33428	Axle bearing lining, brass (2 halves, 5 ¹ / ₄ " bore), for GE-57-H Motor
50223	Armature bearing lining, commutator end, babbitted
50224	Armature bearing lining, pinion end, babbitted
50225	Plug for No. 50223
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The barrel spring type brush-holder and yoke illustrated on the opposite page are being furnished on all GE-57 equipments. In ordering repair parts, care should be taken to determine whether parts required are for this style holder or for the old style holder illustrated on the same page.

38580	BRUSH-HOLDER YOKE, barrel spring type, complete, with holders and cables
50227	Brush-holder yoke, with end plates, bracket and cap screws
19213	Right-hand brush-holder, complete
19214	Left-hand brush-holder, complete
19215	Right-hand body, with pins
19216	Left-hand body, with pins
55851	Pressure arm, with contact spring and flexible pigtail connector
38581	Contact spring, with conductor, tip and rivets
24591	Side washer for pressure arm $(\frac{1}{32}$ x $1\frac{3}{5}$ x $\frac{1}{32}$ thick, Brass)

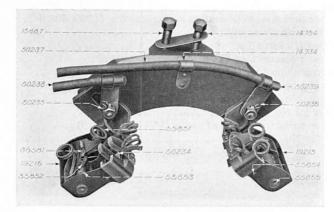
* Must be fitted.

Parts of GE 57-A and H Railway Motors 4525-3

Cat. No.

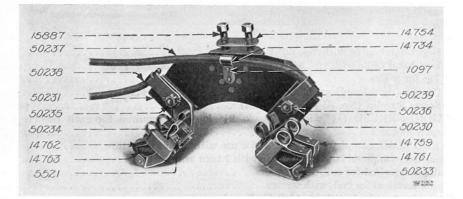
Description

55852	Flexible pigtail connector for No. 55851
55853	Tension spring (10 turns .090" steel wire, $1\frac{1}{2}$ " outside diam.)
55854	Pin for tension spring $\left(\frac{3}{16}'' \ge 3\frac{13}{16}''\right)$



NEW STYLE OR BARREL SPRING TYPE BRUSH-HOLDER

55855	Hinge pin for pressure arm $\left(\frac{1}{4}'' \ge 3\frac{15}{16}''\right)$
50234	Brush clip, complete
5521	Screw fastening brush clip to body (10-24, 3" R.H. Brass) per 100
15887	Cap screw fastening yoke to frame $(\frac{5}{8}$ "-11, $2\frac{1}{4}$ " Hex. H.)
14754	Washer plate for No. 15887



OLD STYLE BRUSH-HOLDER

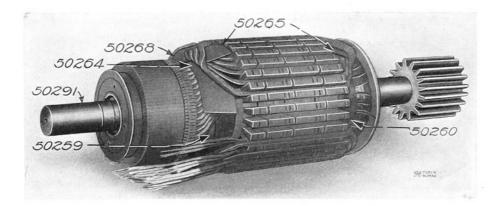
50235	Nut for cap screw fastening body to yoke $(\frac{1}{2}''-13$ Hex. Sp'l)
50236	Cotter pin for No. 50235per 100
50237	Right-hand cable with tip 66" long
50238	Left-hand cable with tip 54" long
50239	Tip for cables
14734	Clip for (right-hand) cable
1097	Screw for clip (No. 8, ³ / ₄ " R.H. Brass) per 100
50226	BRUSH-HOLDER YOKE, Form 1, old style complete, with holder and cables
50227	Brush-holder yoke, with end plates, bracket, cap screws and rivets for brush-holder body

4525-4 Parts of GE 57-A and H Railway Motors

Cat. No.

Description

50228	Right-hand brush-holder, Form 1, complete
50229	Left-hand brush-holder, Form 1, complete
50230	Right-hand body, with pivots for pressure arm
50231	Left-hand body, with pivots for pressure arm
14759	Right-hand pressure arm, with contact spring for Nos. 50230, 50231
14761	Left-hand pressure arm, with contact spring for Nos. 50230, 50231
14762	Contact spring with rivets and tip
14763	Tension spring (16 turns .090" steel wire)
50233	Hinge pin for pressure arm $\left(\frac{1}{4}'' \ge \frac{9}{16}''\right)$
50234	Brush clip, complete
5521	Screw fastening brush clip to body (10-24, 3" R.H. Brass)per 100
15887	Cap screw fastening yoke to frame (5"-11, 24" Hex. H.)
14754	Washer plate for No. 15887
50235	Nut for cap screw fastening body to yoke (1/2"-13, Hex. Sp'l)
50236	Cotter pin for No. 50235per 1000



50237	Right-hand cable with tip, 66" long
50238	Left-hand cable with tip, 54" long
50239	Tip for cables
14734	Clip for (right-hand) cable
1097	Screw for clip (No. 8, 3/ R.H. Brass)per 100
18167	CARBON-BRUSH (1 ³ / ₄ " wide, [§] / ₈ " thick, 2 ¹ / ₄ " long), 2 required for each holder, 4 for each motor
50240	FIELD COIL, complete, 110 ¹ / ₂ turns, for use with 3 turn armature
19222	Field coil, complete, 90 turns, for use with 2 turn armature
50241	Outside terminal for coil, with screws
50242	Inside terminal for coil, with screws
1698	Screw for terminals (12–24, ¹ / ₂ " R.H. Brass)per 100
50243	Short cable for coil (18" long)
50244	Short cable for coil, with connector
50245	Two-way connector, with screws, for short cable
6081	Screw for connector (10–24, ³ / ₈ R.H. Blued) per 1000
50246	Long cable for coil (54" long)
50247	Ground cable, with screw tip (36" long)
50248	Screw tip for ground cable, with screws
11096	Screw for tip (14-24, §" R.H. Blued)per 1000
50257	*ARMATURE, 3 turn, complete, with pinion (No. 9 B. & S. E.D.C.C. wire)
19220	*Armature, 2 turn, complete, with pinion (No. 9 B. & S. E. D. C. C. wire)

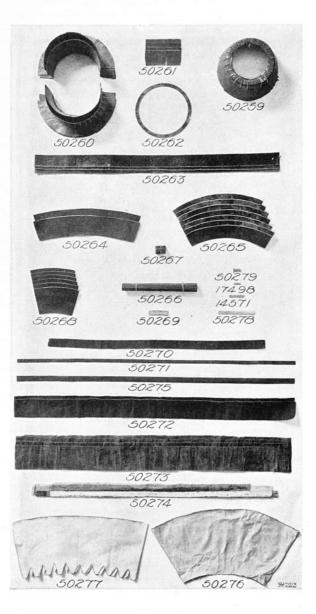
* Number of teeth in pinion must be specified.

Parts of GE 57-A and H Railway Motors 4525-5

Cat. No.

Description

50258	†Armature coil, 3 turn, No. 9 B. & S. (.114" E. D. C. C. wire); per set of 33
19221	†Armature coil, 2 turn, No. 9 B. & S. (.114" E. D. C. C. wire), per set of 37
47572	Armature head, pinion end, for 2 turn armature

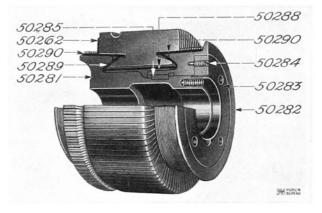


47573	Armature head, commutator end, for 2 turn armature
47574	Armature head, pinion end, for 3 turn armature
47575	Armature head, commutator end, for 3 turn armature
50259	Moulded insulation head for core, commutator end (5 thicknesses .010" red paper, 4
	thicknesses .008" oiled cotton)

†Cat. No. is for one coil.

4525-6 Parts of GE 57-A and H Railway Motors

Cat. No.	Description
50260	Moulded insulation head for core, pinion end (4 half circles)
50261	Set of varnished cambric reinforcing strips for joints of No. 50260 (6" long, 2½" wide, .015" thick, 4 in set)
50262	Mica ring at end of commutator segments
50263	Set of oiled asbestos insulations over commutator and end of armature core just back of commutator segments (40" long, 2" wide, .040" thick, 3 in set)
50264	Set of japanned canvas and oiled cotton insulations over inner leads under coils (2 thicknesses canvas, 1 of oiled cotton, $17'' \log, 3\frac{1}{2}''$ wide, 2 in set)
50265	Set of japanned canvas, japanned muslin and oiled cotton insulations between inner and outer turns of coils, commutator and pinion ends (15" long, 3" wide, 6 in set, 3 at each end)



50266	Set of long and short japanned pressboard strips between coils in slots (12"and 6" long respectively, $\frac{1}{2}$ " wide, 66 in set)
50267	Set of japanned canvas and oiled cotton insulations between outer leads and turns of coils $(1\frac{1}{2}'' \times 1\frac{1}{4}'', 33 \text{ in set})$
50268	Set of japanned canvas and oiled cotton insulations over coils between inner and outer leads $(7\frac{1}{2}'' \ge 4\frac{1}{2}'', 6 \text{ in set})$
50269	Set of pressboard fillers between coils, pinion end $(3\frac{3}{6}" \log, \frac{5}{16}" wide, \frac{3}{16}" thick, 33 in set)$
50270	Japanned canvas and oiled cotton insulation strip over ends of inner leads just back of commutator (34" long, 1 ¹ / ₂ " wide)
50271	Red paper band under binding wire $(45'' \log, \frac{8}{5}'' \text{ wide})$
50272	Strip of japanned canvas over coils, commutator and pinion ends (45" long, 3" wide, 2 in set)
50273	Set of varnished cambric dressings over coils, commutator and pinion ends (45" long, 1 piece each 6" and $4\frac{3}{4}$ " wide, 2 pieces $4\frac{1}{4}$ " wide and 2 pieces $3\frac{3}{4}$ " wide, 6 pieces in set)
50274	Insulation band back of commutator (cotton drill, oiled cotton, red paper, mica and asbestos, 36" long, 2" wide)
50275	Red paper band over dressing at ends of slots $(45'' \text{ long}, \frac{15}{15}'' \text{ wide})$
50276	Outside dressing, commutator end (No. 2 cotton drill)
50277	Outside dressing, pinion end, slotted edge (No. 2 cotton drill)
14571	Binding clip $(2\frac{1}{2}'' \times \frac{1}{2}'' \times .010'' \text{ tin})$
17498	Binding clip $(1\frac{3}{16}^{"} \times \frac{3}{8}^{"} \times .010^{"} \text{ tin})$ per 1000
50278	Binding clip (6" x §" x .020" tin) per 1000
50279	T shaped binding clip $(1\frac{1}{8}'' \times \frac{17}{32}'' \times .020'' \text{ tin})\text{per }1000$
	Acme tape used in winding armature 1 [‡] " wideper lb.
	Acme tape used in binding armature ³ " wide

Parts of GE 57-A and H Railway Motors 4525-7

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Cat. No. Description Cord for filling (³/₁₆ diam.), Hemp; cord for dressing, No. 8; cord for filling in between flange and insulation on pinion end, No. 36 cotton; binding wire is .045" tinned steel requiring approximately 390 feet. 50280 COMMUTATOR, Form 1, complete, for 3 turn armature..... 47576 Commutator, complete, for 2 turn armature..... 50281 Shell..... 50282 Cap..... 50283 Nut for cap (Sp '1)..... 50284 Set screw for nut (3"-16, 14" pointed headless)..... 50285 Key..... 50287 Set of copper and mica segments finished and bound (99 segments), for No. 50280... 55783 Set of copper and mica segments finished and bound (111 segments), for No. 47576. 50288 Mica collar under segments..... 50289Inner mica cone..... 50290 Outer mica cone (2⁷/₄ wide)..... 50291 Shaft, bare..... 50292 Pinion key..... 50293 Pinion nut..... 50294 Washer for nut $(2\frac{1}{16} \times 3\frac{3}{4} \times .062^{\prime\prime} \text{ Sp'l})$ 50295 Thrust collar, pinion end 50296 Thrust collar, commutator end 18016 AXLE KEY, (6¹/′ x 1″ x 1″).....

GEARS AND PINIONS FOR GE 57-A MOTOR

18677	Split gear, 57 teeth, 4" bore, 64" hub diameter
18639	Split gear, 57 teeth, 4 ¹ / ₄ " bore, 6 ¹ / ₄ " hub diameter
18678	Split gear, 57 teeth, $4\frac{1}{2}$ " bore, $6\frac{3}{4}$ " hub diameter
18542	†Pinion Grade, "D" 28 teeth, 3" taper bore for use with Nos. 18677, 18639, 18678
	π Pinion, Grade "C" (Identical with above except quality of material employed). Same
	catalogue number
18642	Split gear, 59 teeth, 4" bore, 6 ² / ₄ " hub diameter
18714	Split gear, 59 teeth, 4 ¹ / ₄ bore, 6 ³ / ₄ hub diameter
18724	Split gear, 59 teeth, 4½" bore, 6¾" hub diameter
18543	†Pinion, Grade "D" 26 teeth, 3" taper bore for use with Nos. 18642, 18714, 18724
· · ·	π Pinion, Grade "C" (Identical with above except quality of material employed). Same
	catalogue number
18914	Split gear, 61 teeth, 4" bore, 6 ² / ₄ " hub diameter
30140	Split gear, 61 teeth, 4 ¹ / ₄ " bore, 6 ¹ / ₄ " hub diameter
28002	Split gear, 61 teeth, $4\frac{1}{2}$ " bore, $6\frac{3}{4}$ " hub diameter
18547	[†] Pinion, Grade "D" 24 teeth, 3" taper bore for use with Nos. 18914, 30140, 28002, 18547
	π Pinion, Grade "C" (Identical with above except quality of material employed). Same
	catalogue number
45500	Split gear, 64 teeth, 3 [#] bore, 6 [#] hub diameter
18658	Split gear. 64 teeth, 4" bore, 63" hub diameter
18692	Split gear, 64 teeth, 4 ¹ / ₄ " bore, 6 ¹ / ₄ " hub diameter
18710	Split gear, 64 teeth, 4½" bore, 6¾" hub diameter
18546	†Pinion, Grade "D" 21 teeth, 3" taper bore for use with Nos. 45500, 18658, 18692, 18710
	πPinion, Grade "C" (Identical with above except quality of material employed). Same catalogue number
18770	Split gear, 66 teeth, 3 ³ / ["] bore, 6 ³ /" hub diameter
18687	Split gear, 66 teeth, 4" bore, 6 ³ / ₄ " hub diameter
18757	Split gear, 66 teeth, 4 ¹ / ₄ " bore, 6 ³ / ₄ " hub diameter

†Grade "D" pinion furnished with all original equipments. π Unless otherwise designated, supply orders will be filled with Grade "C."

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Cat. No.	Description
18824	Split gear, 66 teeth, $4\frac{1}{2}$ " bore, $6\frac{3}{4}$ " hub diameter
18556	†Pinion, Grade "D" 19 teeth, 3" taper bore for use with Nos. 18770, 18687, 18757, 18824,
	π Pinion, Grade "C" (Identical with above except quality of material employed). Same
	catalogue number
45601	Split gear, 69 teeth, 3 ³ / ₄ bore, 6 ³ / ₄ hub diameter
30158	Split gear, 69 teeth, 4" bore, 6 ³ / hub diameter
45602	Split gear, 69 teeth, 44" bore, 64" hub diameter
30145	Split gear, 69 teeth, $4\frac{1}{2}$ " bore, $6\frac{3}{4}$ " hub diameter
18541	†Pinion, Grade "D" 16 teeth, 3" taper bore for use with Nos. 18716, 30158, 30145, 18638.
	πPinion, Grade "C" (Identical with above except quality of material employed). Same catalogue number

GEARS AND PINIONS FOR GE 57-H MOTOR

28134	Split gear, 59 teeth, 5" bore, 8" hub diameter	
18542	[†] Pinion, Grade "D" 28 teeth, 3" taper bore for use with No. 28134	
	π Pinion, Grade "C" (Identical with above except quality of material employed). S catalogue number	ame
45545	Split gear, 63 teeth, 5" bore, 8" hub diameter.	• • • •
45546	Split gear, 63 teeth, 5½" bore, 8" hub diameter.	• • • •
18547	†Pinion, Grade "D" 24 teeth, 3" taper bore for use with Nos. 45545, 45546	• • • •
1001/	π Pinion, Grade "C" (Identical with above except quality of material employed). Si	ame
	catalogue number	
18647	Split gear, 65 teeth, 5" bore, 7½" hub diameter	
28141	Split gear, 65 teeth, 5 [‡] " bore, 8" hub diameter	
18544	†Pinion, Grade "D" 22 teeth, 3" taper bore for use with Nos. 18647, 28141	
	π Pinion, Grade "C" (Identical with above except quality of material employed). Sa catalogue number	ame
28505	Split gear, 66 teeth, 5" bore, 7½" hub diameter.	• • •
26643	Split gear, 66 teeth, 51" hore 71" hub diameter	• • •
18546	Split gear, 66 teeth, 5¼" bore, 7¼" hub diameter.	• • •
10040	[†] Pinion, Grade "D" 21 teeth, 3" taper bore for use with Nos. 28505, 26643	•••
	π Pinion, Grade "C" (Identical with above except quality of material employed). Sa catalogue number	ame
28078	Split gear, 69 teeth, 5" bore, 7½" hub diameter	
28100	Split gear, 69 teeth, $5\frac{1}{4}$ " bore, $7\frac{1}{2}$ " hub diameter	•••
28174	Split gear, 69 teeth, $5\frac{1}{2}$ " bore, $7\frac{1}{2}$ " hub diameter	•••
28062	Split gear, 69 teeth, 6" bore, 8" hub diameter	• • •
18946	†Pinion, Grade "D" 18 teeth, 3" taper bore for use with Nos. 28078, 28100, 28174, 280	 า <i>คจ</i>
	π Pinion, Grade "C" (Identical with above except quality, of material employed). Satisfy the second secon	ame
	catalogue number	• • •
28151	Split gear, 71 teeth, 5" bore, 7½" hub diameter	
28196	Split gear, 71 teeth, $5\frac{1}{4}$ " bore, $7\frac{1}{4}$ " hub diameter	
26682	Split gear, 71 teeth, $5\frac{1}{2}$ " bore, 8" hub diameter	
28545	Split gear, 71 teeth, 6" bore, 8" hub diameter	
18541	[†] Pinion, Grade "D" 16 teeth, 3" taper bore for use with Nos. 28151, 28196, 26682, 285	545.
	π Pinion, Grade "C" (Identical with above except quality of material employed). Sa catalogue number	ame
50249	GEAR CASE (DE-1), complete, adapted for use with gear having $6\frac{3}{4}$ hub diame	ter
	Max. gear 69 teeth, Max. pinion 23 teeth (Malleable Iron), for GE-57-A Motor.	,
38614	Gear case (DE-3), complete, adapted for use with gear having 6 ⁴ / ₄ hub diameter, M	 [^v
	gear 61 teeth, Max. pinion 33 teeth (Malleable Iron), for GE-57-A Motor	ldX.
47036	Gear case (DE-18), complete, adapted for use with gear having 7 ¹ / ₂ hub diameter, M	
	gear 65 teeth, Max. pinion 28 teeth (Malleable Iron), for GE-57-H Motor	lax.
	Sour of teeth, max. prinoit 20 teeth (maneable fron), for GE-5/-H Motor	•••
	tGrade "D" pinion furnished with all original avairments	

†Grade "D" pinion furnished with all original equipments. π Unless otherwise designated, supply orders will be filled with Grade "C."

Parts of GE 57-A and H Railway Motors 4525-9

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Cat. No.	Description
38623	Gear case (DE-52), complete, adapted for use with gear having 8" hub diameter, Max. gear 65 teeth, Max. pinion 28 teeth (Malleable Iron), for GE-57-H Motor
39527	Gear case (DE-170), complete, adapted for use with gear having 7½" hub diameter, Max. gear 71 teeth, Max. pinion 21 teeth (Malleable Iron), for GE-57-H Motor
38631	Gear case (DE-176), complete, adapted for use with gear having 8" hub diameter, Max. gear 71 teeth, Max. pinion 21 teeth (Malleable Iron), for GE-57-H Motor
50254	Lid for oil hole, with spring and hinge pin complete
17463	Spring for lid (20 turns, 104" steel wire)
50255	Hinge pin for lid $(\frac{1}{4}" \times 6")$
50203	Bolt for gear case (1"-8, 43" Sq. H. Sp'1)
15443	Nut for bolt (1"-8, 1" thick, Hex. Rough)
16130	Lock washer for No. 15443

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TO ACCOMPANY BULLETIN NO. 4525

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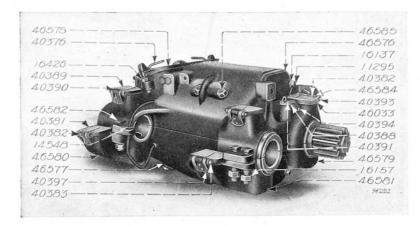
General Electric Company Schenectady, N.Y.

SUPPLY DEPARTMENT

August, 1907

Bulletin No. 4526

PARTS OF GE 81-A RAILWAY MOTOR



GE 81-A RAILWAY MOTOR

Weights

Motor complete, without axle gear and case	1665	lbs.
Armature and pinion (14 teeth)	410	
Axle gear (67 teeth)		
Gear Case	156	**

Cat. No.

Description

46574	FRAME complete, includes upper and lower field castings, lids, pole pieces, bearing caps and linings and all bolts, pins, etc., fastening parts together
46575	Lid with felt packing for upper casting, commutator end
40376	Cam with eye bolt fastening lid in position
16426	Nut for cam eye bolt $(\frac{3}{4}''-10, \frac{1}{2}''$ thick, Hex. Rough)
16136	Lock washer for No. 16426
14547	Spring cotter for lid $(\frac{1}{4}'' \ge 2\frac{1}{2}'')$
46576	Lid with rope packing for upper and lower castings, pinion end
46577	Lid with rope packing for lower casting, commutator end
11295	Cap screw fastening Nos. 46576, 46577 in position $(\frac{5''-11}{8}, 1\frac{5''}{8}$ Hex. H.)
16137	Lock washer for No. 11295
14548	Soft rubber bushing for use with cables
46578	*ARMATURE BEARING CAP, commutator end
46579	*Armature bearing cap, pinion end
46580	*Axle bearing cap, commutator end
46581	*Axle bearing cap, pinion end
18013	Dowel pin for axle bearing caps $(\frac{5}{8}'' \times \frac{7}{8}'')$

* Must be fitted.

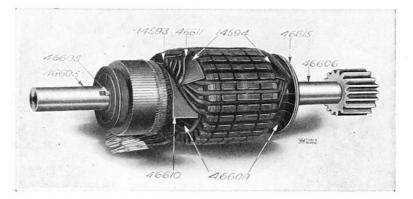
4526-2 Parts of GE 81-A Railway Motor

Cat. No.

GE 81-A RAILWAY MOTOR

Description

40381	Lid for axle bearing cap oil well
40382	Spring for lid (9 turns, .102" steel wire)
40383	Hinge pin for lid (3/ x 3 18 R.H.)
4030	Spring Cotter for No. 40383 (³ / ₃₂ " x ⁵ / ₈ ")
40397	Hinge bracket, with rivets for No. 40381
46582	Bolt fastening upper and lower field castings together and bearing caps in position $(\frac{7}{8}''-9, 4\frac{1}{2}''$ Sq. H. Sp'l)
46583	Hinge bolt (7/8-9, 4 5/16, Sp'l)
16157	Nut for Nos. 46582, 46583 ([*] / ₈ "-9, Hex. Rough St'd)
16135	Lock washer for No. 16157
14551	Hinge pin for frame $(\frac{7}{8}'' \ge 4\frac{3}{8}''$ Sp'l)
16323	Spring Cotter for Nos. 46582, 46583 (³ / ₁₆ " x 1 ¹ / ₂ ")
40389	Lid for axle bearing oil well
46033	Lid for armature bearing oil well
40388	Lid for stand pipe for armature bearing oil well



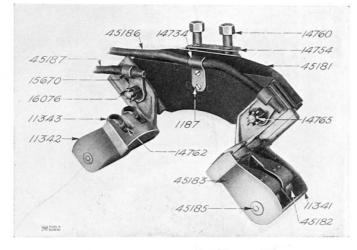
40390	Spring for No. 40389 (17 turns, .102" steel wire)
	Spring for No. 40509 (17 turns, 102 steel wire)
40382	Spring for No. 46033 (9 turns, .102" steel wire)
40391	Spring for No. 40388 (8 turns, .091" steel wire)
40383	Hinge pin for No. 40389 $(\frac{3}{8}'' \ge 3\frac{13}{16}''' R.H.)$.
40393	Hinge pin for No. 46033 $(\frac{3}{8}'' \ge 4\frac{15}{16}'' R.H.)$
40394	Hinge pin for No. 40388 $(\frac{3}{8}'' \times 3\frac{5}{16}'' \text{ R.H.})$
4030	Spring cotter for Nos. 40383, 40393, 40394 (3, "x 5")
40397	Hinge bracket, with rivets, for No. 40389
46584	Hinge bracket, with rivets, for No. 46033
33984	Socket pipe plug for lower casting (1" pipe)
16334	Pipe plug for upper casting $(\frac{3}{8}'' \text{ pipe})$
46585	Bolt fastening pole pieces to frame $(\frac{7}{2}''-9, 3\frac{3}{2}''$ Sq. H.)
46586	Suspension bolt $(\frac{7}{8}''-9, 3\frac{3}{4}''$ Sq. H.)
16157	Nut for Nos. 46585, 46586 (⁷ / ₈ "-9, Hex. Rough St'd)
16135	Lock washer for No. 16157
16064	Spring cotter for No. 46586 $(\frac{3}{16}'' \ge 1\frac{1}{4}'')$
46587	AXLE BEARING LINING, malleable iron and babbitt. (2 halves, $3\frac{3}{4}$ " bore)
41059	Axle bearing lining, malleable iron and babbitt (2 halves, 4" bore)
46588	Axle bearing lining, Brass (2 halves, 4 ¹ / ₂ " bore)
41066	Armature bearing lining, commutator end, brass and babbitt
41067	Armature bearing lining, pinion end, brass and babbitt
46589	Plug for No. 41066

Parts of GE 81-A Railway Motor 4526-3

GE 81-A RAILWAY MOTOR

Description

45180	BRUSH-HOLDER YOKE, complete, with holders and cables
45181	Brush-holder yoke, with end plates, brackets, and cap screws
13852	Screw fastening end plate to yoke (No. 10, ² / ₈ " F.H.)
11339	Right-hand brush-holder, complete
11340	Left-hand brush-holder, complete
11341	Right-hand body, with pins
11342	Left-hand body, with pins
11343	Pressure arm, with contact spring and tips
14762	Contact spring, with tip and rivets
45182	Tension spring (10 turns, .091" steel music wire)
45183	Pin for tension spring $(\frac{3}{16}'' \times 3\frac{3}{8}'')$ Pin H.)
45184	Insulation sleeve for No. 45183 ($\frac{3}{16}$ " x $\frac{5}{16}$ " x 1" long)



45163	Washer for No. 45184 $(\frac{21}{64}" \ge \frac{5}{8}" \ge \frac{1}{16}"$ thick, fiber)
45185	Hinge pin for pressure arm $(\frac{1}{4}'' \ge 3\frac{7}{16}''$ Pin H.)
10110	Spring Cotter for No. 45185 $(\frac{5}{64}" \ge \frac{1}{2}")$
14765	Crown nut for bolt fastening brush-holder body to yoke $(\frac{1}{2}''-13, \text{Hex. Sp'l})$
16076	Spring cotter for No. 14765 $(\frac{1}{3}'' \times 1'')$
14760	Cap screw fastening yoke to frame $(\frac{5}{8}"-11, 1\frac{7}{8}"$ Hex. H.)
14754	Washer plate for No. 14760
45186	Right-hand cable, with tip (54" long, 49 No. 23 B. & S. wire)
45187	Left-hand cable, with tip (44" long, 49 No. 23 B. & S. wire)
15670	Tip for cables
14734	Clip for right-hand cable
1187	Screw for clip (No. 10, 7/ R.H.)
11347	CARBON BRUSH (24" long, 3" wide, 3" thick.) 1 required for each holder, 2 for each motor
11348	FIELD COIL, complete, for 3 turn armature
11349	Outside terminal for coil, with screws
11350	Inside terminal for coil, complete, with connection strip and screws
10251	Screw for terminal (10–32, $\frac{7}{16}$ " R.H.).
15764	Flange, for field coil
15768	Oiled canvas pad for field coil
17972	Inside connection cable for field coils (5 ¹ / ₂ " long, 49 No. 23 B. & S. wire)
46590	Long cable for field coils (48" long, 49 No. 23 B. & S. wire)
46591	Cable for upper field coil, axle side (28" long, 49 No. 23 B. & S. wire)

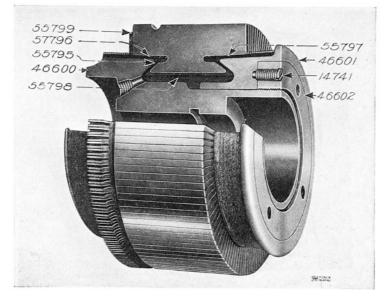
Cat. No.

4526-4 Parts of GE 81-A Railway Motor

GE 81-A RAILWAY MOTOR

Description

46592	Cable for lower field coil, axle side, with connector (20" long, 49 No. 23 B. & S. wire)
17970	Two-way connector for No. 46592 with screws
6081	Screw for No. 17970 (10-24, 3" R.H. Blued)
46593	Ground Cable, with terminal (36" long, 49 No. 23 B. & S. wire)
11295	Cap screw fastening ground cable terminal to frame (§"-11, 1§" Hex. H.)
16137	Lock washer for No. 11295
15946	AXLE KEY $(\frac{3}{4}'' \ge 7\frac{13}{16}'' \ge 7\frac{13}{8}'' > 1)$
43913	*ADJUSTABLE AXLE COLLAR, 2 halves (3 ³ / ₄ axle)
43931	*Adjustable axle collar, 2 halves (4" axle)
43946	*Adjustable axle collar, 2 halves $(4\frac{1}{4}$ axle)
43955	*Adjustable axle collar, 2 halves $(4\frac{1}{2}'' \text{ axle})$
	NOTE: The above axle collars are for use on standard gauge, 48" between wheel hubs
17984	Screw for adjusting axle collars from $4\frac{7}{8}''$ to $7\frac{3}{8}''$ (1"-8, 4" Sp'l)
17981	Bolt for collar $(\frac{3}{4}''-10, 3\frac{1}{2}''$ Sq. H.)



16326	Nut for bolt $(\frac{3}{4}''-10, \text{Hex.})$
16136	Lock washer for No. 16326
17985	Spring cotter for adjusting screw $(\frac{36}{16}'' \times 2\frac{1}{4}'')$
30063	SPLIT GEAR, 67 teeth, $3\frac{3}{4}$ " bore
30064	Split gear, 67 teeth, 4" bore
45511	Split gear, 67 teeth, 4 ⁴ / ₄ " bore
45537	Split gear, 67 teeth, 4 ¹ / ₂ " bore
19351	[†] Pinion, grade "D," 14 teeth, 2 ⁵ / ₁₆ " taper bore, for use with Nos. 30063, 30064, 45511, 45537.
	§Pinion, grade "C" (Identical with above, except quality of material employed) same catalogue number
42972	GEAR CASE (D. L. 37939) complete, adapted for use with gear having 6" hub diame- ter, Max. gear 67 teeth, Max. pinion 21 teeth (Malleable Iron)
	* Includes adjusting screws.

- † Grade "D" pinion furnished with all original equipments.
- § Unless otherwise designated, supply orders will be fitted with grade "C."

Cat. No.

*PRICE SUPPLEMENT

TO ACCOMPANY BULLETIN NO. 4526 PARTS OF GE 81-A RAILWAY MOTOR

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Dec. , 1907

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14734-3 14741-6 14754-3	· · · · · · · ·	.04 .08 .03	41067-2 42972-4 43103-5	· · · · · · ·	14.55 29.00 33.65		· · · · · · ·	4.15 4.25 16.00
14760-3 14762-3 14765-3	· · · · · · · ·	.10 .20 .06	43913-4 43931-4 43946-4	· · · · · · · ·	3.90 4.20 4.50		· · · · · · · ·	.15 .10 .15
15377-6 15498-6 15553-6		per 1000 5.00 per 1000 7.50 .50	43955-4 44501-6 45163-3		4.85 3.50 1.00	46607-6 46608-6 46609 -6	· · · · · · ·	2.75 4.00 1.20
15670-3 15764-3 15768-3	• · • · · •	.25 .60 .40	45180-3 45181-3 45182-3	· · · · · · ·	18.50 4.25 .10	46610-6 46611-6 46612-6	· · · · · · ·	.25 -45 .06
15946 -4 16064-2, 1 6076- 3	5	.50 .04 per 1000 2.00	45183-3 45184-3 45185-3	per 100		4661 36 4661 46 4661 56	· · · · · · · ·	.75 .25 .25
16135-2, 16136-1, 16137-1	4	per 100 5.00 .05 per 100 4.00	45186-3 45187-3 45511-4	· · · · · · · ·	1.25 1.10 38.45	55795 -6 55796-6	not in Bul	1.30 1.50
16157-2, 16323-2	, 5 	.10 per 1000 3.00	45537-4 46033-2		36.65 .65	55797-6 55798-6 55799-6	· · · · · · ·	1.25 .75 1.25

*These prices and data are published for the convenience of customers, and every effort is made to avoid error, but this Company does not guarantee their correctness, nor does it hold itself responsible for any errors or omissions in this publication. Both prices and data are subject to change without notice.

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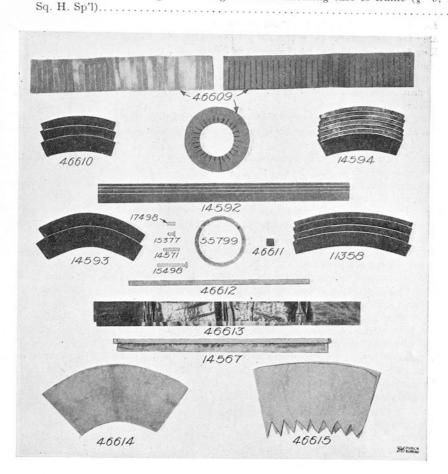
ADDENDA

To Accompany Bulletin No. 4526 Parts of GE 81-A Railway Motor Page 5 Armature Heads

Cat. No.	Location	ARMATUR No. of Turns	e Cat. No.	List Price
59177 59178	Pinion End Com. End	3 3	46598 46598	\$9.50 7.50

Parts of GE 81-A Railway Motor 4526-5

GE 81-A RAILWAY MOTOR



16157	Nut for No. 46582 $(\frac{7}{8}$ –9, Hex. St'd)
16135	Lock washer for No. 16157
16064	Spring cotter for No. 46582 $(\frac{3}{16}'' \times 1\frac{1}{4}'')$
46598	*ARMATURE, 3 turn, complete, with thrust collars and pinion (No. 10 B. & S. E.
	D. C. C. wire)
11352	ΔArmature Coil, 3 turn, No. 10 B. & S. (.118" E. D. C. C. wire) per set of 29
46599	COMMUTATOR, complete
43103	Set of copper and mica segments, finished and bound (115 segments)
46600	Shell
46601	Cap
46602	Nut
	*Number of teeth in pinion must be specified.

 Δ 29 coils in complete set for one armature, Cat. No. is for one coil.

4526-6 Parts of GE 81-A Railway Motor

GE 81-A RAILWAY MOTOR

Cat. No.

Description

14741	Set screw for Nut (📲–16, 1 🔒 Pointed Headless)
44501	Pipe plug for shell (# pipe)
55796	Wide outer mica cone
55797	Narrow outer mica cone
55795	Inner mica cone
55798	Mica collar under segments
46603	SHAFT, bare
46604	Key for shaft $(\frac{1}{2}'' \times \frac{1}{2}'' \times 11 \frac{9}{16}''$ square ends)
46605	Key for commutator $(\frac{2}{3}'' \times \frac{1}{2}'' \times 6\frac{1}{3}''$ square ends)
46606	Key for pinion $(\frac{1}{2}'' \times \frac{1}{2}'' \times 3\frac{3}{4}''$ round end)
15553	Pinion nut (11/2"-8, Hex. Sp'1)
13738	Lock washer for nut
46607	Thrust collar, commutator end
46608	Thrust collar, pinion end
55799	Mica ring back of commutator segments (7§" outside diam., 6§" inside diam., .062")
46609	Set of armature core insulations includes 8 pieces of .010" red paper and 6 pieces of .008" oiled cotton
14592	Set of oiled asbestos strips over ends of armature heads and commutator segments (4
	strips, 30" x 2" x .025")
46610	Set of japanned canvas and oiled cotton insulations over short leads, under coils (3
	in set, 11" long, 2¼" wide)
14594	Set of japanned canvas, japanned muslin and oiled cotton insulations, between inner and outer turns of coils, commutator and pinion ends (6 in set, 3 at each end, 12" long, 2 ³ / ₄ " wide)
14593	Set of japanned canvas and oiled cotton insulations over coils, under long leads (2 in set, 16" long, 3¼" wide)
46611	Set of japanned canvas insulations between leads and coils (58 in set, 1" x 1")
11358	Set of japanned canvas binding insulations, over coils, commutator and pinion ends (4 in set, 17" long, 17" wide)
46612	Horn fiber center band under binding wire $(\frac{3}{4}" \times 36" \times .010")$
46613	Set of varnished cambric dressings, commutator and pinion ends (6 in set, 36" long,
	2 pieces 3 ¹ / ₂ " wide and 4 pieces 3" wide)
14567	Insulation band back of commutator (cotton drill, oiled cotton, red paper, mica and asbestos, 30" long, 2" wide)
46614	Outside dressing, commutator end
46615	Outside dressing, pinion end, slotted edge
14571	Binding clip (2 ¹ / ₂ " x ¹ / ₂ " x .010" tin)
17498	Binding clip (1 3 x 3 x .010" tin)
15377	T shaped binding clip $(1'' \times \frac{15''}{2} \times .020'' \text{ tin bent})$
15498	T shaped binding clip $(4\frac{1}{2}" \times \frac{15}{22}" \times .020" \text{ tin})$
	Acme tape used in connecting and binding armature (1" wide) cord for filling ($\frac{3}{15}$ " diam., hemp) cord for dressing No. 8; binding wire is .045" tinned steel, requiring
	approximately 230 feet.

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Parts of GE 81-A Railway Motor 4526-7

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For all CANADIAN Business, Canadian General Electric Company, Ltd.,

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SUPPLY DEPARTMENT

August, 1907

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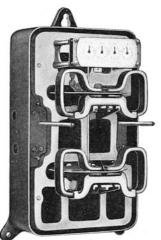
THOMSON POLYPHASE INDUCTION WATTMETERS

Thomson Polyphase Induction Wattmeters are made for the specific purpose of measuring energy in any two-phase, threephase or monocyclic circuit. They may be applied to a circuit carrying a mixed load of lamps, motors or other translating devices and record accurately irrespective of unbalanced load conditions.

Three types of polyphase meters are now being manufactured, viz:



Accuracy under all conditions of service experienced in practice, and high torque insuring continued accuracy, are two of the prominent characteristics of these polyphase meters. The statement may be made without fear of contradiction that in these essentials, the Thomson Polyphase Induction meters herein described, are superior to any other polyphase meter in commercial service.



THOMSON POLYPHASE INDUCTION WATTMETER-TYPE D-3

Type D-3-for house service.

Type DS-2—with metal cover for switchboard use.

Type DS-3—with glass cover for switchboard use.

The electrical features of these three types are identical, but there are some differences of external appearance and mechanical details, as each type has been designed with special reference to the service required of it.

*Supersedes Bulletin No. 4366.

TYPE D-3 WATTMETER GENERAL DESCRIPTION

The external appearance of this meter as shown by the illustration is similar to the Type C-6 direct current meter. The meter is supported by three lugs, the upper one being key-holed and the lower righthand one slotted. This permits of quick installing and levelling.

The cover is fastened by two studs and wing nuts and is directly removable toward

4527-2 Thomson Polyphase Induction Wattmeters

the front. The wing nuts and studs are arranged so that a single sealing wire may be passed through them—a method of sealing that prevents tampering without detection. A groove entirely encircling the edge of the cover is lined with cotton felt, the leading in holes for the wires are also covered with the same material, which fits closely around the wires after insertion. The binding posts have blind holes. These details of construction illustrate the great care taken in design to make the meter thoroughly dust and insect proof.

The meter proper comprises two singlephase meter elements, each acting upon its own disc, both discs being mounted upon a single shaft which actuates the register through a worm gear. It will be noted that this construction is based on the well known method of metering a polyphase circuit by two single-phase meters; the sum of the readings being the total power in the circuit. In the polyphase meter, the addition is accomplished automatically.

REGISTER

The register is direct-reading in kilowatt hours. One complete revolution of the most rapidly moving pointer reads 10 Kw. hours. No constants are used except 10 or multiples thereof and then only in connection with 60 cycle meters above 15 Kw. capacity, 40 cycle meters above 10 Kw. capacity and 25 cycle meters above 5 Kw. capacity. The dial face is made of porcelain with a dull finish. The figures are large and black which with the white background give an extremely legible dial. The mechanical design of the register will permit its removal and replacement without altering in the slightest degree the meshing of the worm on the shaft with the worm wheel.

MAGNETS

There are two sets of magnets arranged astatically in pairs and each pair is held by a single shoe. The permanency of magnet strength is beyond question as it is insured by the rigid process of selection of the steel and the construction, magnetization and ageing of the magnets themselves based upon an experience extending over a period of 20 years.

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BEARINGS

The importance of the meter jewel cannot be overestimated. Almost any material if well polished may be made into a bearing for a meter which in its initial condition will give low friction and prove satisfactory, but this condition of low initial friction must be maintained for a long period and in order to secure this requirement, the jewel and pivot must be of the hardest possible material. All jewels used in polyphase induction meters are cut from selected Eastern sapphire. The General Electric Company manufactures its own jewels and employs an expert lapidary and skilled workmen for cutting and polishing the stones.

The jewels are set in a brass plug which in turn rests on a spring, the strength of which is carefully tested and gauged by high and low limit weights.

The pivots or shaft ends are designed so that they may be easily removed from the meter shaft for inspection or replacement. They are made from the highest grade of piano wire and are drawn down under such enormous pressure that the finest grain is obtained. They are then glass hardened and highly polished.

SHIPPING DEVICE

For protection during transportation, a shipping device is provided with all polyphase meters. It consists of a cap normally drawn down and held by the jewel screw against the force of a lifting spring. When this cap is drawn down, the moving element rests on the jewel and is free to rotate. By backing out the jewel screw, the cap is released and is forced by the spring against the moving element, raising the latter from the jewel and holding it firmly.

CHANGE NOTICE To accompany Bulletin No. 4527 Thomson Polyphase Induction Wattmeters

1

Page 4: The paragraph pertaining to registers should read as follows:

The register is of the four-dial type, reading directly in kilowatt hours on meters of low capacity. On larger meters, a dial face multiplier of 10, 100, 1000, etc., is required. By using this system, the actual energy units remain the same in all sizes, the reading being obtained by the addition of one or more ciphers to the indication of the first pointer. To permit greater accuracy where frequent readings are taken, the register on switchboard meters is constructed to record ten times faster than the corresponding capacity Type I meter. One revolution of the most rapidly moving pointer equals 10 kilowatt hours in meters without constants, except in the case of some low-capacity meters where the usual switchboard meter register would have a dial face multiplier of 1/10. To overcome the use of a fractional multiplier in such cases, a dial face is used having 1 over the right-hand dial, 10 over the second dial, etc. In other words, such dials read 1 kilowatt hour for one revolution of the most rapidly reading pointer. To distinguish these dials, the right-hand circle is black, pointer and figures being white. This distinguishing feature will prevent errors due to any oversight in noting the different units in which the dials read.

Page 14: Note change in dimensions, as follows:

Overall length of meter case should be 13 7/16 in.; the distance between upper potential posts to upper edge of meter case 4 5/64 in.; distance from lower potential posts to lower edge of meter case 4 5/64 in.

Page 15: Note change in dimensions, as follows:

Overall length of meter case should be 149/16 in.; distance from upper potential posts to upper edge of meter case 4 39/64 in.; distance from lower potential posts to lower edge of meter case 4 39/64 in.

Thomson Polyphase Induction Wattmeters 4527-3

MAGNETIC CIRCUIT

The magnetic circuit is so designed and arranged that it is practically closed upon itself and any projected magnetic fields tending to demagnetize the damping magnets are eliminated. The magnets are further safeguarded by their position which is some distance from the coils and the plane in which they lie is at right angles to the projected field.

TORQUE

Long life with accuracy is obtained in a motor meter by providing a high torque or turning moment. In all rotating meters, there are two kinds of work performed; one is overcoming the drag of the disc in passing between the poles of the magnets, which is the innate law of the perfect meter, the other is overcoming friction, which is a variable, and which does not conform to the law of the perfect meter. In order that this variable factor shall not interfere with the accuracy of the meter, it is essential that it shall be as small as possible and also that the ratio of the work in overcoming the drag of the disc to the work in overcoming friction shall be very large. Practically, this is accomplished by providing a high torque, permitting a heavy drag or load in turning the disc through the field of the permanent magnets, and rendering friction variations of negligible effect.

The torque of these polyphase meters at full load is greater and the weight of the moving element less than that of the earlier types. This extremely high torque has not been secured at the expense of increased energy consumption (for the total watt loss in the meter coils is less than the earlier forms), but is due purely to economical and scientific arrangement of the meter parts.

LIGHT LOAD ADJUSTMENT

Accuracy on light loads is of the utmost importance and means to obtain such accuracy under all conditions of service should be provided in all meters. For this purpose, all Thomson High Torque Induction meters are furnished with a light load device or starting plate. This starting plate is a small rectangular conductor encircling the potential pole and can be moved from a central position in either direction by means of an adjusting lever. At either side of the lever, the letters "F" and "S" are cast in the front of the frame and indicate which way to move the lever for "fast" or "slow."

CREEPING

Creeping on potential alone is prevented in General Electric induction meters in a simple yet effective manner. In each disc, there are two diametrically opposite holes in such a position that as the disc rotates, the holes will pass under the center of the poténtial pole. These holes increase the resistance to the flow of the eddy currents, so that if there is any tendency for the disc to creep, it will not make more than half a revolution but will come to rest when one of the holes is near the potential pole. When current is flowing in the series coils of the meter, rotation of the disc is in no way prevented, nor the accuracy of the meter impaired.

ACCURACY

The most exhaustive tests will prove that the accuracy of these polyphase meters under both favorable and adverse conditions is superior to that of others designed for similar service. Variation of power factor, voltage, frequency or wave form which may be experienced in central station practice produce inappreciable errors.

CAPACITIES

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The Type D-3 meter is made for use on any two-phase, three-phase or monocyclic circuit of frequencies from 25 to 133 cycles. They are made self-contained up to and including 650 volts and 150 amperes, excepting for 4-wire, 3-phase circuits where the current capacity is limited to 75 amperes Above these limits, current and potential

4527-4 Thomson Polyphase Induction Wattmeters

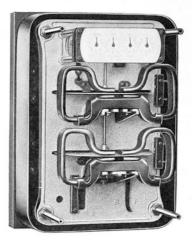
transformers *must* be used. For 4-wire, 3-phase circuits above 75 amperes, three current transformers are necessary. The frequency of the circuit must always be given in ordering.

FINISH AND CONNECTIONS

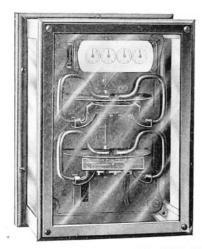
The external finish of the Type D-3 meter is black japan, and the internal metal parts are dipped and lacquered. The meter is made for side connections.

METERS FOR SWITCHBOARD SERVICE, TYPES DS-2 AND DS-3





THOMSON POLYPHASE WATTMETERS FOR SWITCHEOARD SERVICE-TYPE DS-2



SWITCHEOARD WATTMETER-TYPE DS-3

These polyphase meters are designed for switchboard use and are provided with studs for making connections back of the panel.

The registers are direct reading in kilowatt hours. One complete revolution of the most rapidly moving pointer equals 1 Kw. hour.

The internal parts and their arrangement are identically the same as those in the D-3 meter and hence insure equal accuracy and satisfaction.

The types DS-2 and DS-3 meters are ordinarily furnished for primary service and are listed with current and potential transformers. They can be furnished, however, for secondary circuits in the same capacities as the D-3 meters.

The DS-2 meter is contained in a cast metal case finished in dull black. The front of the cover has a pebbled surface with raised portions of polished copper.

The DS-3 meter is contained in a rectangular case of plate glass. The metal parts of the case and interior of meter are finished in dull black.

Thomson Polyphase Induction Wattmeters 4527 -5

THOMSON POLYPHASE INDUCTION METERS-TYPE D-3

FOR SECONDARY THREE-PHASE, TWO-PHASE AND MONOCYCLIC CIRCUITS. 25-133 CYCLES Rectangular Pattern, Side Connected, Black Japan Finish

	CAT. NO.				NON-INDUCTIVE	H.P. CAPACITY MOTORS
3-Wire 3-Phase, 3-Wire 2-Phase and Monocyclic	4-Wire 2-Phase	4-Wire 3-Phase	Amps.	2 and 3-Phase	Monocyclic	2 and 3-Phase and Monocyclic
41314 41315 41316 41317 41318	$\begin{array}{r} 41341 \\ 41342 \\ 41343 \\ 41344 \\ 41345 \end{array}$	41368 41369 41370 41371 41372	3 5 10 15 25	1 2 3 5	1 1 3	1 2 3 5
41319 41320 41321 41322	41346 41347 41348 41349	41373 41374 *	50 75 100 150	10 15 20 30	5 8 10 15	10 15 20 30
'	· · ·	······	200-240 VOLT	ÌS	·	1
41323 41324 41325 41326 41327	$\begin{array}{r} 41350\\ 41351\\ 41352\\ 41353\\ 41353\\ 41354\end{array}$	41375 41376 41377 41378 41379	$ \begin{array}{r} 3 \\ 5 \\ 10 \\ 15 \\ 25 \end{array} $	1 2 4 6 10	1 2 3 5	1 2 4 6 10
41328 41329 41330 41331	41355 41356 41357 41358	41380 41381 * *	50 75 100 150	20 30 40 60	10 15 20 30	20 30 40 60
			400-480 VOL'I	rs		·
44961 44962 44963 44964 44965 44966 44966 44967	44970 44971 44972 44973 44974 44975 44975	44979 44980 44981 44982 44983 44983 44984 44985	3 5 10 15 25 50 75	2 4 8 12 20 40 60	1 2 4 6 10 20 30	2 4 8 12 20 40 60
44968 44969	44977 44978	*	100 150	80 120	40 60	80 120
		·	500-600 VOLT	rs	. <u>.</u>	•
41332 41333 41334 41335 41336	41359 41360 41361 41362 41363	41382 41383 41384 41385 41386	3 5 10 15 25	3 5 10 15 25	$1\frac{1}{2}$ 3 5 8 12	$3 \\ 5 \\ 10 \\ 15 \\ 25$
41337 41338 41339 41340	41364 41365 41366 41367	41387 41388 * *	50 75 100 150	50 75 100 150	25 40, 50 75	50 75 100 150

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100-120 VOLTS

NOTE-Always state normal voltage and frequency of circuit.

*Not made self-contained in capacities above 75 amperes.

4527-6 Thomson Polyphase Induction Wattmeters

THOMSON POLYPHASE INDUCTION WATTMETERS-TYPE D-3

FOR PRIMARY THREE-WIRE THREE-PHASE, THREE AND FOUR-WIRE TWO-PHASE AND MONOCYCLIC CIRCUITS

Rectangular Pattern, Side Connected, Metal Cover, Japan Finish

	RW. CAPACITY NON	-INDUCTIVE LOAD	H.P. CAPACITY MOTORS	25-40 CYCLBS	60-133 CYCLES
Amps.	2 and 3-Phase	Monocyclic	2 and 3-Phase Mono- cyclic	Cat. No.	Cat. No.
5	10	5	10	42800	42810
10	20	· 10	20	42801	42811
1 5	30	$\tilde{15}$	30	42802	42812
$\tilde{20}$	40	$\tilde{20}$	40	42803	42813
30	60	30	60	42804	· 42814
40	80	40	80	42805	42815
60	120	60	120	42806	42816
80	160	80	160	42807	42817
100	200	100	200	42808	42818
150	300	150	300	42809	42819
	·	2000	-2300 VOLTS		•
5	20	10	20	42820	42830
10	40	20	40	42821	42831
15	60	30	60	42822	42832
20	80	40	80	42823	42833
30	120	60	120	42824	42834
40	160	80	160	42825	42835
60	240	120	240	42826	42836
80	320	160	320	42827	42837
100.	400	200	400	42828	42838
150	600	300	600	42829	42839

1000-1150 VOLTS

THOMSON POLYPHASE INDUCTION WATTMETERS-TYPE DS-2

FOR PRIMARY THREE-WIRE THREE-PHASE, THREE AND FOUR-WIRE TWO-PHASE AND MONOCYCLIC CIRCUITS

Rectangular Pattern, Back Connected, Cast Metal Cover, Dull Black Finish

A.m.o.c	KW. CAPACITY NON	NINDUCTIVE LOAD	H.P. CAPACITY MOTORS	25-40 CYCLES	60-133 cycles
Amps.	2 and 3-Phase	Monocyclic	2 and 3-Phase Mono- cyclic	Cat. No.	Cat. No.
5 10 15 20 30	10 20 30 40 60	5 10 15 20 30	10 20 30 40 60	41389 41390 41391 41392 41393	41409 41410 41411 41412 41413
40 60 80 100 150	80 120 : 160 200 300	40 60 80 100 150	80 120 160 × 200 300	41394 41395 41396 41397 41398	41414 41415 41416 41417 41417 41418

NOTE—In ordering, specify nature and frequency of circuit. Catalogue Numbers include two current and two potential transformers.

Thomson Polyphase Induction Wattmeters 4527-7

THOMSON POLYPHASE INDUCTION WATTMETERS-TYPE DS-2 (Continued)

FOR PRIMARY THREE-WIRE THREE-PHASE, THREE AND FOUR-WIRE TWO-PHASE AND MONOCYCLIC CIRCUITS

Rectangular Pattern, Back Connected, Cast Metal Cover, Dull Black Finish

	KW. CAPACITY NON	INDUCTIVE LOAD	H.P. CAPACITY MOTORS	25-40 CYCLES	60-133 CYCLES
Amps.	2 and 3-Phase	Monocyclic	2 and 3-Phase Mono- cyclic	Cat. No.	Cat. No.
5	20	10	20	41399	41419
10	40	20	40	41400	41420
15	60	30	60	41401	41421
20	80	40	80 .	41402	41422
30	120	60	120	41403	41423
40	160	80	160	41404	41424
6 0	240	120	240	41405	41425
80	320	160	320	41406	41426
100	400	200	400	41407	41427
150	600	300	600	41408	41428

2000-2300 VOLTS

THOMSON POLYPHASE INDUCTION WATTMETERS-TYPE DS-3

FOR PRIMARY THREE-WIRE THREE-PHASE, THREE AND FOUR-WIRE TWO-PHASE AND MONOCYCLIC CIRCUITS

Rectangular Pattern, Back Connected, Glass Cover, Dull Black Finish

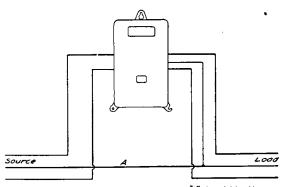
	KW. CAPACITY NO	N-INDUCTIVE LOAD	H.P. CAPACITY MOTORS	25-40 CYCLES	60-133 CYCLES
Amps.	2 and 3-Phase	Monocyclic	2 and 3-Phase Mono- cyclic	Cat. No.	Cat. No.
5 10 15 20 30	10	5 10 	10 20 30 40 60	41528 41529 41530 41531 - 41532-	$\begin{array}{r} 41548\\ 41549\\ 41550\\ 41551\\ 41552\end{array}$
40 60 80 100 150	80 120 160 200 300	40 60 80 100 150	80 120 160 200 300	41533 41534 41535 41536 41537	41553 41554 41555 41556 41557
	I	2000-	2300 VOLTS		
5 10 15 20 30 11 40 60	240	40 60 80 120	$ \begin{array}{r} 20 \\ 40 \\ 60 \\ 80 \\ 120 \\ 160 \\ 240 \\ 320 \\ \end{array} $	41538 41539 41540 41541 41542 41543 41544 41544	$\begin{array}{c} 41558 \\ 41559 \\ 41560 \\ 41561 \\ 41561 \\ 41562 \\ - \\ 41563 \\ 41564 \\ 41565 \end{array}$
80 100 150	320 400 600	160 200 300	320 400 600	41545 41546 41547	41565 41566 41567

1000-1150 VOLTS

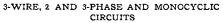
NOTE-In ordering, specify nature and frequency of circuit.

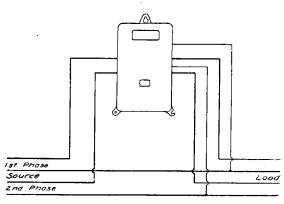
Catalogue Numbers include two current and two potential transformers.

CONNECTIONS THOMSON POLYPHASE WATTMETERS—TYPE D-3 25 CYCLES AND OVER

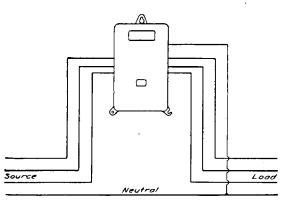


Note- On 3 wire 2 phase circuits, wire A"should be the common return, on monocyclic circuits wire "A" must be the teoser wire

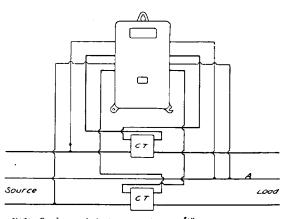




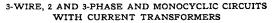
4-WIRE 2-PHASE CIRCUITS



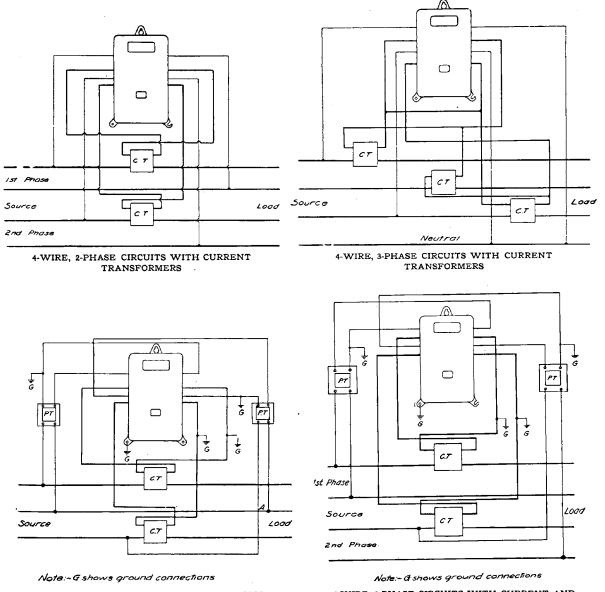
4-WIRE 3-PHASE CIRCUITS



Note- On 3 wire 2 phase circuits, wire A"should be the common return, on monocyclic circuits wire "A" must be the teaser wire



CONNECTIONS THOMSON POLYPHASE WATTMETERS—TYPE D-3 25 CYCLES AND OVER

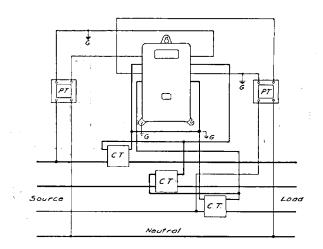


3-WIRE, 2 AND 3-PHASE AND MONOCYCLIC CIRCUITS WITH CURRENT AND POTEN-TIAL TRANSFORMERS

.

4-WIRE, 2-PHASE CIRCUITS WITH CURRENT AND POTENTIAL TRANSFORMERS

4527-10 Thomson Polyphase Induction Wattmeters



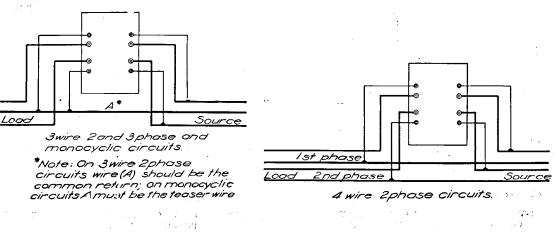
CONNECTIONS THOMSON POLYPHASE WATTMETERS—TYPE D-3 25 CYCLES AND OVER

Note - G shows ground connections

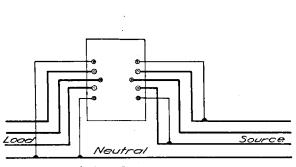
4-WIRE, 3-PHASE CIRCUITS WITH CURRENT AND POTENTIAL TRANSFORMERS

.

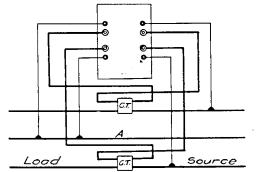
CONNECTIONS THOMSON POLYPHASE SWITCHBOARD WATTMETERS— TYPES DS-2 AND DS-3



CONNECTIONS THOMSON POLYPHASE SWITCHBOARD WATTMETERS— TYPES DS-2 AND DS-3

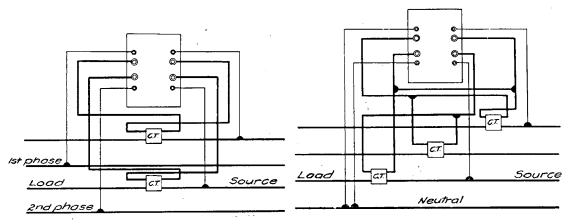


Awire 3phase circuits.



3wire 2 & 3 phase and monocyclic circuits

*NOTE: —On 3 wire 2 phase circuits (A) should be the common return on monocyclic circuits (A) must be the teaser wire,

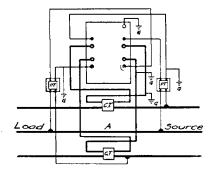


Awire 2 phose circuits

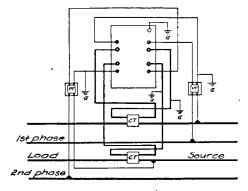
4wire 3 phase circuits

4527-12 Thomson Polyphase Induction Wattmeters

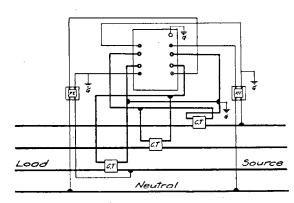
CONNECTIONS THOMSON POLYPHASE SWITCHBOARD WATTMETERS— TYPES DS-2 AND DS-3



3 wire 3 phase and monocyclic Circuits *Note ~ On 3 wire & phase circuits(A) should be the common return; an monocyclic circuits A must be the tooser wire

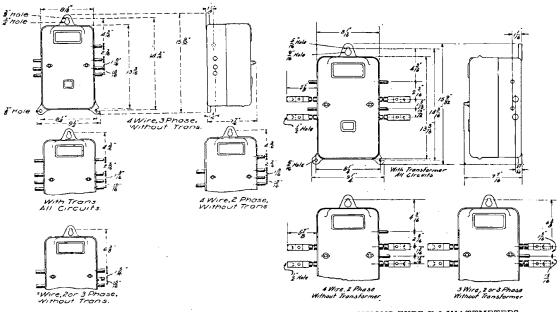


4 Wire 2 phose circuits



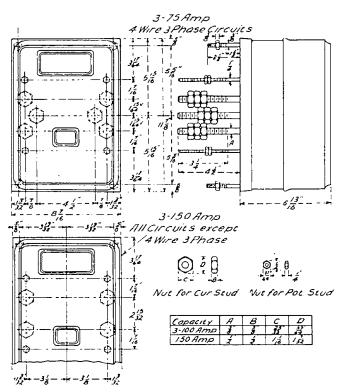
4 wire 3 phose circuits

DIMENSIONS THOMSON POLYPHASE WATTMETERS-TYPE D-3



DIMENSIONS TYPE D-3 WATTMETERS 3 TO 75 AMPERES DIMENSIONS TYPE D-3 WATTMETERS 100 AND 15) AMPERES 4527-14 Thomson Polyphase Induction Wattmeters

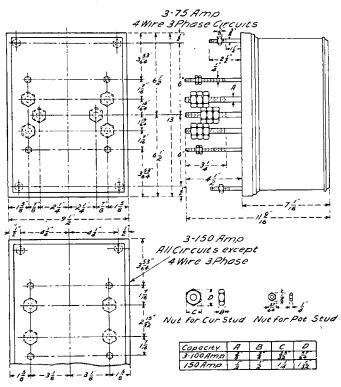
DIMENSIONS THOMSON POLYPHASE SWITCHBOARD WATTMETERS-TYPE DS-2



DIMENSIONS TYPE DS-2 WATTMETERS

GENERAL ELECTRIC COMPANY Thomson Polyphase Induction Wattmeters 4527–15

DIMENSIONS THOMSON POLYPHASE SWITCHBOARD WATTMETERS— TYPE DS-3



DIMENSIONS TYPE_DS-3 WATTMETERS

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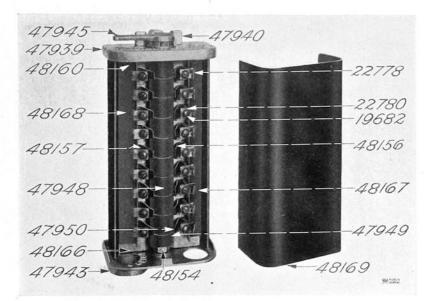
August, 1907

A D.W.

Bulletin No. 4528

PARTS OF TYPE DH CUT-OUT SWITCHES

TYPE DH 7, FORM A CUT-OUT SWITCH



Cat. No.

Description

	Following are the interchangeable parts.
47939	CAP PLATE, with handle stop
47940	Handle stop
47941	Locking plunger
47942	Compression spring for No. 47941 (6 turns, .064" spring steel wire)
19682	Screw fastening No. 47940 to cap plate (14-24, 3" R.H. Blued)
47943	Base plate
13848	Screw fastening Nos. 47939, 47943 to connection board (No. 10, 3" F.H.)
48164	CYLINDER, complete, with shaft and handle
47945	Handle, with pin
48165	Shaft
47947	Brass bushing with pin, for shaft
47948	Cylinder bushing, large
47949	Cylinder bushing, small
47950	Contact
48154	Nut with pin for shaft $\left(\frac{7}{16}$ "-14, Hex. Sp'l)
40438	Washer for No. 48154 $\left(\frac{152''}{152''} \times \frac{7}{8}'' \times .125''\right)$
48166	Connection board, with anchor blocks
48156	Contact finger
48157	Contact base.

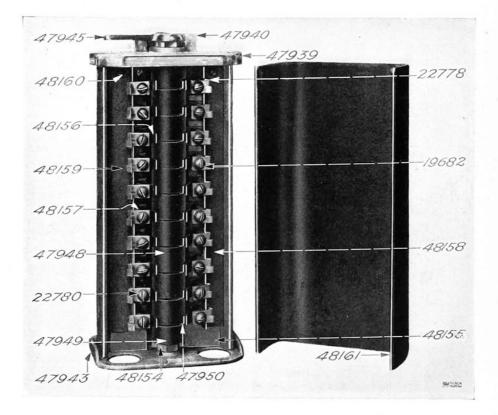
4528-2 Parts of Type DH Cut-out Switches

Cat. No.

TYPE DH 7, FORM A CUT-OUT SWITCH

Description

47250	Screw fastening Nos. 48156, 48157 to connection board (8-32, 5" F.H. Brass)
22778	Copper terminal for contact base
19682	Screw fastening No. 22778 to base (14-24, 3" R.H. Blued)
22780	Lock washer for No. 19682 (¹⁷ / ₆₄ " x ¹ / ₂ " x .060" Ph. Brz.).
48167	Insulation strip for contact bases (right-hand)
48168	Insulation strip for contact bases (left-hand)
48160	Screw fastening Nos. 48167, 48168 to connection board (No. 10, 1/ R.H. Blued)
33795	Washer for No. 48160 $\left(\frac{13}{61}'' \times \frac{13}{32}'' \times .040''$ Brass $\right)$
48169	Cover, complete.



TYPE DH 8, FORMS A AND B CUT-OUT SWITCHES

NOTE: The accompanying illustration of the Type DH-8, Form A Cut-out switch is also representative of Form B. The differences being in the cap plate, base plate and in the omission of the cover on the Form B.

Following are the interchangeable parts:

CAP PLATE, with handle stop, for DH-8-A Cut-out switch
Cap plate, with handles top, for DH-8-B Cut-out switch
Handle stop
Locking plunger
Compression spring for No. 47941 (6 turns, .064" spring steel wire)
Screw fastening No. 47940 to cap plate (14-24, 3" R.H. Blued)
Base plate, for DH-8-A Cut-out switch
Base plate, for DH-8-B Cut-out switch

Parts of Type DH Cut-out Switches 4528-3

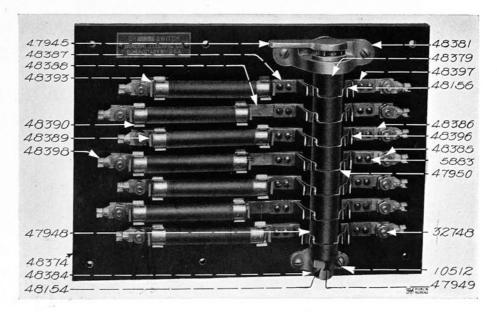
TYPE DH 8, FORMS A AND B CUT-OUT SWITCHES

Cat. No.

Description

13848	Screw fastening cap plate and base plate to connection board (No. 10, 3" F.H.)
47944	CYLINDER, complete, with shaft and handle
47945	Handle, with pin.
47946	Shaft
47947	Brass bushing with pin, for shaft.
47948	Cylinder bushing, large
47949	Cylinder bushing, small
47950	Contact
48154	Nut with pin for shaft (⁷ / ₁₆ "-14, Hex. Sp'l)
40438	Washer for No. 48154 $(\frac{16}{32}'' \times \frac{7}{8}'' \times .125'')$.
48155	Connection board, with anchor blocks
48156	Contact finger
48157	Contact base
47250	Screw fastening Nos. 48156, 48157 to connection board (8-32, §" F.H. Brass)
22778	Copper terminal for contact base
19682	Screw fastening No. 22778 to base (14-24, 3" R.H. Blued)
22780	Lock washer for No. 19682 $(\frac{17}{64}" \ge \frac{1}{2}" \ge .060"$ Ph. Brz.)
48158	Insulation strip for contact bases (right-hand)
48159	Insulation strip for contact bases (left-hand)
48160	Screw fastening Nos. 48158, 48159 to connection board (No. 10, 1" R.H. Blued)
33795	Washer for No. 48160 $(\frac{13}{64}" \times \frac{13}{32}" \times .040"$ Brass)
48161	Cover, complete, for DH-8-A Cut-out switch only

TYPE DH 15, FORMS A, B, C, E AND F CUT-OUT SWITCHES



NOTE: The above illustration of the Type DH-15, Form C Cut-out Switch is also representative of Forms A, B and E. The Type DH-15, Form A Cut-out Switch is for mounting directly on a panel.

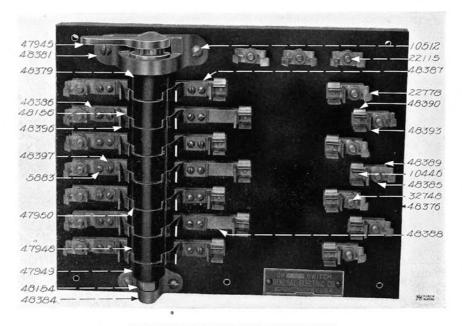
	Following are the interchangeable parts:
48374	BASE for DH-15, Forms B and C switches
48375	Base for DH-15, Form E switch

4528-4 Parts of Type DH Cut-out Switches

TYPE DH 15, FORMS A, B, C, E AND F CUT-OUT SWITCHES

Description

48376	Base for DH-15, Form F switch
48377	Insulation back for Nos. 48374, 48375
48378	Insulation back for No. 48376
14192	Screw fastening insulation back to base (No. 8, §" F.H.)
48379	CYLINDER, complete, with shaft and handle
47945	Handle, with pin
48380	Shaft
47947	Brass bushing with pin, for shaft
47948	Cylinder bushing, large
47949	Cylinder bushing, small
47950	Contact
48154	Nut with pin, for shaft (76"-14, Hex. Sp'l)
40438	Washer for No. 48154 $\left(\frac{15''}{32} \times \frac{7}{8}'' \times .125''\right)$



TYPE DH 15, FORM F CUT-OUT SWITCH

48381	Upper bearing for cylinder, with plunger, spring and screw plug
47941	Locking plunger for cylinder handle
48382	Compression spring for No. 47941 (7 turns, .064" Black Spring wire)
48383	Screw plug $(\frac{5}{4}''-11, \frac{3}{4}'' \log)$
48384	Lower bearing for cylinder
56902	Screw fastening Nos. 48381, 48384 to panel (14–24, 1 ¹ / ₂ " R.H. Brass), for DH–15, Form A switch
10512	Screw fastening Nos. 48381, 48384 to base (14–24, §" R.H. Brass), for DH–15, Form B, C, E and F switches.
48385	Nut for Nos. 56902, 10512 (14-24, Hex. Brass)
22780	Lock washer for No. 48385 (¹⁷ / ₆₄ " x ¹ / ₂ " x .060" Ph. Brz.)
48386	Contact base (right-hand) for DH-15, Forms A, B, C and E, and (left-hand), for DH-15, Form F switches.
48387	Short contact base (left-hand) for DH-15, Forms A, B, C and E, and (right-hand), for DH-15, Form F switches.

Cat. No.

ERRATA

To Accompany Bulletin No. 4543 Parts of R53–A Controller

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The prices of the contact segme follows:	ents shown on page 2 are as
40484—Screw for segments	
49092	
49093	
49094	• • • • • • • • • • • • • • • • • • • •

ERRATA

To Accompany Bulletin No. 4528

Parts of Type DH Cutout Switches.

Page 6: Cat. Nos. 14426, 48398, 22778 and 48385 appearing at the top of this page are parts of Forms A, B, C, E and F Cutout Switches and belong under the heading on page 5.

The sixth Cat. No. from the bottom of the page should be 48397 instead of 48398.

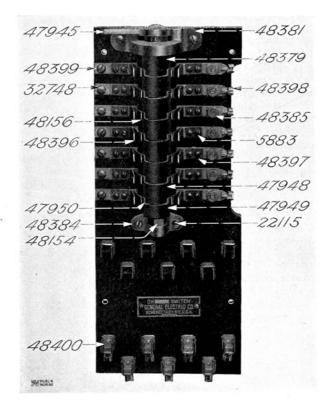
Parts of Type DH Cut-out Switches 4528-5

TYPE DH 15, FORMS A, B, C, E AND F CUT-OUT SWITCHES

Description

48388	Long contact base (left-hand for DH-15, Forms A, B, C and E and (right-hand), for
	DH–15, Form F switches)
48389	Fuse base
48390	Fuse clip for DH-15, Forms A, C and F switches
48391	Fuse clip for DH-15, Form B switch
48392	Fuse clip for DH-15, Form E switch
48393	Fuse stop
48394	Screw fastening contact bases to panel and fastening Nos. 48389, 48390, 48393 in position (8-32, 1 ¹ / ₂ " R.H.), for DH-15, Form A switch
695	Screw fastening contact bases to base (8-32, ¹ / ₂ " R.H.), for DH-15, Forms B, C, E and F switches.

Cat.No.



10446	Screw fastening fuse base, clip and stop in position (8-32, 5" R.H.), for DH-15, Forms
	B, C, E and F switches
48395	Washer for No. 48394 $\left(\frac{3}{16}'' \ge \frac{3}{8}'' \ge .034''\right)$
33796	Washer for Nos. 695, 10446 ($\frac{3}{16}$ " x $\frac{3}{8}$ " x .030" Brass)
48156	Contact finger
48396	Finger stop
5883	Screw fastening Nos. 48156, 48396 to contact base (8-32, 5" R.H. Blued)
48397	Washer plate for No. 5883
32702	Connection screw (14-24, 2" R.H. Brass), for DH-15, Form A switch
32748	Connection screw (14–24, 1 ¹ / ₄ " R.H. Brass), for DH–15, Forms B, C and E and long con- nection screw for DH–15, Form F switches
99115	Short connection screw for DH-15, Form F switch (14-24, 1" R.H. Brass)

4528-6 Parts of Type DH Cut-out Switches

TYPE DH 15, FORM D CUT-OUT SWITCH

Cat. No.

.

Description

14426	Washer for connection screws (##"x ½" x .060" Brass)
48398	Copper terminal for DH–15, Forms A, B, C and E switches
22778	Copper terminal for DH-15, Form F switch
48385	Nut for connection screws (14-24, Hex. Brass)
48379	CYLINDER, complete, with shaft and handle
47945	Handle, with pin
48380	Shaft
47947	Brass bushing with pin, for shaft
47948	Cylinder bushing, large
47949	Cylinder bushing, small
47950	Contact
48154	Nut with pin, for shaft (1/1"-14, Hex. Sp'l)
40438	Washer for No. 48154 (152" x 37" x .125")
48381	Upper bearing for cylinder, with plunger, spring and screw plug
47941	Locking plunger for cylinder handle
48382	Compression spring for No. 47941 (7 turns, .064" Black Spring wire)
48383	Screw plug (§"-11, §" long)
48384	Lower bearing for cylinder
22115 .	Screw fastening Nos. 48381, 48384 to panel (14-24, 1" R.H. Brass)
48385	Nut for No. 22115 (14–24, Hex. Brass)
22780	Lock washer for No. 48385 (# x ½" x .060" Ph. Brz.)
48399	Contact base
32748	Long screw fastening No. 48399 to panel (14-24, 1 ⁺ R.H. Brass)
5504	Short screw fastening No. 48399 to panel (8-32, 3" R.H.)
14426	Washer for No. 32748 (# x ½" x .060" Brass)
48395	Washer for No. 5504 (👬 " x 📲 " x .034")
48398	Copper terminal for No. 32748
48385	Nut for No. 32748 (14–24, Hex. Brass)
48156	Contact finger
48396	Finger stop
5883	Screw fastening Nos. 48156, 48396 to contact base (8-32, 5" R.H. Blued)
48398	Washer plate for No. 5883
48400	Fuse clip, with stop and stud
48398	Large copper terminal for No. 48400
22778	Small copper terminal for No. 48400
14426	Washer for fuse clip stud ($\frac{17}{47}$ x $\frac{1}{2}$ x .060" Brass)
48385	Nut for fuse clip stud (14–24, Hex. Brass)

Parts of Type DH Cut-out Switches 4528-7

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Toronto, Ontario.

General Electric Company Schenectady, N.Y.

SUPPLY DEPARTMENT

September, 1907

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WRIGHT DEMAND INDICATORS

The Wright Demand Indicator is a device for registering the maximum ampere demand of appreciable duration in any electrical circuit.

The extensive adoption of this Indicator demonstrates its usefulness in determining load factor, the maximum output of genera-

tors, transformers, feeders, etc., and the demands of individual consumers.

The Wright Demand Indicator may be used on either direct or alternating current circuits and records the maximum current which has passed through it at any time since it was last set.

It is purposely designed to be slow acting. If the maximum load lasts only four minutes, the Indicator will record approximately 90 per cent. of the maximum. If the load lasts ten minutes, approximately 97 per cent. is recorded and if the load continues about 40 minutes, the full 100 per cent. is registered. Momentary overloads like the starting current in motors, arc lamps, etc., or short circuits are not recorded.

front so that the Indicator can be read without opening the hinged cover. The construction of the Indicator permits it to be placed in any locality without risk of damage, and it is practically impossible for it to get out of order.

A liquid is hermetically sealed in a glass



vessel consisting of two bulbs connected by a "U" tube, and a central tube called the "Index" tube connected to the upper end of the right hand side of the "U." Around the left hand or heating bulb, is placed a band of resistance metal, through which is passed the current to be measured, or a definite shunted portion of it. The heating effect of the current increases the temperature of the left hand bulb, causing the air to expand which forces the liquid up the right hand side of the "U" tube and into the "Index" tube, where it remains until the Indicator is reset. The height of the liquid in the "Index" tube as shown by the scale indicates the maximum current which

5-AMPERE WRIGHT DEMAND INDICATOR

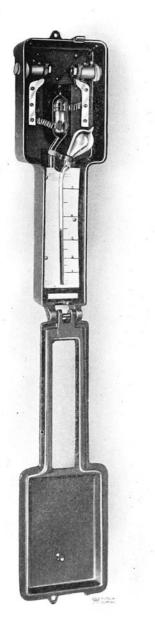
CONSTRUCTION AND PRINCIPLE OF OPERATION

The working parts are enclosed in a cast iron case which can be securely sealed against tampering and which is fitted with a glass has passed through the Indicator.

It is the difference in temperature of the air in the two bulbs which causes the flow of the liquid. Any change in external temperature causes equal air expansion in both bulbs and therefore does not affect the reading. 4533-2 Wright Demand Indicators

THE GLASS TUBE

The glass tube is made from selected stock and is thoroughly annealed since it is the care taken in the annealing process which



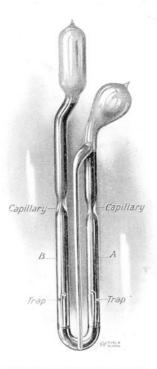
5-AMPERE INDICATOR WITH COVER OPEN gives it the ability to withstand rough usage. The glass tube is mounted on a suitable hinged support, enabling the Indicator to be reset by raising the tube and allowing the liquid to return to its original position in the "U" tube.

Rigidly fastened inside the lower part of the "U" tube are the "traps" which are essentially small inverted glass fun-These traps nels. prevent the passage of air from one side of the "U" to the other. When the tube is tilted up for resetting, bubbles of air may pass the capillaries and if it were not for the traps, these bubbles would go to the bottom of the "U": then when the tube is restored to its position. normal the bubbles might pass up the wrong side of the "U"

and destroy the calibration. The traps, however, due to action of the capillaries, remain covered by the liquid when the tube is in the inverted position and the air bubbles pass by and collect beyond the entrance to the traps.

TERMINALS

The leading-in holes for service wires are insulated with porcelain bushings. The terminals which are located in the top of the case, are made in the form of a horizontal friction hinge holding the tube support. This friction hinge automatically retains the tube in the inverted position during the period of resetting and insures excellent electrical contact at all times.



INDICATOR TUBE WITH LIQUID

HEATING BANDS

The heating bands are made of a special high resistance metal with zero temperature coefficient and are non-inductive. In capacities as high as 25 amperes, the entire current is passed through the heating bands. In Indicators of larger capacity, the heating bands are connected either to internal

Wright Demand Indicators 4533-3

or external shunts. The heating bands are so designed that they will clamp firmly about the heating bulb, irrespective of any variations in bulb dimensions.

SCALES

Illustrations of some of the Indicator scales are shown in this Bulletin. The lowest scale reading is $\frac{1}{5}$ (20 per cent.) of the rated



600-AMPERE, DIRECT-CURRENT WRIGHT DEMAND INDICATOR—CLOSED

capacity of the Indicator which has been found to be most practical for all commercial applications. The scale reads direct in amperes.

CAPACITIES

Wright Demand Indicators of all capacities from 5 to 150 amperes inclusive may be used interchangeably on direct or alternating current circuits of any frequency. Indicators of 200 amperes capacity and over are furnished with shunts for direct current service, and with current transformers for alternatingcurrent circuits.

The shunts are in all cases, internal except in connection with Indicators of 800 amperes and over.

Current transformers must be used in all cases on alternating-current circuits where the potential exceeds 1150 volts.

SHUNTS

The shunts are so designed that they present a large surface contact. This feature together with that of the radiating strips insures minimum temperature rise. The resist-



600-AMPERE, DIRECT-CURRENT WRIGHT DEMAND INDICATOR-OPEN

ance part of the shunt is made of a special alloy having a zero temperature coefficient, and all live parts are properly shielded.

OVER-LOAD CAPACITY

The liberal dimensions of the terminals and the general design of the Indicator give it a large over-load capacity so that it may be safely operated on loads of double its rated capacity without injury. It should be remembered, however, that when operating at its rated current the index tube is filled in 40 minutes, hence an over-load may quickly fill the tube and render an accurate record impossible.



WEATHER-PROOF EQUIPMENTS

For outdoor installations, the Indicator can be furnished mounted in a weather-proof box with supports for hanging in any convenient location beside the transformer.

WRIGHT DEMAND INDICATORS

FOR CIRCUITS NOT EXCEEDING 750 VOLTS

Direct or Alternating Current

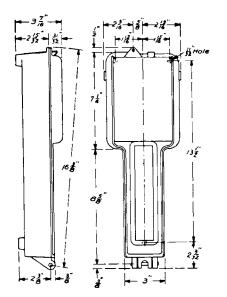
Cat. No.	Amperes	List Price
48337	5	\$12.00
48338	10	12.00
48339	15	12.00
48340	25	12.00
48341	35	16.00
48342	50	16.00
48343	75	16.00
48344	100	16.00
48345	150	23.00

Direct Current Only

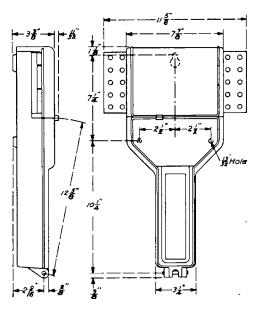
Cat. No.	Amperes	List Price
48346	200	\$24.00
48347	300	26.00
48348	400	29.00
48349	600	35.00

Prices of Wright Demand Indicators of larger ampere capacities furnished on application.

Wright Demand Indicators 4533-5

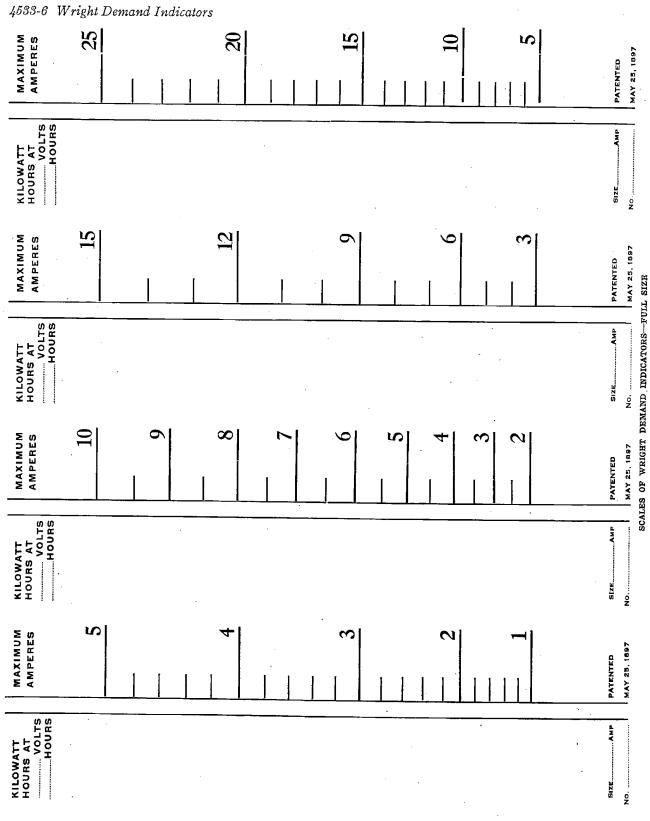


DIMENSIONS OF WRIGHT DEMAND INDICATORS



¹⁵⁰ TO 600 AMPERES, DIRECT CURRENT

⁵ TO 100 AMPERES DIRECT AND ALTERNATING CURRENT



	GENERAL ELECTRIC COMPANY	
, •	Wright Demand Indicators 4	4533-7
MAXIMUM AMPERES	100 30 40 70 80 90 100 20 30 40 50 60 7 80 9 100	PATENTED May 25, 1897
KILOWATT HOURS AT VOLTS HOURS	•	Size
MAXIMUM Amperes	75 15 80 15	PATENTED MAY 25, 1897 JLL SIZE
KILOWATT HOURS AT VOLTS HOURS		IP PATENTED BIZE AMP PATENT MAY 25, 1997 NO MAY 25 MAY 25 SCALES OF WRIGHT DEMAND INDICATORS—FULL SIZE
MAXIMUM Amperes	33 4 8 8 1	PATENTED MAY 25, 1897 LES OF WRIGHT DB
KILOWATT HOURS AT VOLTS HOURS	· · ·	Size ARP
MAXIMUM AMPERES	35 36 10 11 20 25 30 30 33 30 30 30 30 30 30 30 30 30 30	PATENTED May 25, 1897
T.S. RS		AN Y
KILOWATT HOURS AT VOLTS HOURS		Si III Si III V

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

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FOREIGN.

FOREIGN DEPARTMENT, Schenectady, N. Y., and 44 Broad St., New York, N. Y. LONDON OFFICE, 83 Cannon St., London, E. C., England.

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Toronto, Ontario.

General Electric Company Schenectady, N.Y.

TURBINE DEPARTMENT

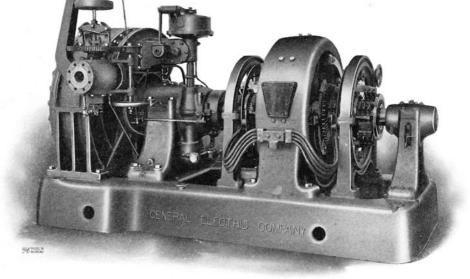
September, 1907

Copyright, 1907 by General Electric Company *Bulletin No. 4534

CURTIS STEAM TURBINES-HORIZONTAL SHAFT TYPE

The characteristics of the Curtis steam turbine as developed by the General Electric Company specially adapt it for driving horizontal shaft generators. sizes and 100 lbs. for the larger. The use of superheated steam in the Curtis turbine results in greater steam economy, as in any type of reciprocating engine or turbine, but without the usual attendant difficulties from lubrication and warping of parts.

These sets require minimum attendance and



150 KW. TURBINE CONNECTED TO DIRECT CURRENT GENERATOR

The shaft is very short, of small diameter, and has a comparatively low surface speed in the bearings, resulting, with the light weight of the revolving parts, in low bearing friction and small tendency to wear.

These advantageous features characterize the line of horizontal shaft Curtis turbine sets built in sizes of 20 Kw., 35 Kw., 75 Kw., 100 Kw., 125 Kw., 150 Kw., and 300 Kw., for direct current, and 100 Kw. and 300 Kw., for alternating current.

They can be arranged to operate either non-condensing or condensing, and at any steam pressure above 80 lbs. for the smaller

* Supersedes Bulletin No. 4445.

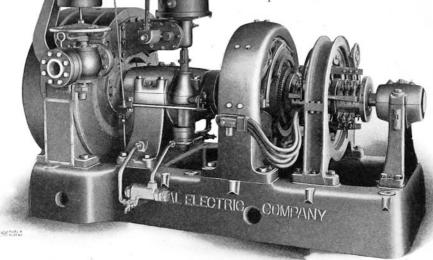
may be advantageously installed for supplying light and power in mills, machine shops, laundries, apartment houses; for heating and lighting plants on steam vessels, in office buildings, railroad stations, and for train lighting. They are also extensively used for exciting alternating current generators in central power stations.

The design embodies the simplicity of a water wheel, ample strength of all parts, and a neat, attractive appearance. The large number of these turbines in successful commercial service gives ample proof of their reliability. GENERAL ELECTRIC COMPANY 4534-2. Curtis Steam Turbines—Horizontal Shaft Type

These machines are built either with a single piece shaft and two bearings, or with a two-piece shaft and four bearings. In the

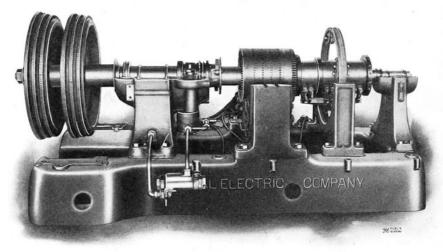
mon base. All parts of the turbine and generator are interchangeable and easy of access.

The governing mechanism is simple and reliable, controlling the speed perfectly under conditions of fluctuating load and varying steam pressure.



100 KW. TURBINE CONNECTED TO DIRECT CURRENT GENERATOR

latter type the turbine shaft is connected to the generator shaft by means of a flexible coupling. In both designs the turbine and generator are mounted on a comFor condensing operation the packing is so designed that air leakage is prevented, thus eliminating the difficulties of maintaining a high vacuum, which can be used to great ad-

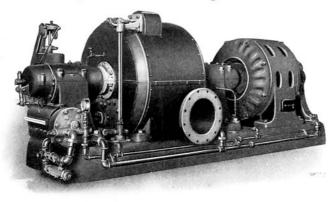


100 KW. TURBINE AND DIRECT CURRENT GENERATOR PARTLY ASSEMBLED

Curtis Steam Turbines—Horizontal Shaft Type 4534-3

vantage as the turbine has a large exhaust passage and no exhaust valves. Turbines built for condensing service can be operated non-condensing in case of necessity. continuous operation with little attention. The commutating pole construction eliminates sparking under all conditions of load.

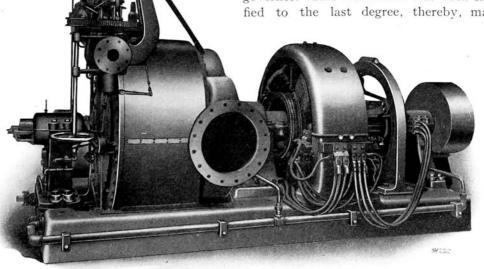
The generators for direct current are built



100 KW. TURBINE CONNECTED TO ALTERNATING CURRENT GENERATOR

The generators are of the most improved type and embody many new features, such as commutating poles and special commutator construction, particularly adapting them to for 125 and 250 volts; the generators for alternating current are built for any of the standard voltages used in this class of service.

For safety in operation these turbines are in a class by themselves, and cannot be excelled. In addition to the positive and efficient automatic governor, they are equipped with an entirely independent emergency governor. This mechanism has been simplified to the last degree, thereby, making



4534-4 Curtis Steam Turbines—Horizontal Shaft Type

failure to operate a practical impossibility.

Cleanliness has been especially considered in designing these machines, and surfaces



20 KW. TURBINE WITH DIRECT CURRENT GENERATOR

which may require cleaning are either painted or covered with planished iron. The oiling system is entirely enclosed, is automatic, and there is absolutely no oil throwing.

These turbines require less floor space than any type of horizontal engine, and about the same floor space as vertical engines, but have much less height. Owing to their



TURBINE NOZZLE

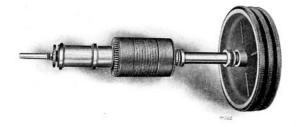
light weight, small size and the absence of reciprocating parts, massive foundations are unnecessary.

These units are economical in steam consumption and are so designed that their economy is not dependent on adjustments. There are no wearing parts affecting economy, nor opportunities for leakage, and efficiency will, therefore, be maintained indefinitely.

The exhaust steam from the Curtis turbine is absolutely free from oil as no internal lubrication is necessary. Where the exhaust steam is used for heating or for manufacturing processes, or where condensed steam is returned to the boilers, this is of vital importance. This feature is of especial value in connection with laundering, dye works, bleacheries and paper mills.

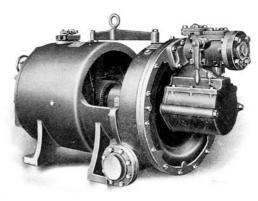
One of the most important advantages of these turbines is the great smoothness of operation which is almost essential in buildings where noise is objectionable, and on trains and boats.

Should the turbine be flooded with water there can be no danger of stripping the buckets nor other damage. Steam is admitted in a steady flow and there is no risk of steam



35 KW. TURBINE WHEEL AND ARMATURE ASSEMBLED ON SHAFT

hammer. These turbines can be started up promptly from a cold condition without danger from accumulations of condensed steam.



35 KW. TURBINE WITH DIRECT CURRENT GENERATOR

Every turbine is carefully tested before leaving the factory.

General Electric Company Schenectady, N.Y.

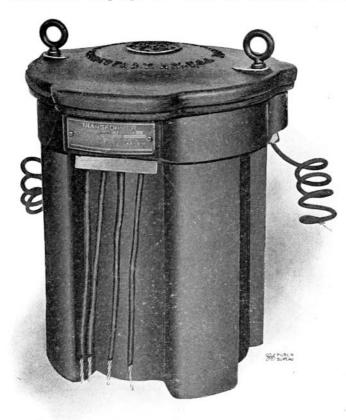
TRANSFORMER DEPARTMENT

September, 1907

Copyright, 1907 by General Electric Company Bulletin No. 4535

GENERAL ELECTRIC TRANSFORMERS-TYPE H IMPROVED DESIGN

The universal popularity of the General other types was quickly appreciated. Hun-Electric Type H Transformer long ago in- dreds of thousands of kilowatt capacity



IMPROVED DESIGN, TYPE H TRANSFORMER

dicated that this form of construction would supersede all others. Over ten years ago, the General Electric Company placed the first design of the Type H Transformer on the market and its great superiority over all now in service bears witness to the fact that no other type of design so nearly fulfills the ideal conditions of safety, economy and durability. Superior transformer design, as exemplified in the Type H Transformer.

4535-2 General Electric Transformers—Type H Improved Design

needs no better recommendation than has been given it by other manufacturers in their gradual but steady tendencies towards General Electric standards.

In this, as in many other classes of electrical apparatus, the excellence of final commercial product depends to a considerable degree on the careful selection by the designing engineers, of the value to be assigned to the variable properties of the apparatus. If the value of low core loss is unduly magnified, the resulting design is liable to have unduly high copper loss and poor regulation; if too bulky or unnecessary insulations are used, The progress made in its development from year to year is a matter of history, and it is truthfully said that the history of transformer development is the history of the Type H Transformer. The redesigned Type H Transformer now being placed on the market marks an additional era in the development.

If we imagine both sets of coils in the Type H wound on one leg of the laminated iron core, we should have a simpler but unbalanced form. Now, if this imaginary transformer has its core divided vertically into four flat sections and these sections be swung around at right angles to each other, a



GROUP OF TYPE H TRANSFORMERS-.6 KW. TO 50 KW.

the transformer will generally have a high reactance with a tendency to overheat and a low efficiency.

Of the many types of transformers that have been placed before the public, the Type H has proved itself best adapted to the most even balancing of all the variable characteristics incident to efficient design, and the General Electric Company, after eighteen years' experience with many designs and a careful investigation of all types, is as firmly convinced as it was ten years ago that the Type H construction is best for transformers of small and medium capacity.

THE IMPROVED TYPE H

Recognizing the stronger position this transformer has each year assumed, the General Electric Company has constantly made every endeavor towards its improvement. transformer having a cross-shaped core is produced. This novel form of construction is used in the redesigned Type H.

ADVANTAGES OF THE NEW DESIGN

In adopting this type of construction, full consideration has been given to the retention of all essential electrical, magnetic and mechanical features which have produced such excellent results in the Type H Transformers heretofore manufactured, and at the same time advantage has been taken of a form of construction which permits important improvements.

The latest design of Type H Transformer has the winding on the center leg only. It is cylindrical in shape and presents large surfaces, allowing the oil free access to all parts of the coil and core. It gives a short mean length of turn in the winding as well as a

General Electric Transformers—Type H Improved Design 4535-3

short mean length in the magnetic circuit in the core, resulting in low copper and core losses, high efficiency and good regulation.

The proportions of the winding space in the redesigned Type H Transformers are similar to those of the superseded design, giving the same advantages, some of which may be summarized as follows:

(1) Simplicity of winding and insulation as there are only cylindrical surfaces between primary and secondary.

(2) Thin coils, bringing the oil in close proximity to all parts of the copper and thus allowing rapid radiation of heat.

(3) Uniform expansion and contraction under alternate heating and cooling by reason of uniform heating, ample oil ducts, and the symmetrical arrangement of core and coils, with consequent prevention of chafing of insulations and insurance of long life.

In addition to these advantages, the following important properties are found in the new Type H design:

1st-Better efficiencies.

2nd—Greater uniformity of impedances whereby the various sizes of the line can be made to operate in multiple more perfectly, each taking its correct proportion of the load.

3rd-Improved connection board.

4th—Improved method of supporting primary and secondary leads.

5th—Improved method of clamping transformers in box.

REACTANCE DROP

By a careful intermixing of the coils the reactance obtained is small and the resulting regulation, particularly on loads of low power factor, is greatly improved.

COOLING

That part of the steel core composing the magnetic circuit outside of the winding is divided into four equal parts, each part being arranged at such a distance from the winding that all portions of the winding and core are equally exposed to the action of the oil (the cooling medium), and on the larger sizes the winding is divided by ample channels through which sheets of oil are continually sweeping. The result is a uniform temperature throughout the transformer, thus eliminating the detrimental effects of unequal expansion in the coils with consequent rubbing and abrasion of the insulation.

SAFETY, DURABILITY AND ECONOMY

Safety, durability and economy are the essential features of all electrical apparatus in the order of their importance.



TYPE H TRANSFORMER-CORE AND COILS

In no branch of electrical manufacture have these features been more carefully considered than in the production of the General Electric Type H Transformers. Safety, durability and economy are dependent upon:

Insulation,	Aging,
Temperature Rise,	Copper Loss,
Core Loss,	Regulation.

INSULATION

Insulations are classified in accordance with the duties they have to perform.

1st.—Insulation between primary, secondary and all other parts.

2nd.—Insulation between layers.

3rd.—Insulation between turns.

4535-4 General Electric Transformers—Type H Improved Design

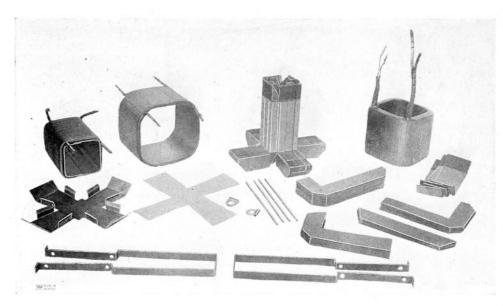
Each of these has its special electrical and mechanical strains to withstand; each has its possible weakness. To use too little or unsuitable material in any of these places means short life; to use too much means needlessly high losses or temperature rise.

Insulation Between Primary and Secondary.—The most important characteristic of a transformer, safety, is directly dependent upon the insulation between primary and secondary.

The design of the Type H Transformer is

the transformer be destroyed by abnormal conditions. Such a mica cylinder projecting well beyond either end of the primary winding, of sufficient thickness to withstand from 15,000 volts to 20,000 volts, and regularly tested in manufacture to 10,000 volts for one minute, is practically indestructible when used on circuits of voltage not exceeding 2,500.

Insulation Between Layers.—On account of the large proportion of the available winding space in a transformer which must neces-



PARTS OF TYPE H TRANSFORMER-IMPROVED DESIGN

particularly well adapted to successful insulation at this point, by the use of a thick shield built up of layers of mica.

Mica is an unequaled insulation because of its fire-proof property and high dielectric strength. It is, however, a very unsatisfactory and unsafe insulation to depend upon where sharp bends are necessary. In the Type H Transformer this condition does not arise, since when the secondaries are wound the sharp corners disappear and an insulating sleeve of mica is readily wound on which forms a shield between primary and secondary, even should the fibrous insulations on sarily be occupied by insulation, it is essential that the insulation should be of the best quality to insure reliability, and as thin as possible to insure high efficiency.

By employing windings that are practically cylindrical in form, the use of short layers, difficult to insulate, has been avoided. Between layers the limiting feature is not electrical but mechanical strength of insulation, as the potential between layers seldom exceeds 200 volts.

Paper is almost universally used between layers, but as is well known, the various kinds of this material differ widely

General Electric Transformers—Type H Improved Design 4535-5

both as to mechanical and electrical strength. Cheap papers, having practically no fibre, crack with the slightest tension of the wires when used in transformers. Other papers with fairly good strength will quickly become brittle when subjected to a temperature even lower than that which must be expected in a transformer under load.

The paper used in the Type H Transformer has been selected after years of experience, and the uniformity of its quality and purity is assured by constant inspection and electrical test of every sheet used.

There are, in many types of transformers, two fertile sources of "short circuits" between layers. One is insufficient insulation between the outside turns of two adjacent layers, and the other the "crawling" of the superimposed layers on each other, due to unequal temperatures in different parts of the coils.

The first defect is due to an attempt to economize space, the paper not being allowed to project sufficiently beyond the ends of the layers to prevent the last turn of one layer from falling on the next one below. The maximum pressure existing between layers occurs at the corners, and a perfect sheet of insulation extended beyond the layer at each end so arranged that it is impossible for the turns to come out of place is found in the Type H Transformers.

The second defect mentioned, namely, the "crawling" of the layers on each other, is a more serious one, perhaps, since it occurs only after the transformer has been in service a considerable length of time. If ample oil ducts are not provided between the coils and between coils and core, different temperatures will result in the transformer structure which will cause an unequal expansion of copper in different parts of the structure. A slight motion of one layer on another is thus produced which must in time crack the insulation between the layers, especially where one wire rides over an adjacent one at the crossing from one layer to the next.

The Type H Transformers, containing a minimum number of layers and having thin coils, equally cooled by the surrounding oil in all parts, expand equally throughout and are there-



POLE INSTALLATION

fore free from deterioration of this character.

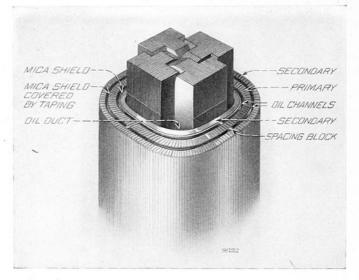
Insulation Between Turns.—Cotton wrapping on the wire is universally used to insulate turn from turn in transformers. Defects or bad spots in such covering are not easily detected, especially in small coils where the wire must be wound with rapidity. The General Electric Company, unlike other transformer manufacturers, buys its wire bare and applies the cotton covering in its own shops. It can therefore take such care and make such thorough inspection of this work that faults are reduced to a minimum.

Drying and Filling.—The coils of all the smaller transformers, after winding, are subjected to the vacuum drying and compound filling process developed by the General Electric Company. This effectively dries out any moisture which may be present in the interstices of the winding and then closes them against reabsorption.

4535-6 General Electric Transformers—Type H Improved Design

The compound, filling all crevices as it does, cements the winding into a solid block of copper and insulation, which dissipates the and should be measured by the increase of resistance of the copper.

Great care is taken in designing the Type



OIL DUCTS, OIL CHANNELS AND INSULATION

heat generated within it with comparative ease, and gives a uniformly low temperature throughout.

In the larger sizes, the primary coils are treated by the above process after which they are taped in and out several times, each tape being thoroughly saturated with varnish. The secondary coils are interwound, two in one layer, making very thin coils. These are not subjected to the above process, but are thoroughly saturated with varnish, after all moisture has been expelled, so that the same results are obtained: moisture is excluded and heat dissipated.

TEMPERATURE

High temperatures in transformers are seriously objectionable because they cause deterioration of insulation. Claims made for temperature rise mean absolutely nothing, unless all conditions are understood. The temperature rise should be based on the **average** temperature rise of either the primary or secondary after an eight-hour run, H Transformers to maintain the proper distribution of iron and copper losses, so that the average increase in temperature of the winding is practically that of the hottest point in the transformer.

By sacrificing uniform heating and insulation in the design of a transformer, it is possible to obtain a transformer of lower core loss, better regulation, and less cost, but one which it is dangerous to use. Such "economy" should be most carefully guarded against.

USE OF OIL

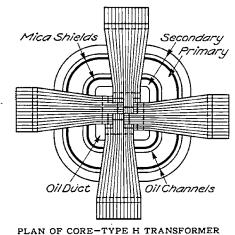
Oil is a better heat-conducting medium than air, and a transformer will have a much lower temperature with oil than without. The use of oil preserves the insulation, keeping it soft and pliable, and prevents oxidization by air; consequently, the use of oil maintains uniform core loss and a superior insulation.

The General Electric Company was the pioneer in advocating the use of oil in transformers. It is mentioned in the following words as far back as Bulletin No. 3006, issued February 1st, 1892:

"A new and valuable feature is the introduction of oil into the transformers to keep moisture from the insulation, to greatly increase the insulation and to prevent, as far as possible, its destruction by high potential discharges occasioned by lightning."

CORE CONSTRUCTION

The core used in the redesigned Type H Transformer contains four magnetic circuits of equal reluctance in multiple, each circuit consisting of a separate core similar to that of the superseded Type H Transformer. In this novel construction one leg of each circuit is built up of two different widths of punchings forming such a cross section that when the four circuits are assembled together they interlock to form a central leg, upon which the winding is placed.



The four remaining legs consist of punchings of equal width. These occupy a position surrounding the coil at equal distances from the center on the four sides; forming a channel between each leg and coil, thereby presenting large surfaces to the oil and allowing it free access to all parts of the winding.

In the small sizes the punchings are all of the same length assembled alternatively, forming two lap joints equally distributed in the four corners of the core, while on the large sizes each width of punching is made in two lengths, so that the corresponding punching of the inner and outer circuits intermesh, forming lap joints in two corners and giving a magnetic circuit of very low reluctance.

CORE LOSS

Since under ordinary conditions of service, transformers are connected to the lines for the entire 24 hours of each day, it is essential that the light load loss, i. e., the core loss, should be as small as is consistent with the maintenance of proper values of the other characteristics.

In the design and construction of the cores of Type H Transformers, consideration has been given to the most minute details tending to minimize core loss.

The core loss claims are based on a sine wave and will be from 10 per cent. to 15 per cent. lower on circuits supplied by many types of generators now in commercial use.

AGING

The General Electric Company has devoted a large amount of time and money in carefully investigating the matter of aging, and has found that it is impossible to obtain uniformly non-aging steel, without employing special treatment which is the outcome of many years of experience. By the use of such methods, a steel has been obtained which is practically non-aging, not only under normal conditions, but even at temperatures well beyond those which would be safe for the insulation of the transformer.

COPPER LOSS

Copper loss being dependent upon the length and cross section of the conductor used, can be calculated with precision by the designer. It should be fixed at such a value that the other characteristics—core loss, heating and regulation — will be maintained within the most effective limits.

While low core loss is of great importance, it should also be kept in mind that copper loss

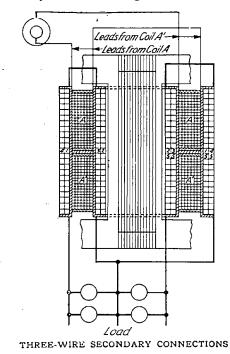
4535-8 General Electric Transformers—Type H Improved Design

reaches its highest value at the "peak" of the load and at the time the station is being taxed to its utmost capacity. Again, since copper loss varies with the square of the load, it follows that transformers connected to carry overloads on the "peak" have poor efficiency and regulation at such times unless designed for low copper loss.

Particular attention is called to the low copper loss and good regulation of the Type H Transformers.

REGULATION

The principal factors in a transformer affecting its regulation, are the "CR," or copper loss (resistance) drop and the reactive drop of its windings. On a non-inductive load the latter, unless very large, does not materially affect the regulation, which has



practically the same value as the resistance drop. On an inductive load, however, the reactive drop of the windings is more nearly in phase with the load voltage and therefore has considerable effect on the regulation. It is, therefore, essential that both of these components be made as small as possible. By the careful proportioning of the core and coils and the proper location of the latter, both the resistance drop and reactive drop of the Type H Transformer are reduced to a minimum.

PORCELAIN CONNECTION BOARD, BUSHINGS AND LEADS

Inside the case is a porcelain connection board, by means of which the primary coils may be connected either in series or in multiple. The secondary windings are divided into two parts, and the four secondary as well as the two primary leads are brought out through the transformer casing. The board is provided with barriers on its upper surface which separate the different terminals.

Each lead where it leaves the transformer is sealed into a porcelain bushing so as to prevent the entrance of moisture or other foreign substance or the leakage of oil, and these bushings are similarly sealed into the case.

THREE-WIRE SECONDARY WINDINGS ON TYPE H TRANSFORMERS

The General Electric Company, in its Pamphlet 9087, issued November 14th, 1900, called attention to the necessity of properly distributing the secondary windings on core type transformers if balanced voltage is to be maintained on a three-wire circuit fed from the transformer. The popularity of the Type H Transformer has led to extensive copying of its general design and many of its detailed features. Some of these copiers are posing as original investigators and developers of this type of transformer. For instance, one manufacturing company has published in the technical press, an article describing their recently made "experiments" demonstrating the necessity of so designing the windings of the core type transformer as to avoid the lack of balance in the secondaries of such transformers "as heretofore constructed."

As the General Electric Company's patent covering this "re-discovery" was issued

nine years ago, and was the result of experiments made a considerable time previous to the issue of the patent, this Company believes it is justified in reprinting here a copy of the principal claim of the patent, numbered 595,403, issued December 14th, 1897: "In a transformer, the combination of a core, a winding mounted thereon, and a winding in inductive relation to the first named winding and connected to a three-wire circuit, comprising a plurality of coils connected to each side of the three-wire circuit, said coils being so arranged on the core that they receive substantially equal induction from the first mentioned winding under balanced and unbalanced loads."

The method used in the redesigned Type H Transformer for accomplishing this result is shown diagramatically on opposite page.

As will be seen, the method adopted consists of distributing equally, on each side of the primary coil, both halves of the secondary winding, so that each secondary, throughout its length, is closely adjacent to the entire primary winding.

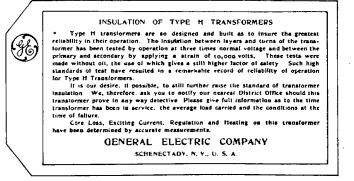
In order to insure the exact equality of resistance and reactance in the two secondary windings necessary to obtain perfect regulation of the two halves, the inside portion of the secondary winding on one side of the primary coil is connected in series with the outside portion of that on the other side. As a result the drop of voltage in either side of the secondary of Type H Transformers,

under any ordinary conditions of unbalanced load, does not exceed the listed regulation drop.

This particular arrangement is used because it accomplishes the results desired perfectly, and is the simplest and best method for this construction. Several other methods could be and have been used. The patent covers all such methods.

GROUNDING SECONDARIES OF TRANSFORMERS

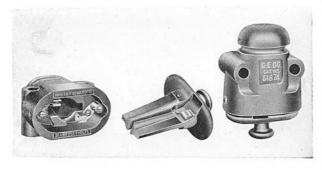
Grounding the secondaries of Type H Transformers has been approved by the American Institute of Electrical Engineers and the National Electric Light Association. The National Board of Fire Underwriters has incorporated in the National Electric Code rules covering this matter. To insure good service with a grounded secondary, superior insulation between the primary and secondary is necessary, for the reason that, under these conditions, only one ground, i. e., one on the primary, is sufficient to put a strain of the full potential of the primary circuit on the insulation between primary and secondary coils, whereas ordinarily it requires an accidental ground on both primary and secondary. The General Electric Company recommends the grounding of the secondary rather than the use of a grounded shield, for the reason that while the shield might prevent primary voltage appearing on the secondary by breaking down the insulation between coils, there would be no protection if a cross should occur outside of the transformer. On the other hand, if the secondary circuit is properly grounded, it is impossible to obtain a difference of potential between the house wiring and the ground greater than the lamp voltage. The mica shield, used between the primary and secondary windings of Type H Transformers, makes the approved method of grounding perfectly safe.



4535-10 General Electric Transformers—Type H Improved Design

WORKMANSHIP

Notwithstanding the fact that the General Electric Company employs only skilled labor for winding its transformer coils many of its men having been engaged exclusively on this work for over 15 years—the most perfect system is used in preparing and placing the insulating materials on the coils. Nothing is left to the judgment of the workman, as is so commonly the case in this class of work, consequently a perfectly uniform



SINGLE-POLE PRIMARY SWITCH AND CUT-OUT -CAT. No. 51874

production results. All insulations, to the smallest pieces of paper, are detailed in drawings to exact size and are produced by the aid of gauges and special machinery, and in all departments the same accurate methods are used as are customary in other mechanical operations, but which are usually sadly lacking in the winding and insulating of transformers. These methods have resulted in such durability in Type H Transformers, that in three years, during which records were kept, less than one-third of one per cent. of the capacity sold were reported as burned out from all causes, including lightning and overload. In order to follow closely any defects which might occur in its transformers, the General Electric Company attaches a tag similar to the one illustrated on p. 9 to each transformer.

INSULATOR TYPE PORCELAIN CUT-OUTS

The primary switch and cut-out shown in the accompanying illustration is shaped so as to be used as an insulator, and the wires may be brought directly from the line to the cut-out and thence to the transformer without other support. The cut-out is made of porcelain, finished in black to harmonize with the transformer case, and is easily installed and wired.

The plug is so arranged that ordinary uncovered fuse wire may be used, although this is not recommended since the rating of fuse wire depends entirely on the alloy and the

length in which it is used, and it is therefore possible that the block may be improperly fused. The use of the listed fuses is recommended, as they are accurate in operation and easy to handle. Alloy fuses having copper terminals are used for currents up to and including 10 amperes, but fuses with capacities exceeding 10 amperes are punched from one piece of sheet metal. The hand is protected from injury by a shield above the handle, and the plug, when once inserted, is held firmly in place by the spring contacts.

Cat. No.	Cápacity in Amps.	Cat. No.	Capacity in Amps
23174	1	23180	15
23175	2	23181	20
23176	3	23182	25
23178	5	23183	30
23179	10		

FUSES FOR INSULATOR TYPE CUT-OUTS

For the 40 kw. and 50 kw. sizes, when operated at 1100 volts Cut-Out, Cat. No. 51874 is not suitable and instead of it Cat. No. 5696 should be furnished. If the transformers are to be operated at 1100 volts this Cut-Out should be specially ordered.

General Electric Transformers-Type H Improved Design 4535-11

GENERAL ELECTRIC TYPE H OIL TRANSFORMERS

	Seconda	ry Volts	-				Effici	ency		Net Weight
Kw.	110 or 220 Cat. No.	122 or 244 Cat. No.	Core Loss	Cop. Loss	Per Cent. Reg.	Full Load	t Load	Load	Load	in Lb. Inc. Oil
.6 1	$24041 \\ 24042$	24036 24037	$21 \\ 27$	15 24	2.54 2.45	94 .3 95 .2	93.9 94.9	92.4 93.8	87 .2 89 .8	90 100
$\begin{array}{c} 1.5\\ 2.\end{array}$	24043 24044	24038 24039	32 37	34 45	$\begin{array}{c}2.30\\2.28\end{array}$	95.8 96.1	95.7 96.0	94 .9 95 .4	91 .7 92 .6	$\begin{array}{c} 160 \\ 165 \end{array}$
$\frac{2}{3}.5$	$\begin{array}{r} 24045\\ 4125\end{array}$	24040 4161	41 45	53 61	$\begin{smallmatrix}2.15\\2.08\end{smallmatrix}$	96.4 96.6	96.4 96.6	$95.8 \\ 96.1$	93.4 93.9	$\begin{array}{c} 195 \\ 200 \end{array}$
4 5	4127 4129	4164 4167	55 62	74 90	1.92 1.90	96.9 97.1	96.9 97.1	96 .5 96 .7	94 .4 94 .9	$\begin{array}{c} 295\\ 325\end{array}$
$\begin{array}{c} 7.5\\ 10 \end{array}$	4133 4135	4173 4176	84 102	122 149	1.75 1.59	97.3 97.6	97.4 97.6	97.0 97.3	95.3 95.9	400 450
$15 \\ 20$	4137 4139	4179 4182	137 162	209 268	1 .51 1 .42	97.7 97.9	97.8 98.0	97.5 97.8	96.2 96.6	810 900
$\frac{25}{30}$	4141 4143	4185 4188	187 210	$\begin{array}{c} 311\\ 359 \end{array}$	$1.31 \\ 1.25$	98.1 98.1	98.1 98.2	97.9 98.0	96.8 97.0	$\begin{array}{c}1175\\1230\end{array}$
40 50	4025 4095	4026 4096	258 307	450 540	$\begin{array}{c} 1.20 \\ 1.15 \end{array}$	98.3 98.3	98.3 98.4	98.2 98.3	97.2 97.3	1580 · 1615

FREQUENCY LIMITS, 50-140 CYCLES; NORMAL, 60 CYCLES; PRIMARY VOLTAGE, 1100 OR 2200 DATA BASED ON 1100 OR 2200 VOLTS, 60 CYCLES, SINE WAVE

The average temperature rise of eitner primary or secondary will not exceed 45°C. in eight nours full load and 50°C. in twenty-four hours full load. Temperature rise determined by increase of resistance method.

GENERAL ELECTRIC TYPE H OIL TRANSFORMERS

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FREQUENCY LIMITS, 50-140 CYCLES; NORMAL, 50 CYCLES; PRIMARY VOLTAGE, 1100 OR 2200 DATA BASED ON 1100 OR 2200 VOLTS, 125 CYCLES, SINE WAVE

	Secondar	ry Volts					Effic	iency		Net Weight
Kw.	110 or 220 Cat. No.	122 or 244 Cat. No.	Core Loss	Cop. Loss	Per Cent. Reg.	Full Load	+ Load	Load_	Load	in Lb. Inc. Oil
.6 1	$\begin{array}{c} 24041\\ 24042 \end{array}$	24036 24037	15 19	15 24	$2.54 \\ 2.45$	95.2 95.9	$95.1 \\ 95.8$	$94.0 \\ 95.2$	90 .4 92 .2	90 100
${1\over 2}.5$	24043 24044	24038 24039	23 26	34 45	2 .30 2 .28	96.3 96.6	96 .4 96 .7	95.9 96.4	93 .7 94 .5	160 165
$\begin{array}{c} 2.5 \\ 3 \end{array}$	$\begin{array}{r} 24045\\ 4125\end{array}$	24040 4161	$\frac{29}{32}$	$\begin{array}{c} 53\\61\end{array}$	$\begin{array}{c} 2.15\\ 2.08\end{array}$	96.8 97.0	97.0 97.1	96.7 97.0	95.3 95.4	195 200
4 5	-4127 4129	4164 4167	39 44	74 90	1.92 1.90	97.2 97.4	97.4 97.5	97.2 97.4	95.8 96.2	295 325
7.5 10	4133 4135	4173 4176	60 72	$\begin{array}{c}122\\149\end{array}$	1.75 1.59	97.6 97.8	97 .8 98 :0	97.6 97.9	96.5 96.9	400 450
$15 \\ 20$	4137 4139	4179 4182	$\begin{array}{c} 97 \\ 115 \end{array}$	209 268	$1.51 \\ 1.42$	98.0 98.1	98.1 98.3	98.1 98.2	97.2 97.4	810 900
25 30	4141 4143	4185 4188	$\begin{array}{c} 133 \\ 149 \end{array}$	311 359	$\begin{array}{c}1.31\\1.25\end{array}$	98.3 98.3	98.4 98.5	98.3 98.4	97.6 97.8	1175 1230
40 50	4025 4095	4026 4096	$\begin{array}{c} 183 \\ 218 \end{array}$	450 540	1.20 1.15	98.4 98.5	98.6 98.6	98.5 98.6	97 .9 98 .0	$1580 \\ 1615$

The average temperature rise of either primary or secondary will not exceed 40°C. in eight hours and 45°C. in twenty four hours full load. Temperature rise determined by increase of resistance method.

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4535-12 General Electric Transformers—Type H Improved Design

GENERAL ELECTRIC TYPE HB OIL TRANSFORMERS

	Secondary Volts					Effici	ency		Net Weigh
Kw.	110 or 220	Loss	Cop. Loss	Per Cent. Reg.	Full	4	+	4	in Lbs. Ind Oil
Cat. No.	ļ <u> </u>			Load	Load	Load	Load		
.6	43678	27	15	2.60	93.4	92.7	90.6	84.3	85
1	43679	35	24	2.53	94.4	93.9	92.4	87.3	90
1.5	43680	43	28	1.99	95.5	95.0	93.8	89.3	100
2	43681	50	34	1.80	96.0	95.6	94.5	90.6	165
2.5	43682	55	40	1.71	96.3	96.0	95.1	91.6	170
3	3716	60	47	1.67	96.6	96.3	95.4	92.3	195
4 5	3705	70	- 67	1.77	96.7	96.5	95.8	93.1	205
5	3706	78	87	1.90	96.8	96.7	96.2	93.3	290
7.5	3708	101	120	1.77	97.1	97.1	96.6	94.5	325
10	3709	123	145	1.61	97.4	97.3	96.9	95.0	400
15	3710	168	214	1.60	97.5	97.5	97.1	95.4	455
20	3711	196	235	1.34	97.9	97.9	97.5	96.0	820
25	3712	241	270	1.19	98.0	97.9	97.6	96.0	900
30	3713	276	295	1.09	98.1	98.1	97.7	96.2	1170
40 [`]	35271	349	352	1.00	98.3	98.2	97.9	96.4	1230
50	35272	435	- 382	.85	98.4	98.3	97.9	96.5	1600

FREQUENCY LIMITS, 60-140 CYCLES; NORMAL, 60 CYCLES; PRIMARY VOLTAGE, 1100 OR 2200 DATA BASED ON 1100 OR 2200 VOLTS, 60 CYCLES, SINE WAVE.

The average temperature rise of either primary or secondary will not exceed 50°C. in eight hours full load and 55°C. in twentyfour hours full load. Temperature rise determined by increase of resistance method.

GENERAL ELECTRIC TYPE HB OIL TRANSFORMERS

FREQUENCY LIMITS, 60-140 CYCLES; NORMAL, 60 C	YCLES; PRIMARY VOLTAGE, 1100 OR 2200
DATA BASED ON 1100 OR 2200 VOLTS	3, 125 CYCLES, SINE WAVE.

	Secondary Volts					Effic	iency		Net Weight
Kw.	110 or 220 Cat. No.	Core Loss		Per Cent. Reg.	Full Load	‡ Load	Load	Load	in Lbs. Inc. Oil
6 1	43678 43679	19 25	$15 \\ 24$	$2.60 \\ 2.53$	94 .6 95 .3	94 .2 95 .1	92.9 94.2	88.2 90.3	85 90
$\begin{array}{c} 1 \ .5 \\ 2 \end{array}$	43680 43681	31 36	28 34	1.99 1.80	$96.2 \\ 96.6$	96.0 96.5	95 .2 95 .7	91.9 92.9	100 165
2.5	43682 3716	39 43	$\begin{array}{c} 40\\ 47\end{array}$	$1.71 \\ 1.67$	$96.9 \\ 97.1$	96.8 97.0	$rac{96.2}{96.5}$	93.7 94.2	170 195
4 5	3705 3706	50 55	67 87	1.77 1.90	$97.2 \\ 97.2$	97 .2 97 .3	96.8 97.0	94 .9 95 .4	205 290
$\begin{array}{c} 7.5\\ 10 \end{array}$	3708 3709	72 87	120 145	1.77 1.61	97 .5 97 .7	97.6 97.8	97.3 97.6	95.9 96.3	325 400
$15 \\ 20$	3710 3711	119 139	$\begin{array}{c} 214 \\ 235 \end{array}$	1.60 . 1.34	97 .8 98 .2	97.9 98.2	97.7 98.1	96.6 97.0	455 820
25 30	. 3712 3713	171 196	$\begin{array}{c} 270 \\ 295 \end{array}$	1 .19 1 .09	$98.3 \\ 98.4$	98.3 98.4	98 .1 98 .2	97 .1 97 .2	900 1170
40 50	35271 35272	248 309	$\begin{array}{c} 352\\ 382 \end{array}$	1 .00 .85	98 .5 98 .6	98 .5 98 .6	98 .3 98 .4	97 .4 97 .4	1230 1600

The average temperature rise of either primary or secondary will not exceed 45°C. in eight hours full load and 50°C. in twenty-four hours full load. Temperature rise determined by increase of resistance method.

General Electric Transformers-Type H Improved Design 4535-13

GENERAL ELECTRIC TYPE HOIL TRANSFORMERS

FREQUENCY	LIMITS,	50-140	CYCLES;	NORMAL,	60	CYCLES;	PRIMARY
				00 OR 2200		•	

	Seconda	ry Volts		No. of 50-Watt	Approximate
Watts Capacity	110 or 220	122 or 244	Quarts of Oil Required	Lamps	Shipping Weight
	Cat. No.	Cat. No.			in Lbs. Inc. Oil
600	24041	24036	3.5	12	$\begin{array}{c} 105\\ 115\end{array}$
1000	24042	24037	3	20	
1500	$24043 \\ 24044$	24038	9	30	180
2000		24039	7.5	40	185
2500	24045	24040	8.5	50	220
3000	4125	4161	8	60	225
4000	4127	4164	17	80	330
5000	4129	4167	16	100	360
7500	4133	4173	29	150	445
10000	4135	4176	27	200	495
15000	4137	4179	60	300	865
20000	4139	4182	56	400	955
25000	4141	4185	100	500	1245
30000	4143	4188	96	600	1300
40000	4025	4026	150	800	1665
50000	4025	4096	144	1000	1700

Transformers for 1100 or 2200 volt service have porcelain connection boards for the primary coils, by means of which they may be adapted for either circuit. The secondary voltage may be changed by connections of the secondary leads outside of the transformers. Prices include oil, boxing, two primary fuse boxes, Cat. No. 51874, and transformer hanging hooks. If operated on 1100 volts, the 40 kilowatt and 50 kilowatt sizes should be provided with fuse boxes. Cat. No. 5606. which should be specially ordered Special prices will be quoted on transformers for other than 1100 or 2200 volt circuits.

GENERAL ELECTRIC TYPE HB OIL TRANSFORMERS

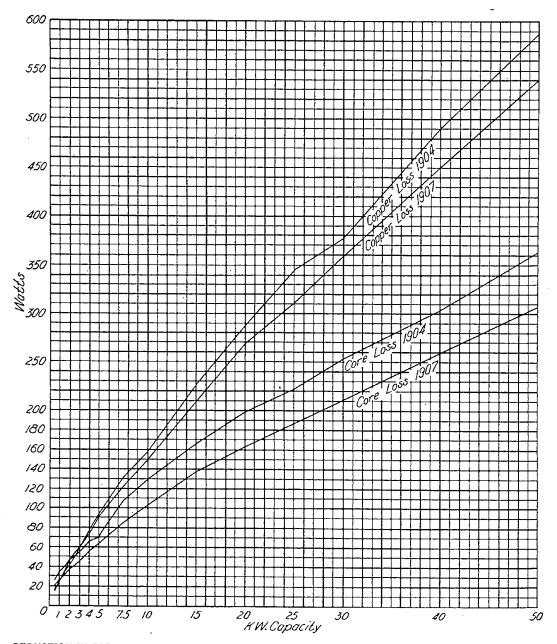
FREQUENCY LIMITS, 60-140 CYCLES; NORMAL, 60 CYCLES; PRIMARY VOLTAGE, 1100 OR 2200

Watts Capacity	Secondary Volts 110 or 220 Cat. No.	Quarts of Oil Required	No. of 50-Watt Lamps	Approximate Shipping Weigh in Lbs. Inc. Oil
600	43678	3	12	100
1000	43679	3.5	20	105
1500	43680	39	30	115
2000	(43681		40	185
2500	43682	· 7.5	50	190
3000	3716	8.5	60	220
4000	3705	8	80	$\begin{array}{c} 230\\ 325 \end{array}$
5000	3706	17	100	
7500 10000	3708 3709	$\begin{array}{c}16\\29\end{array}$	150 200	$\begin{array}{c} 360\\ 445\end{array}$
15000	3710	27	300	$\begin{array}{c} 500 \\ 875 \end{array}$
20000	3711	60	400	
.25000	3712	56	500	$\begin{array}{c} 955\\1240\end{array}$
30000	3713	100	600	
40000	35271	96	800	$\begin{array}{c} 1300 \\ 1685 \end{array}$
50000	35272	150	1000	

These transformers have porcelain connection boards for the primary coils, by means of which they may be adapted to either 1100 or 2200 volt circuits. The secondary voltage may be changed by connections of the secondary leads outside of the transformers. Prices include oil, boxing, two primary fuse boxes, Cat. No. 51874, and transformer hanging hooks. If operated on 1100 volts, the 40 kilowatt and 50 kilowatt sizes should be provided with fuse boxes, Cat. No. 5696, which should be specially ordered.

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4535-14 General Electric Transformers-Type H Improved Design



REDUCTION IN CORE AND COPPER LOSSES OF GENERAL ELECTRIC TYPE H TRANSFORMERS, 1904 TO 1907

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

SALES OFFICES.

BOSTON, MASS., 84 State Street. NEW YORK, N. Y., 44 Broad Street. SYRACUSE, N. Y., Sedgwick, Andrews & Kennedy Building. BUPPALO, N. Y., Ellicott Square Building. NEW HAVEN, CONN., Malley Building. PHILADELPHIA, PA., 218-226 South Eleventh Street. BALTIMORE, MD., Continental Trust Building. CHARLOTTE, N. C., Trust Building. PITTSBURG, PA., Park Building. ATLANTA, GA., Empire Building. NEW ORLEANS, LA., Hennen Building. CINCINNATI, OHIO, Perin Building, Fifth and Race Streets. COLUMBUS, O., Columbus Savings & Trust Building. CLEVELAND, OHIO, Citizens' Building. NASHVILLE, TENN., Stahlman Building. CHICAGO, ILL., Monadnock Building. DETROIT, MICH., Majestic Building. ST. LOUIS MO., Wainwright Building. KANSAS CITY, Mo., 2114 Central Street. ORLAHOMA CITY, OKLA., Culbertson Building. DALLAS, TEXAS, Scollard Building. HELENA, MONTANA, Power Block. DULUTH, MINN., Providence Building. MINNEAPOLIS, MINN., Pheonix Building. DENVER, COLO., Kittredge Building. SALT LAKE CITY, UTAH, Dooly Building. SAN FRANCISCO, CAL., Union Trust Building. Los Angeles, Cal., Delta Building. PORTLAND, ORE., Worcester Building. SEATTLE, WASH., Alaska Building. FOREIGN. FOREIGN DEPARTMENT. Schenectady, N. Y., and 44 Broad Street, New York, N. Y. LONDON OFFICE. 83 Cannon Street, London, E. C., England. For all CANADIAN Business, Canadian General Electric Company, Ltd., Toronto, Ont.

General Electric Company Schenectady, N.Y.

RAILWAY DEPARTMENT

September, 1907

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RAILWAY SIGNALS, TOP MAST, DIRECT CONNECTED TWO POSITION TYPE

In order to meet the demand for a simple motor signal for two-position operation, the

> General Electric Company has developed a signal, known as the M-113, which is believed to mark as great an advance over other

> > two-position signals as was made by the M-110

Fig. 1

signal (see G. E. Bulletin 4484), over three-position signals of older types. This new design embodies all of those features which have been found

to be desirable in electric motor signal construction. Special attention has been given not only to simplicity of design, but to the choice of the best possible material for each part. This, combined with the ample proportions of all wearing surfaces, insures long life and the highest attainable efficiency. These signals have undergone an extended test under all kinds of weather conditions, and special tools have been designed for their production. They are now offered to the railroads as representing the best that has been produced in signals of this class.

The M-113 signal belongs to what is known as the top mast, or direct connected type. There are several practical advantages to be gained by the location of the motor and operating mechanism at the top of the signal mast, at the point where the work is to be done, these are as follows:

Simplicity. With mechanism located at the base of the mast it is necessary to change from the rotary motion of the motor and gears to a straight line motion, and to provide means for transmitting this motion to the top of the mast in such a way as to turn the signal shaft, or spindle, and give the proper indication of the signal arm. With top mast construction, this is avoided and a

> simplicity, rigidity and compactness of design is secured which is impossible with any other location of the motor mechanism.

> **Reliability.** Because of the greater simplicity, and the consequent reduction in friction, the apparatus is much less liable to derangement.

> > On account of this construction, the insulation of the entire mechanism and case from the mast becomes an easy matter,

and thus a large percentage of the troubles due to grounded wires is

avoided. Economy. The reduc-

tion in the

number of

Fig. 2

Fig. 3

moving parts and consequently in the friction, results in a marked reduction in power consumption. This is a matter the 4536-2 Railway Signals, Top Mast, Direct Connected Two Position Type

importance of which is second only to that of rehability; and is of special moment where signals are operated from primary batteries.

Installation. All moving parts of the signal being contained in, or attached to, the mechanism case at the top of the mast, the signal can be installed with a minimum of labor on any kind of a pole. This feature is especially valuable in temporary installations or repair work, as the signal can be easily placed on a pole, and wires run to the proper terminals in the case when the installation will be complete.

Maintenance. Objections to top mast signals are based principally on the ground of difficulty of maintenance. Experience has shown, however, that from the standpoint of maintenance, the top mast signal has a distinct advantage over those of the other class. It requires less attention on the part of the maintainer than one located near the surface of the ground because the mechanism is away from water and surface moisture, so that there is much less accumulation of dirt and condensation of water inside the case. Furthermore, all parts of the signal requiring inspection or care, are placed at one point, and may, therefore, be readily inspected when any part of the signal is examined. A small but convenient platform is provided for the maintainer.

MECHANISM

Figure 4 shows the M-113 signal mechanism complete in the position corresponding to the stop position of the blade.

The supporting frame of the mechanism which carries the bearings for the signal shaft and the reduction gearing, is made so as to form a weather proof case. The joint between the door and the case is made with a gasket of elastic felt, which is specially adapted to this purpose. At the bottom of the case, and cast integrally with it, is the socket by which it is secured to the top of the mast. Inside this socket is an insulating bushing which eliminates the possibility of grounds, even if the wiring comes in contact with the case or if, through accident, the insulation of any current carrying part of the mechanism be broken down. A similar socket is provided at the top of the case for the reception either of the pinnacle, should the signal be at the extreme top of the mast, or an extension of the mast, if one or more mechanisms are to be placed above.

The form of the case is such that, with a suitable bracket for supporting the lamp, any of the various standard spectacle castings now in use may be applied to the signal. The whole external design presents a symmetrical appearance when mounted on the mast, and its shape is such that it does not interfere with the distinct indication of the semaphore arm.

The operating parts of this signal consist primarily of a motor, reduction gears, means for engaging and disengaging the signal shaft from the driving gear, means for preventing shock to the signal parts when the signal returns by gravity to its stop position, and the necessary electrical contact devices for securing the desired movements.

The motor is but a slight modification of that used in the M-110 (3-position type) signals. It is of the best possible construcsion throughout. The entire magnetic circuit is made of laminated steel of the best quality.

The field coils are wound with enamelled magnet wire, which is water proof and of high insulation resistance and puncture test. Each coil is finished with several layers of insulating tape which support the coil so that no spool is necessary and the best possible insulation is secured. The motor field is compounded, and the series and shunt coils are separate, to guard against the possibility of a cross connection and to lessen the cost of repairs, in case a coil should become injured. The purpose of this compound winding will be apparent from a further description of the signal.

The armature is wound with double cotton covered magnet wire on a well insulated core.

GENERAL ELECTRIC COMPANY Railway Signals, Top Mast, Direct Connected Two Position Type 4536-3

The armature is afterward treated by the vacuum japan process, so that all the insulation is thoroughly impregnated with an insulating compound which renders it water proof and greatly increases its insulation resistance.

The commutator is of the best possible construction and of ample size, so that its life is practically

unlimited.

The motor bearings are carefully made and provided with oil wells and ring lubrication.

The brushes are laminated copper of ample carrying capacity, and are provided with brush holders which insure a minimum variation in contact pressure and are easily adjusted. The supporting studs, on each of which are mounted two brushes, are thoroughly insulated by mica from the motor frame, and are permanently connected to the

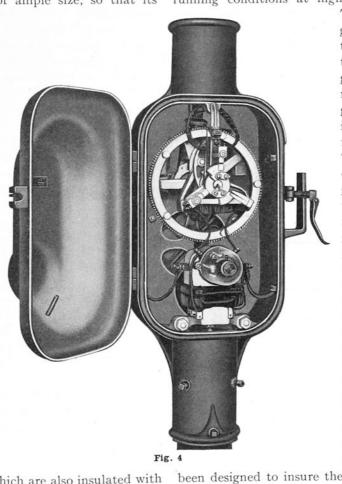
motor terminals which are also insulated with the best quality of mica. The commutator is protected by a cover of clear glass, which is held in place by means of a threaded stud fastened to the outer bearing. The knurled nut which secures the commutator cover is fastened permanently to the glass, so that it cannot be lost or mislaid. Inside the commutator cover, and next to the commutator itself, is a ball ratchet, which prevents a backward rotation of the motor. The func-

tion of this ratchet will be explained later.

The reduction gearing of this signal has received most careful attention. The gears are accurately cut on automatic machines. The motor pinion and the gear with which it meshes are made of alloys which differ in their composition, so as to secure the best running conditions at high rotative speed.

The intermediate gear is made of the same alloy as the high speed gear, while the main driving gear is of cast iron and of very rugged design. The pinion which drives the main gear, as well as that driving the intermediate gear, are of high grade steel, and each with its shaft is formed in one piece, thus insuring the most substantial construction and preventing the possibility of a pinion working loose. The shafts are accurately finished to gauge, and special tools have

been designed to insure the accurate finish of the bearings to secure perfect alignment and mesh of the gears. It is on account of the accuracy of this work that this signal operates with so little friction. The high speed gear and the motor pinion are protected by a case attached to the inside of the frame, while the intermediate gear and its pinion are protected by a gear case made of a single piece and bolted to the outside of the frame with which it makes a weather-proof joint.



GENERAL ELECTRIC COMPANY 4536–4 Railway Signals, Top Mast, Direct Connected Two Position Type

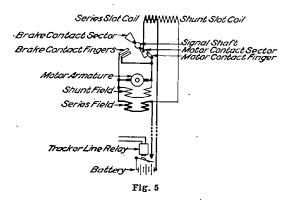
To the face of the main gear are attached driving pins of case hardened steel. The engagement of these pins with the pawl of the slot-arm fastened to the signal shaft moves the signal from stop to proceed position. The slot-arm is mounted on a squared portion of the signal shaft by means of an accurately broached square hole in its hub. This slot-arm carries the so-called slot-magnet, the armature of which is attached to one end of a bell crank lever. The other end of this lever is attached to the pawl which is drawn into position for engagement with the driving pins whenever the slot-magnet is energized. The slot-magnet coils consist of enamelled wire, of the same quality used in the motor field coils, wound on spools separate from the magnet cores, so that they can be readily replaced in case of injury. Each leg of the slot-magnet carries two coils; the series coil is connected in the motor circuit, and the shunt coil connected outside of the control contacts which break the motor circuit. Current is carried to this moving slot-coil by means of two segmental collector rings and heavy German silver contact fingers engaging with them. The outer end of the series coil is connected directly to the motor control contact sector.

It will be noted that no flexible moving wires are used in this machine.

On the signal shaft, directly back of the main gear, is mounted an eccentric. The strap of this eccentric is cast in one piece with the cylinder of the dash-pot, or liquid buffer, which prevents shock to the mechanism when the signal returns by gravity to its stop position. The area of this dash-pot is such that ample retardation is secured without resort to any form of packing, or the use of small ports which are liable to become clogged. The eccentric is so arranged as to give no retarding effect at or near the clear position of the signal, so that the first movement is rapid and the signal is retarded in ample time to prevent any injurious shock. The dash-pot is filled with a light oil, which is specially imported for this purpose, and

does not materially change with a reduction of temperature to 50° F. below zero. Means are provided to effectually exclude all dirt from both the cylinder itself and all portions of the piston rod. The upper end of the piston rod is fastened to a piece which is journaled on a shaft at the top of the signal case or frame.

The circuit controller which governs the movement of the signal, is mounted at the end of the main shaft where it may be most conveniently inspected. This controller consists of contact fingers, made of hard rolled German silver, engaging with contact sectors which are made of a special non-corrosive metal that is extremely hard and has been found to be most suitable for this purpose. The contact sectors are mounted on a collar which is securely fastened to the main shaft,



but from which it can be readily removed. They are insulated from this collar by means of a moulded insulating material which is specially adapted to this purpose. The fingers for engagement with these sectors are mounted on studs held in a casting which is journaled on the main shaft and prevented from rotating by means of a projection at the top of the case. The motor contact stud is provided with a quick break device to prevent burning. The whole construction of these parts is very substantial and, as all parts are made interchangeable and to accurate gauges, no adjustment is necessary.

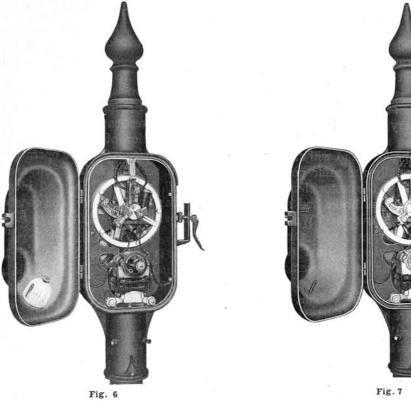
All of these signals are provided with a substantially constructed counting device

GENERAL"ELECTRIC COMPANY Railway Signals, Top Mast, Direct Connected Two Position Type 4536-5

for registering the number of movements. This device has been made a part of the General Electric Company's standard mechanism, as it is believed that a careful record of the operation of each signal is extremely desirable, and conducive to the best results.

OPERATION

When the signal circuit is closed, current will flow through the shunt coils of the slotmagnet, and in another circuit through the drawn away by pressure of the driving pins against the pawl. The slot-magnet being energized, the pawl is held in the path of the driving pins, and, as the motor revolves, one of the driving pins, is forced against the pawl thereby turning the slot-arm and the signal shaft to which it is connected. When the arm of the signal has come almost to its extreme position of "proceed," the motor current is broken by means of the controller, but this does not arrest the movement of the signal,



series coil of the slot-magnet, and thence through the motor control sector and its contact fingers to the armature and series field of the motor. At the same time a portion of the current will flow around the armature of the motor through the shunt field. As the armature of the slot-magnet is resting against the stop pins in the pole pieces when the signal is in the stop position (see Figure 4) only sufficient energy is required in the slot-magnet to hold the armature from being



on account of the inertia of the revolving armature and other parts. It is evident that, on account of a shunt field winding, the motor, driven by its own inertia, becomes a generator maintaining its field excitation. Immediately after the circuit between the motor and the battery is opened, connection is made through another contact sector closing a low resistance circuit between the motor brushes, thus converting the motor into a powerful electric brake to arrest the further

movement of the signal. A diagram of the circuits which accomplished this result is shown in Fig. 5. As soon as the motor stops, the ball ratchet, before mentioned, prevents any backward rotation of the motor armature and the signal is held in its clear position, as shown in Figure 6, until the main circuit between the signal and battery is opened. It will be understood that the higher the voltage of the battery the greater will be the speed of the motor at the time the battery current is cut off and the greater will be the inertia of the moving parts. It is also evident that the greater the speed of the motor the higher will be the E. M. F. generated in its armature, and the greater will be the current opposing its forward movement when it is acting as a generator. It will, therefore, be seen that, whatever the voltage of the battery, the motor will make practically the same number of revolutions after its current is broken, and will stop the signal arm at essentially the same position. This method of stopping the motor eliminates the necessity for a friction brake and at the same time secures better results. When the main signal circuit is opened, and the slotmagnet de-energized, its heavy armature falls away from the cores, and this movement is assisted by the pressure of the driving pin against the pawl (see Figure 7). This movement of the armature throws back the pawl from engagement with the driving pin, and the signal shaft, together with the slot-arm, are free to assume the position to which they are normally carried by gravity. As the signal arm comes to its stop position, the rotation of the slot-arm causes the armature to swing back against the poles of the magnet so that it is in position to be held firmly in place when current is again applied, as shown in Figure 4.

ACCESSIBILITY OF PARTS

An important advantage of this type of construction, resulting largely from the amount of space around the mechanism, is the accessibility of all parts of the mechanism, and the readiness with which any part may be removed, in case repairs or renewals become necessary. By unscrewing two nuts, shown at the bottom of the motor base and disconnecting the wires, the motor may be quickly removed. By detaching from the main shaft the collar, above mentioned, which supports the contact sectors, the circuit controller, slot-arm, main driving gear and dashpot can be quickly and easily removed.

The proper lubrication of this signal has also received careful attention. Not only have all parts been made easy of access for oiling, but means have been provided in all bearings to retain sufficient oil so that frequent oiling is not necessary to its successful operation.

All the interior wiring is carefully done, and terminals of ample proportions are provided for all wires leading into the case.

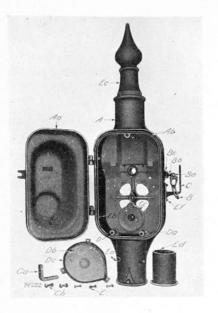
The construction of the case, or frame, is well shown in *Figure 8*. The operating parts of the signal, aside from the motor, are shown in *Figure 10*, from which a good idea of its simplicity can be obtained. The construction of the motor itself is fully shown in *Figure 9*.

* ADAPTABILITY

In case it is desired to use this mechanism for upper quadrant indication, the change can be readily effected. The motor is reversible with a slight alteration in connections and a reversal of the brushes. The gearing is symmetrical with respect to the vertical axis of the signal, and the slot-arm and other parts are designed so as to be reversible. It is evident, therefore, that this change can be effected quickly and at practically no expense.

This signal, as has been stated, is designed primarily for two-position operation. With the proper circuit controller it may be used to give three-position indications, in which case, however, in indicating a "back-up" train movement, the signal arm will first go to "stop" and then immediately assume the proper "caution" position. The General Electric Company's top mast, three-position, M-110 signal, and the Company's Signal Relays are described in Bulletins on these subjects.

CASE FOR M-113 SIGNAL MECHANISM

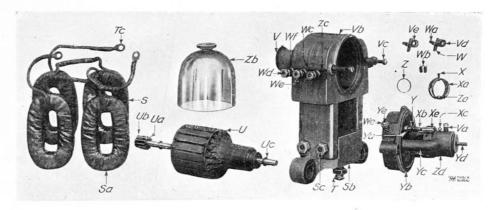


- A Mechanism Case.
- Aa Door with Hinge Pins.
- Ab Gasket for Door.
- B Hasp for Door.
- Ba Hasp Nut with Rivet.
- Bb Hinge Bolt with Rivet.
- Bc Hinge Bolt Lug with Rivets.
- C Lamp Bracket.
- Ca Stop for Semaphore Spectacle.
- Cb Bolt with Nut for Spectacle Stop.
- Cc Gear guard with Screw.
- D Motor Stud.
- Da Nut for Motor Stud.
- Db Outside Gear Cover.
- Dc Gasket for Gear Cover.
- E Bolt with Nut for Gear Cover.
- Ea Set Screw for Case.
- Eb Wiring Cleat with Screw,
- Ec Pinnacle.
- Ed Insulator for Case.
- Ef Bolt with Nut for Lamp Bracket.

When ordering, state type of signal from name plate. Give name of part and corresponding reference letter.

Fig. 8

PARTS OF SIGNAL MOTOR, CY-18-C-5



- S Series Field Coil.
- Sa Shunt Field Coil.
- Sb Motor Base.
- Sc Bolt for Motor Base with Nut.
- T Adjusting Screw with Nut.
- Tc Cable Terminal.
- U Armature Complete with Pinion and Taper Pin.
- Ua Armature Pinion.
- Ub Taper Pin for Armature Pinion.
- Uc Washer for Armature Shaft.
- V Bearing Cap, (Pinion End).

Va Oil Cup.

Fig. 9

- Vb Field Frame.
- Vc Screw for Motor Yoke.
- Vd Brush-holder (Right).
- Ve Brush-Holder (Left).
- W Motor Brush.
- Wa Brush-Holder Set Screw.
- Wb Brush-Holder Spring.
- We Motor Terminal Block, with Mica.
- Wd Terminal Stud complete.
- We Terminal Nut.
- Wf Clamping Nut for Terminal.

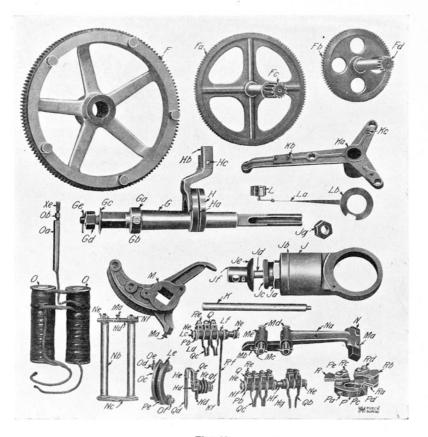
Railway Signals, Top Mast, Direct Connected Two Position Type 4536 - 8

- Х Screw for Ball Retaining Ring.
- Xa Ball Retaining Ring.
- Xb Brush-Holder Stud complete.
- Xc Motor Bearing Set Screw.
- Xe Knurled Cap-Nut.
- Υ Set Screw for Brush-Holders.
- Insulation for Brush-Holder Stud. Ya
- Leather Gasket for Commutator Cover. Yb
- Yc Motor Yoke.
- Yd Bearing Cap with Stud for Commutator Cover.

- Ye Motor Terminal complete with Insulation.
- Z Oil Ring.
- Za Ball $\frac{5}{16}$ " diameter.
- Commutator Cover with Clamping Nut. Zb
- Zc Screw Fastening Terminal Block (not shown in cut).
- Zd Armature Bearing, (not shown in cut).

When ordering, state type of signal from name plate. Give name of part and corresponding reference letter.

PARTS OF M-113 SIGNAL MECHANISM



- F Driving Gear complete.
- Fa Intermediate Gear.
- Fb High Speed Gear.
- Driving Pinion with Taper Pin. Fc
- Fd High Speed Pinion with Taper Pin.
- G Main Shaft with Keys.
- Collar for Main Shaft. Ga
- Screw for Shaft Collar. Gb
- Gc Washer for Main Shaft.
- Gd Nut for Main Shaft.
- Ge Cotter Pin for Main Shaft.
- H Eccentric.

Fig. 10

- Ha Lubricating Felt for Eccentric.
- Safety Stop. Hb
- Hc Clamping Screw with Nut for Safety Stop.
- Hd Motor Contact Stud with Insulating Sleeve only.
- He Motor Contact Stud Complete, as shown.
- Upper Contact Stud with Insulating Sleeve Hf only.
- Hg Upper Contact Stud complete as shown. T Buffer.
- Cap with Screens. Ja
- Jb Lead Gasket.

Jc	Knurled Nut for Buffer Piston.
Jd	Buffer Piston complete.
Je	Buffer Shield.
Jf	Buffer Coupling, with Cotter Pin.
Jg	Nut for Buffer Piston.
K	Connecting Pin for Buffer.
Ka	Contact Stud Support.
Kb	Screws for Counter.
Ke	Fiber Locking Pin.
Kd	Locking Plate.
Ke	Insulating Washer for Motor Stud.
Kf	Insulating Tube for Motor Stud, not shown.
L	Counter.
La	Counter Link with Rivets.
LЪ	Counter Collar.
Lc	Brake Contact Stud with Insulating Sleeve only.
Ld	Brake Contact Stud Complete as shown.
Le	Collector Segment Terminal Screw, with Washers.
Lf	Spacer for Brake Contact Stud.
М	Slot Arm.
Ma	(No. 14-24 Screws, F.H. Steel 1" long.)
МЬ	Pawl for Slot Arm.
Mc	Pawl Pins $\frac{7}{16}$ " c 11" with Cotters.
Md	
Me	Pawl Link.
Ν	Slot Armature.
Na	Armature Lever.
NЬ	Magnet Core with Nut and Washer.
Nc	Magnet Core Support.
Nd	Magnet Yoke.
Ne	$\frac{5}{16}$ Steel Nut.
370	E a 777 /

- Nf $\frac{5}{16}''$ Washer.
- O Slot Coil.

- Oa Square Insulating Sleeve.
- Ob Terminal for Motor Sector.
- Oc Collector Segment.
- Od Collector Segment Screw, (No. 14-24 R.H. 1⁴/₄ long) with Washer.
- Oe Brass Spacer for Segment Screw.
- Of Insulating Washer for Collector Segments.
- P Contact Sector Collar with Screw and Counter Pin.
- Pa Set Screw for Sector Collar.
- Pb Insulating Washer for Contact Studs.
- Pc Contact Sector Spacer 4" Thick.
- Pd Contact Sector Spacer #" Thick.
- Pe Insulating Tube for No. 14 Screw, (not shown in cut).
- Q Contact Finger Terminal.
- Qb Collector Finger.
- Qc Contact Finger.
- Qd Motor Fingers complete with Support, Terminal and Studs.
- Qe Screw for Motor Terminal.
- Qf Nut 3"-16.
- R Motor Contact Sector.
- Ra Brake Contact Sector.
- Rb Contact Sector for Additional Circuit.
- Rc Sector Screw, (No. 14-24 R.H. 1⁴ long), with Washer.
- Rd Sector Screw, (No. 14-24 R.H. 2" long), with Brass Washer.
- Re Terminal Screw with Nut.
- Rf Brake Circuit Connector.
- Xe Knurled Cap-Nut.

When ordering, state type of signal from name plate. Give name of part and corresponding reference letter.



SUPPLY DEPARTMENT

October, 1907

Bulletin No. 4543

PARTS OF R 53-A CONTROLLER 49071+ \$49079 St PUBLIN

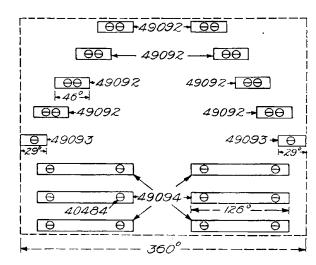
R 53-A Controller, Complete

Cat. No.	Description L	ist Price
23912	*Operating handle, malleable iron	\$2.50
	Following are the Interchangeable parts:	
49062	FRAME, complete, includes lining, spring and pawl posts and pole piece hinge pin	
49065	Cap for top of controller with spring catch for cover, and pole piece hinge pin	
49066	Spring Catch with rivets, for cover per 100	5.00
24242	Screw fastening No. 49065 to frame (3/8"-16, 1" R.H.)per 100	
49067	Sheet iron cover, complete per 100	4.00
49068	HINGED POLE PIÈCE	2.50
49069	Upper hinge pin for pole piece (5/16" x 1")per 100	1.50
49070	Lower hinge pin for pole piece (5/16" x 1 1/8")per 100	
37712	Spring catch, complete, with two screws, for pole piece	

* Not included in complete controller; must be ordered separately.

PARTS OF R 53-A CONTROLLER

Cat. No. Description List Price 306 Screw for No. 37712 (10-24, 3/4" F.H.).....per 100 \$3.00 49071 ARC DEFLECTOR, complete..... 2.50 10884*(Screw fastening No. 49071 to pole piece (10-24, 1 1/4" R.H.)per 100 .60 49072 ** Insulating bushing used with No 10884..... .08 BLOW-GUT COIL, wound, complete, with leads and connector..... 49073 : 7.00 49074 Two-Way Connector with screw, for lead..... .15 23261 Sinding screw for No. 49074 (8-32, 1/4" R.H. Blued)per 100 .75 49025 Retaining plate for blow-out coil..... .50 49076 CYLINDER, complete, with shaft, insulation disks, collar and star wheel 35.00 49077 Complete se of copper contact segments, with screws......per set 3.00 Contact segments and screws for same are listed on page 2. 40474 Insulation disk..... .25 49078 Collar for shaft with pin..... .20 Star wheel with pin, must be fitted..... 49079 1.15 49080 . Check pawl with roller and pin for tension spring..... .60 49081 Roller, with pin..... .10



49082	Pin fastening tension spring to pawlper 100	4.00
49083	Pivot pin for pawl	.10
49084	Washer for No. 49083 (7/16" x 13/16" x .094")	3.50
15519	Spring cotter for No. 49083 (3/32" x 3/4")per 1000	2.00
13632	Tension spring for pawl (26 turns, .091" black spring wire)	.06
49095	Pin fastening spring to frameper 100	3.50
49096	CONTACT BOARD, complete, with anchor blocks, without fingers	3.00
19685	Screw fastening No. 49096 to frame (14-24, 7/8" R.H. Blued)per 100	.85
14426	Washer for No. 19685 (17/64" x 1/2" x .060" Brass)per 100	1.00
37976	Contact finger, with spring	.29
49085	Finger stop	.35
38551	Set screw for No. 49085 (8-32, 7/16" R.H Blued)per 100	.50
49086	Copper terminal for contact fingerper 100	2.50
49087	Screw fastening Nos. 37976, 49085, 49086 to contact board (14-24, 1/2" Fill. H.	
	Blued)per 100	1.50
49088	Finger shield, with barriers	1.15
49089	Insulation strip under contact board	.15
49090	Wire guardper 100	3.00
49091	Screw fastening No. 49090 for frame (10-24, 5/16" R.H. Blued)per 100	.80

Parts of R 53-A Controller 4543-3

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⁶ 49065—1	49080-2	

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RAILWAY DEPARTMENT

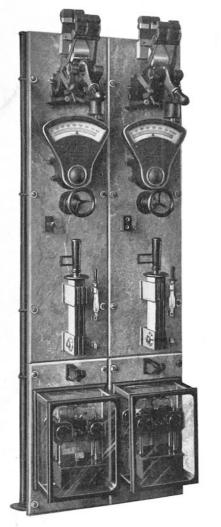
December, 1907

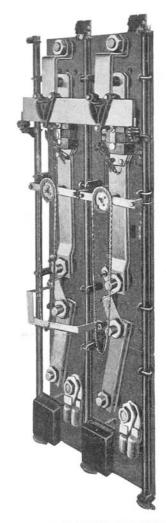
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*Bulletin No. 4544

SW

CONTINUOUS CURRENT RAILWAY SWITCHBOARDS





FRONT AND BACK VIEWS OF CONTINUOUS CURRENT ROTARY CONVERTER PANELS WITH WATTMETERS ON SUB-BASES

railway use, manufactured by the General Electric Company, is the result of continued

The present design of switchboards for improvements in previous designs. Simplicity of arrangement, facility of installation, reliability and safety in operation and long

*Superseding Bulletin No. 4387.

4544-2 Continuous Current Railway Switchboards

life are the important features of these switchboards.

Although each panel is an independent unit and may be ordered separately, the panels are especially designed to be used together to form switchboads, regardless of the great difference in capacities which has necessitated using two heights of panels.

This bulletin covers several classes of panels, all of which are for 600

V. continuous current railway service, the negative bus being grounded. The following types of panels are included:



Generator panels, including circuit breaker and equalizer switch panels.

Rotary converter panels.

Feeder panels for one circuit.

Feeder panels for two circuits with one ammeter per panel.

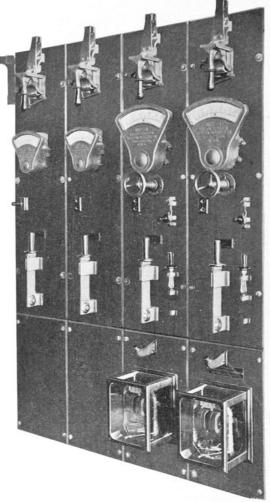
Feeder panels for two circuits with two ammeters per panel.

In order to reduce the number of parts on each type of panel, and particularly with a view to minimizing the chance of a short circuit, the General Electric Company has designed and standardized generator, converter and feeder panels furnished with main current carrying parts of positive polarity only.

The circuit breakers, ammeters, rheostat hand-wheels, switches and other devices are of uniform design and occupy corresponding positions on all the panels, regardless of the capacity or style of the panel, thus giving a symmetrical appearance to a switchboard composed of any combination of generator, converter and feeder panels.

GENERATOR PANELS

Until recently it has been the custom to connect railway generator panels in the negative side of the circuit in order that the circuit breaker would protect the machine in case of an accidental ground on the positive side of the machine, or in the armature winding, this arrangement involving the mounting of the positive and equalizer switches on pedestals or panels beside the machines. These switches must be carefully protected from accidental contact with crane chains or anything else which would form a ground connection and the operator must be careful to open them before working on the machine or near the pedestal. As the feeder panels



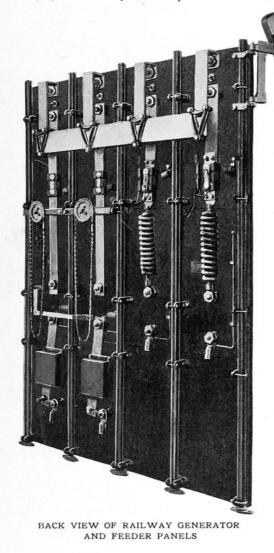
FRONT VIEW OF RAILWAY GENERATOR AND FEEDER PANELS WITH VOLTMETERS ON SWINGING BRACKET

are necessarily connected in the positive side of the circuit, it will be seen that both polarities must be brought to the switchboard when negative generator panels are used, involving

Continuous Current Railway Switchboards 4544-3

more cable than is necessary when positive generator panels are used.

The positive generator panel arrangement is also preferable because no change is necessary in case rotary converters are added to the equipment, to operate in parallel with the



generators. Direct current rotary converter panels are always connected in the positive side, as the automatic device in the alternating current side offers ample protection from grounds in the machine.

In addition to the advantages spoken of above there are several less important advantages gained by the use of positive generator panels, and the General Electric Company has consequently standardized these panels, although this connection necessitates the use of an additional circuit breaker, on the negative side of the machine, connected inside

> of the series field. This circuit breaker is intended to protect the machine in case of an accidental ground on the positive side or in the armature winding and should be set for

a higher current than the switchboard breaker in order that both breakers will not trip in case of overloads.

The negative circuit breaker and the equalizer switch are mounted on a small panel designed for installation close to the machine controlled. It is not necessary to use negative circuit breakers with generators driven by electric motors, as the automatic switches or fuses in the alternating current side offer ample protection from grounds in the direct current machines.

Generator panels are made in capacities ranging from 250 amperes to 6250 amperes. No negative switches are used as the series fields are connected permanently to ground.

The standard panels covered by catalogue numbers are equipped with:

1 Carbon break circuit breaker.

1 Thomson illuminated dial ammeter with shunt.

1 Hand-wheel and chain operating mechanism for rheostat.

1 Potential receptacle.

1 S. P. S. T. carbon break field switch with discharge clip.

1 Card holder.

1 S. P. S. T. plain lever main switch.

1 S. P. D. T. quick break station lighting switch, for panels controlling generators from 100 Kw. to 1200 Kw. inclusive.

1 Thomson recording wattmeter (optional).

1 Lightning arrester for positive side (not mounted on panel)

4544-4 Continuous Current Railway Switchboards

Supporting framework and tie rods.

All connections on back of panel including bus-bars.

1 Circuit breaker and equalizer switch panel.

ROTARY CONVERTER PANELS

The single polarity panels designed for the control of the continuous current end of rotary converters are similar, in most respects, to the generator panels. They are not provided with field switches, as suitable field break-up switches are included with all railway converters manufactured by the General Electric Company. The equalizer switches are mounted on the frames of the machines and included in the price of the converters and no negative switches are required as the series fields are connected permanently to ground. The circuit breakers are provided with low voltage release coils which trip the breakers if the voltage drops below a certain point. These low voltage release coils are also used in connection with a centrifugal speed limiting switch which is mounted on the rotary converter shaft and which short-circuits the low voltage release coil and opens the circuit breaker in case the speed exceeds normal by a predetermined amount.

Rotary converter panels are made in capacities ranging from 250 amperes to 3750 amperes. The standard panels are each equipped with:

1 Carbon break circuit breaker with low voltage release coil.

1 Thomson illuminated dial ammeter with shunt.

1 Hand-wheel and chain operating mechanism for rheostat.

1 Potential receptacle.

1 Card holder.

1 S. P. S. T. plain lever main switch.

1 S. P. D. T. quick break station lighting switch, except for 1500 Kw. panels.

1 Thomson recording wattmeter (optional).

1 Lightning arrester for positive side of circuit (not mounted on panel).

Supporting framework and tie rods.

All connections on back of panel including bus-bars.

The rotary converter panels listed in this bulletin are designed on the basis of the converters being started only from the alternating current side. If it is especially desired to

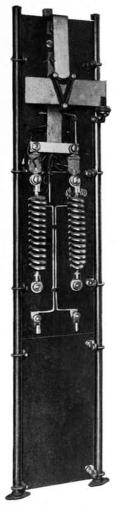


FRONT VIEW OF TWO CIRCUIT FEEDER PANEL

start from the direct current side, one multipoint starting rheostat switch can be added to the standard equipment. For 60 cycle rotary converters the General Electric Company recommends the 'installation of both alternating and direct current starting devices. Continuous Current Railway Switchboards 4544-5

CIRCUIT BREAKER AND EQUALIZER SWITCH PANELS

These panels are designed for mounting beside the machines and are self-supporting. The backs of these panels are enclosed with



BACK VIEW OF TWO CIRCUIT FEEDER PANEL

a metal cover which is removable. The panels are mounted 28" above the floor, the space below the panel also being enclosed by expanded metal.

FEEDER PANELS

Feeder panels are made in three styles, as described below.

Potential receptacles are included with each feeder circuit to allow of the trolley voltage being read (before closing the feeder switches) in cases where feeders are interconnected or continued to other sources of power.

The feeder panels for one circuit are each equipped with:

1 Carbon break circuit breaker.

1 Thomson feeder type ammeter with shunt.

1 Potential receptacle.

1 Card holder.

1 S. P. S. T. plain lever switch.

1 Kicking coil.

1 Lightning arrester (not mounted on panel).

All necessary supports and tie rods.

All connections on back of panel including bus-bars.

The feeder panels for two circuits with one ammeter per panel are each equipped with:

1 Carbon break circuit breaker.

1 Thomson feeder type ammeter with shunt.

2 Potential receptacles.

2 Card holders.

2 S. P. S. T. plain lever switches.

1 Kicking coil.

2 Lightning arresters (not mounted on panel).

All necessary supports and tie rods.

All connections on back of panel including bus-bars.

The feeder panels for two circuits with two ammeters per panel are each equipped with:

1 Carbon break circuit breaker.

2 Thomson feeder type ammeters with shunts.

2 Potential receptacles.

2 Card holders.

2 S. P. S. T. plain lever switches.

2 Kicking coils.

2 Lightning arresters (not mounted on panel).

All necessary supports and tie rods.

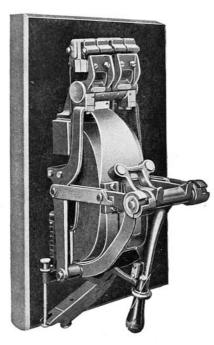
4544-6 Continuous Current Railway Switchboards

ing bus-bars.

All connections on back of panel includ- of these circuit breakers are given in other Bulletins.

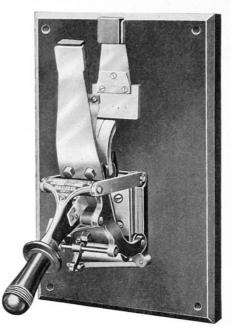
CIRCUIT BREAKERS

The panels listed in this bulletin are equipped with carbon break circuit breakers which have proven very satisfactory for the severe conditions met in railway service and which are of more recent design than the magnetic blowout type formerly used. Type "C" form "P" circuit breakers are used for all capacities up to and including 1200



TYPE C, FORM K, CARBON-BREAK CIRCUIT BREAKER :650 Volts, 10000 Amps.

amperes. Above this capacity type "C" form "K" circuit breakers are used. All circuit breakers are equipped with auxiliary switches for connection to an alarm bell or an indicating lamp circuit. If it is desired to leave any circuit breaker in the open position, the tell-tale switch may be opened by hand to cut out the bell or lamp. When the circuit breaker is again closed the tell-tale switch is automatically reset. Descriptions



TYPE C, FORM P, CARBON-BREAK CIRCUIT BREAKER 650 Volts, 800 Amps.

INSTRUMENTS

Thomson Astatic Illuminated Dial Instruments are used in connection with generator and rotary converter panels. The ammeters are of the electro-magnetic type, but the voltmeters are constructed with permanent magnets in order that they may indicate reversal of polarity by a deflection of the pointer to the left of zero.

The voltmeters are not mounted on the panels, but are arranged for mounting on a swinging bracket at the end of the switchboard, each panel being supplied with a potential receptacle for connecting the voltmeter to the machine or feeder controlled by that panel. Although brackets are designed for either one or two voltmeters, it is preferable to have two and connect one permanently to the bus, and the other to the potential receptacles for reading the voltage of any machine or feeder.

Voltmeters and potential plugs may be ordered as follows:

Continuous Current Railway Switchboards 4544-7

One 750-Volt Thomson Astatic Illuminated Dial Voltmeter, permanent magnet type, including swinging bracket and 2-point potential plug, Cat. No. 58435.

Two 750-Volt Thomson Astatic Illuminated Dial Voltmeters, permanent magnet type,



THOMSON ASTATIC AMMETER

including swinging bracket and 2-point potential plug, Cat. No. 58436.

Thomson Astatic Ammeters, Feeder Type, are furnished on all feeder panels. These instruments are identical in principle with



THOMSON ASTATIC VOLTMETER

the Illuminated Dial type, but are smaller and the scales are not illuminated.

A complete description of astatic instruments with sample scales is given in a separate Bulletin.

SWITCHES

The main switches supplied on these panels are of the plain lever type, as the carbon break circuit breakers have proved so reliable that it is not necessary to provide quick break switches.

The field switches are quick break with discharge resistance clips. Opening the field switch breaks the field circuit and, at the same time, throws a resistance in shunt with the field to take up the inductive discharge.



TYPE L, FORM D 12, PLAIN LEVER SWITCH

To protect the switch contacts from serious burning, carbon break contacts are provided.

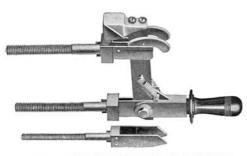
To provide for connecting the station lighting circuit to any machine, each generator and converter panel is supplied with a S. P. D. T. 60 ampere lighting switch connected in such a manner that there is no danger of paralleling the machines through the lighting switches. The lighting circuit must be connected between the main switch and the machine so that the lights will not be extinguished when the circuit breakers open because of a short circuit on the system.

On panels of large capacity, the lighting switches are not supplied, as it is assumed

4544-8 Continuous Current Railway Switchboards

that in large stations the purchaser will make special arrangements for station lighting.

Fuses for the lighting circuits are not provided with the panels. They should be mounted on the wall near the lights, and the point at which they should be connected may be determined by reference to the diagram of connections.



SINGLE-POLE FIELD DISCHARGE SWITCH

POTENTIAL PLUG SWITCHES

All machine and feeder panels are provided with receptacles to connect the voltmeter to any machine or feeder circuit. The plug to be inserted in these receptacles is not supplied with the panel, but is included in the catalogue number of the voltmeter, because only one plug should be used on any switchboard, to obviate the chance of paralleling the machines through the voltmeter connections.

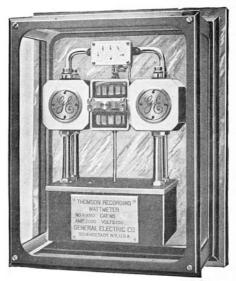
WATTMETERS

Thomson Recording Wattmeters are made in ampere capacities suitable for panels of all standard ratings, although the construction varies to a considerable extent. In order, therefore, that wattmeters may have a similar external appearance they are all, irrespective of ampere capacity, furnished with rectangular glass cases when supplied on railway panels.

Great care has been exercised in the design of these meters that they may be free from the effects of short circuits and stray fields from bus-bars or other sources. Wattmeters of 800 amperes capacity and above have a double armature astatically arranged, and the magnets are shielded by an iron case, thus further insuring them against detrimental external influences.

Wattmeters are recommended on individual machine panels in preference to a total wattmeter on a total output or station panel, for the following reasons, *viz*:

(1) The load factor on individual wattmeters would be much higher than on a total meter which would have to be large enough



THOMSON ASTATIC RECORDING WATTMETER TYPE G

to carry the "peak" load of the whole station, whereas the average load is much lower than the "peak."

(2) When it is desired to increase the station capacity the individual wattmeter scheme is the more flexible, as it is necessary to add only another generator panel with its wattmeter. If a total meter had been installed it would be necessary to replace it by a larger meter and, possibly, a new panel would be required. It is clear that this would be exceedingly inconvenient and expensive, entailing a possible shut down of the plant to change the heavy connections.

Generator panels with recording wattmeters are provided with terminals to allow

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of the connection of a jumper cable for short circuiting the generator through the wattmeter and ammeter for testing purposes, the machine being disconnected from the bus. The wattmeter potential coils, should of course, be excited from a constant potential source during the test, the current being regulated by varying the field of the machine under test.

LIGHTNING ARRESTERS

The lightning arresters used with all railway switchboards are the well-known type "M" form "D-2," which have been employed successfully for several years. For complete description refer to Bulletin on Direct Current Lightning Arresters.

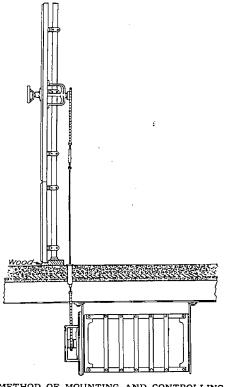
Lightning arresters are furnished with all generator, rotary converter and feeder panels. It is desirable to isolate the arresters from the switchboard. When used on a feeder panel, the panel is equipped with a kicking coil made of bare copper rod coiled and connected between the main switch and the circuit breaker.

* RHEOSTATS

Field rheostats are not included in the equipment of the panels and are not designed to be mounted on the back of the panel. Chain operating mechanisms are furnished complete, for the operation of rheostats, these mechanisms being designed to operate the rheostats when mounted as shown in accompanying diagram. If it is desired to locate the rheostat back of the switchboard, either on or above the switchboard gallery, special mechanisms must be called for when ordering. In such cases the method of operation should be specified. Discharge resistances are made a part of the rheostats furnished with General Electric railway generators.

MATERIAL AND SIZE OF PANELS

The standard material adopted for the main panels is black enameled slate. The slate used is free from metallic veins which would impair the insulating qualities. The enamel is applied in layers, each layer being baked on and thoroughly rubbed down. It is then given a hand finish which produces an extremely smooth surface and high polish. Panels of blue Vermont marble or of natural black slate can be substituted, if preferred. The auxiliary generator panels are made of natural black slate, with oiled finish.



METHOD OF MOUNTING AND CONTROLLING FIELD RHEOSTAT

Panels with circuit breakers of 3000 amperes capacity and less are 90" high and 16" wide. Above that capacity they are 108" high and 24" wide. The 108" panels are made in three sections, viz: a sub-base 28" high, a main panel 46" high and a circuit breaker section 34" high. The 90" panels are made in two sections, viz: a sub-base 28" high and a main panel 62" high. The panels are 2" thick and all front edges are beveled. For sizes of auxiliary generator panels refer to table on page 12.

GENERAL ELECTRIC COMPANY

4544-10 Continuous Current Railway Switchboards

Where the panel extends above the secondary contacts of the circuit breaker, an arc deflector is provided to prevent the arc scorching the panel.

SUPPORTING FRAME

Panels are supported on $1_4''$ pipe framework in accordance with the standard practice of the General Electric Company.

Since all the main switchboard panels are of positive polarity it is recommended that the framework be insulated from the ground, thereby reducing to a minimum the chance of



FIVE CABLE TERMINALS MOUNTED ON ONE STUD

short circuits on the switchboard. The tie rods for supporting the switchboard from the wall are also insulated from the frame of the panels.

If the floor of the station is made of concrete or other material which would establish a ground, the switchboard should be mounted on a wooden sill set on the floor and securely fastened thereto. The best method of carrying the main cables to the switchboard is to provide suitable floor bushings for the various leads, locating them about 4 inches behind it. An illustration of this construction is shown in the accompanying diagram.

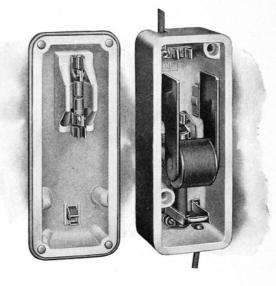
BUS-BARS AND CONNECTIONS

As heretofore stated, bus-bars are supplied

with the panels, and are 5" wide, except on large capacity panels where bars 10" wide are necessary. Connections from the panel to the bus are made by clamping the connection bars to the bus-bars, which arrangement does not require holes being drilled in the bus-bars.

Cable lugs for connecting cables to bus-bars can be found in Bulletin on Cable Terminals.

Connections on the back of the panel are made of bare copper bars varying from $\frac{3}{16}$ "



TYPE M, FORM, D-2, LIGHTNING ARRESTER-INTERIOR

to $\frac{3}{8}''$ thick, which are attached to the studs of the apparatus with contact nuts, one nut being placed between each pair of connection bars.

Small potential wiring consists of insulated copper wire, fastened to the back of the panel by fiber cleats. The necessary cartridge fuses are inserted in the potential circuits.

The current density of all connection bars is figured at 1000 amperes per square inch cross section.

METHOD OF STARTING

To throw a generator in parallel with other generators already running, the following procedure should be followed:

Continuous Current Railway Switchboards 4544-11

First—Close negative circuit breaker and equalizer switch (on panel near machine).

Second—Close field switch (on main panel).

Third-Close positive circuit breaker (on main panel).

Fourth—Insert potential plug in receptacle and regulate voltage.

Fifth—When the proper voltage is obtained, close the main switch.

After a rotary converter has been started

from the alternating current end and built up with the proper polarity, the following procedure should be followed to throw the direct current end in parallel with other machines running:

First—Close equalizer switch (on machine) Second—Close circuit breaker (on panel)

Third—Insert potential plug in receptacle and regulate voltage.

Fourth-When the proper voltage is obtained, close positive switch (on panel.)

4544-12 Continuous Current Railway Switchboards

Kw. Capacity	Ampere	Catalogue	Numbers	For General — Outline	Approximate Shipping Weight in Lbs				
of Generator 50% Overload	Capacity of Panel	With Wattmeter	Without Wattmeter	See Fig. No.	With Wattmeter	Without Wattmeter			
100	250	48839	48853	1	2600	2600			
150	375	48840	48854	1	2600	2600			
200	500	48841	48855	1	2600	2600			
250	625	48842	48856	1	2700	2 60 0			
300	750	48843	48857	1	2700	2600			
400	1000	48844	48858	1 1	2800	2700			
500	1250	48845	48859	1	2800	2700			
650	1620	48846	48860	1	3300	3200			
800	2000	48847	48861	1 1	3400	3300			
1000	2500	48848	48862	1	4000	3900			
1200	3000	48849	48863	1	4000	3900			
1600	4000	48850	48864	2	4500	4300			
2000	5000	48851	48865	2	5000	4800			
2500	6250	48852	48866	2 2	5100	4800			

CATALOGUE NUMBERS OF GENERATOR PANELS

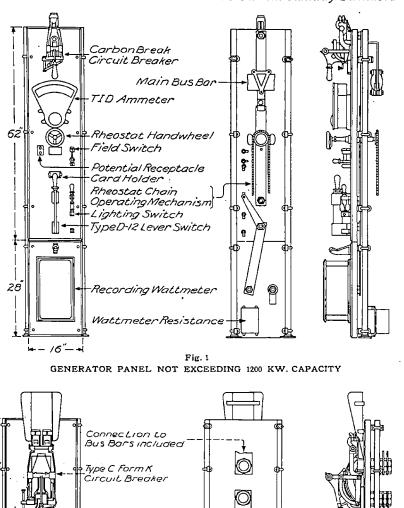
For Diagram of connections for Generator Panels see Fig. 6, Page 17.

EQUIPMENT * OF GENERATOR PANELS

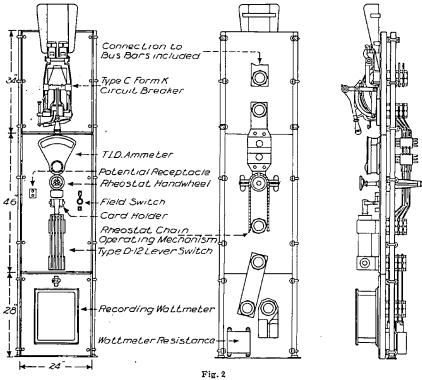
Generator				acity of Ec	luipment			Size of	Size of	Cable Terminals Designed Fo		
00 /0	Circuit Br e aker	Ammeter	Main Switch	Equalizer Switch	Lighting Switch	Field Switch	Watt- meter	Main Panel	Auxiliary Panel	Main Cables	Equalizer Cables	
500 1 650 2 800 2 1000 3 1200 3 1600 4	300 500 500 800 1200 1200 2000 2000 3000 3000 4000 6000	400 500 800 1000 1500 2500 3000 4000 4000 5000 8000	300 400 600 800 1000 1200 2000 2000 3000 3000 4000	200 200 300 300 400 600 800 1000 1200 1500 2000	60 60 60 60 60 60 60 60 60 60 80 00 80 80 80 80 80 80 80 80 80 80 80	100 100 100 100 100 100 100 100 100 100	200 300 450 600 800 1200 1200 2000 2000 3000 4000	90"x16" 90"x16" 90"x16" 90"x16" 90"x16" 90"x16" 90"x16" 90"x16" 90"x16" 90"x16" 108"x24"	90"x16"	3/0 300,000 600,000 600,000 1,500,000 1,500,000 2,000,000 2-1,500,000 2-2,000,000 3-2,000,000	$\begin{array}{c} 1,500,000\\ 2,000,000\\ 2-2,000,000\end{array}$	

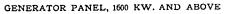
* Equipment also includes other apparatus as listed on page 3.

NOTE.-Above data are for general information only and must not be used for contracts or for construction without confirmation.



Continuous Current Railway Switchboards 4544-13





4544-14 Continuous Current Railway Switchboards

Kw. Capacity Rotary	Ampere	Catalogue	Numbers	For General	Approximate Shipping Weights in Li			
Converter 50% Overload	Capacity of Panel	With Wattmeter	Without Wattmeter	Outline See Fig. No.	With Wattmeter	Without Wattmeter		
100	250	48464	48470	3	1000	1000		
150	375	48465	48471	3	1000	1000		
200	500	48466	48472	3	1000	1000		
300	750	48467	48473	3	1000	1000		
400	1000	48468	48474	3	1100	1000		
500	1250	48469	48475	3	1100	1000		
750	1875	48476	48478	3	1200	1100		
1000	2500	48477	48479	3	1800	1600		
1500	3750	48480	48481	4	2000	1800		

CATALOGUE NUMBERS OF ROTARY CONVERTER PANELS

For Diagram of connections for Rotary Converter Panels see Fig 7, Page 17.

Kw. Capacity		Ampere	Capacity of J	Equipment		o	Cable Terminal	s Designed For
Rotary Converter 50% Overload	Circuit Breaker	Ammeter	Main Switch	Lighting Switch	Wattmeter	Size of Panel	Main Cables	† Equalizer Cables
100	300	400	300	60	200	90" x 16"	3/0	. 3/0
150	500	500	400	60	300	90" x 16"	300,000	300,000
. 200	500	800	600	60	450	$90'' \ge 16''$	500,000	500,000
300	800	1000	800	60	600	90" x 16"	800,000	800,000
400	1200	1500	1000	60	800	90" x 16"	1,000,000	1,000,000
500	1200	2000	1200	60	1200	90″ x 16″	2-600.000	600.000
750	2000	2500	2000	60	1500	90" x 16"	2-1.000.000	1,000,000
1000	3000	4000	3000	60	2000	90" x 16"	2 - 1.500.000	1,500,000
1500	4000	5000	4000	None	3000	$108'' \ge 24''$	2-2,000,000	2,000,000
1000	1000	0000	1000	1.0ne		100 X 24	2-2,000,000	2,000,000

EQUIPMENT * OF ROTARY CONVERTER PANELS

Equipment also includes other apparatus as listed on page 4.

† Equalizer switches are mounted on the rotary converters.

Note.-Above data are for general information only and must_not be used for contracts or for construction without confirmation.

Continuous Current Railway Switchboards 4544-15

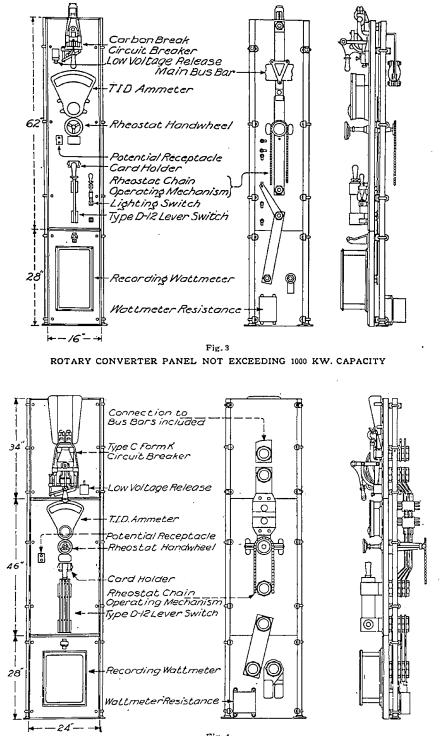
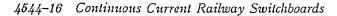
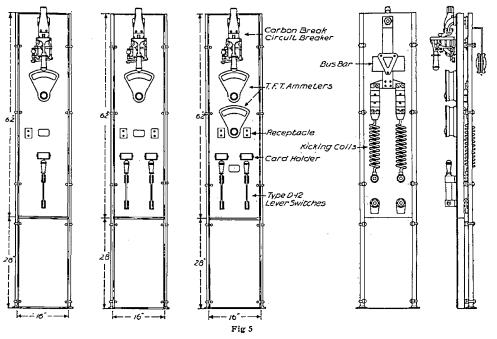


Fig. 4 ROTARY CONVERTER PANEL, 1500 KW. CAPACITY





FEEDER PANELS

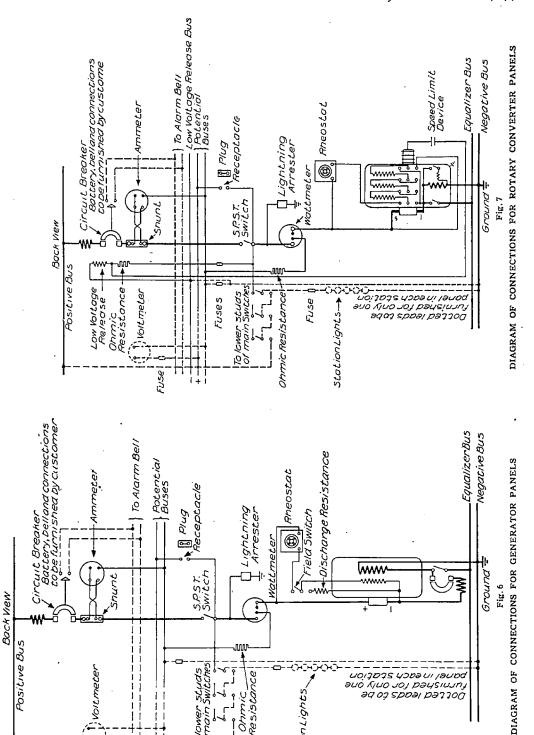
CATALOGUE NUMBERS AND EQUIPMENT * OF FEEDER PANELS

Ampere Capacity	Number	Ampere Capacity	Catalogue	For General Outline	Approxi- mate Ship-	Ampere C	apacity of Ec	luipment	Size of	Cable
of Panel	of Circuits	of Each Circuit	Numbers	See Fig. No.	ping weight in Lbs.	Circuit Breaker Ammet		Ammeter Switch		Terminals Designed For
500 800 1200 2000	1 1 1 1	500 800 1200 2000	48456 48457 48458 48463	5 5 5 5	1100 1100 1100 1100 1200	500 800 1200 2000	$600 \\ 1000 \\ 1500 \\ 2500$	600 800 1200 2000	90" x 16" 90" x 16" 90" x 16" 90" x 16"	600,000 1,000,000 2,000,000 2–1,500,000
800 1200	$\frac{\cdot 2}{2}$	400 600	48459 48460	5 5	1100 1100	800 1200	$1-1000 \\ 1-1500$	$2-400 \\ 2-600$	90" x 16" 90" x 16"	400,000 800.000
800 1200	2 2	400 600	$\frac{48461}{48462}$	5 5	1150 1150	800 1200	$2-600 \\ 2-800$	$2-400 \\ 2-600$	90" x 16" 90" x 16"	400,000 800,000

* Equipment also includes other apparatus as listed on page 5. For Diagram of connections for Feeder Panels see Fig. 8, Page 18.

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NOTE.-Above data are for general information only and must not be used for contracts or for construction without confirmation.



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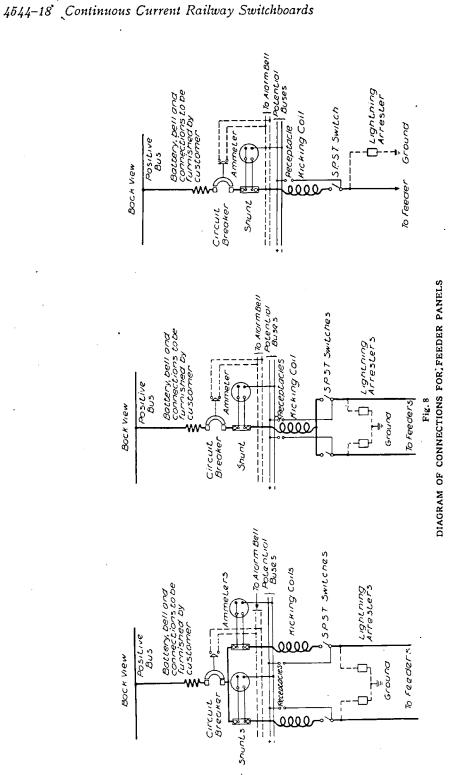
Resistance

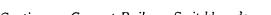
Station Lights,

Continuous Current Railway Switchboards 4544-17

שטעפן וע פעכט ברעריסט געגעוצט בע נסג מען א מעפ מגררפע ופעקצ בס מפ

GENERAL ELECTRIC COMPANY





GENERAL ELECTRIC COMPANY

General Electric Company Schenectady, N.Y.

SMALL MOTOR DEPARTMENT

October, 1907

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SINGLE-PHASE MOTORS, TYPE IS, FORM KG

THE field for the use of single-phase motors of moderate capacity is con-



1/2 H.P. TYPE IS, FORM KG MOTOR

stantly growing by reason of the increasing tendency of central stations to gen-

erate polyphase current and feed a large portion of the lighting load through single-phase distribution.

Power is frequently required near such circuits for the operation of light machinery, and it is most conveniently

furnished by the installation of the General Electric Company's Type IS, Form KG single-phase motors.

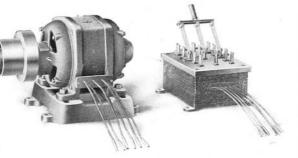
The phenomenal success of General Electric polyphase motors is believed to be largely due to the simple and substantial character of the design, combined with a careful selection of materials and the employment of skilled labor in construction. The same characteristics have been incorporated in these single-phase motors as far as possible.

GENERAL DESCRIPTION

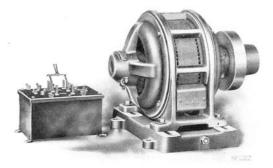
The KG motors are in appearance similar to those of polyphase design. Sizes 4 to 5 h.p. inclusive are built in a unique form of construction known as the riveted frame, in which the laminations of the stator core are riveted together between cast iron flanges to which the end heads are secured, thus exposing the core directly to the air. The cast iron shell or box frame employed in less advanced designs is entirely omitted.

This new form of construction possesses several important advantages, such as im-

> proved ventilation, reduced weight and extreme compactness. These desirable features are attained without sacrificing quality in any respect, or lowering the high standard which the General Electric Company maintains



5 H.P. TYPE IS, FORM KG MOTOR



10 H.P. TYPE IS, FORM KG MOTOR

*Supersedes Bulletin No. 4455.

4545-2 Single-Phase Motors, Type IS, Form KG

at all times in apparatus of its manufacture.

The larger sizes $(7\frac{1}{2}, 10 \text{ and } 15 \text{ h.p.})$ are built in a form known as the skeleton frame, differing in detail, but similar in design and affording the same advantages as possessed by the riveted frame form of construction.

The bearing brackets are removable and can be shifted 90 or 180 degrees, for the purpose of wall or ceiling suspension, respectively.



A-Clutch Body, B-Friction Band, C-Adjusting Spring, D-Outer Clutch Shell with Pulley Sleeve, E-Solid Removable Pulley

assembled under a heavy pressure in the frames.

The windings are similar to those of a threephase motor, consisting of a large number of coils placed progressively in the slots.

THE PULLEY

Clutch pulleys are furnished with motors of 1 h.p. and larger. By the use of these clutches the starting current on the six-lead



 $F{\rm -Internal}$ Mechanism Comprising Parts A, B and C $G{\rm -Outer}$ Shell and Pulley Comprising Parts D and E

PARTS OF CENTRIFUGAL CLUTCH PULLEY FOR USE ON TYPE IS MOTORS

Internal automatic devices for starting are eliminated, thus producing a motor of simplest mechanical construction.

Motors ranging from 1 h.p. to 5 h.p. inclusive, are fitted with six terminals, while the remaining motors have three terminals.

The $\frac{1}{4}$ and $\frac{1}{2}$ h.p. motors have slotted feet for the purpose of tightening the belt. With the larger motors iron sliding bases are provided for this purpose, although motors can be supplied without bases, if so desired. All bases are designed for supporting motors when installed on floor, side wall, or ceiling.

THE ROTOR

The Rotor is of the high resistance squirrelcage type, consisting of a number of slotted soft steel discs assembled upon a shaft and carrying in the slots, copper bars which extend beyond the core at each end, and are permanently connected to short-circuiting rings.

THE STATOR

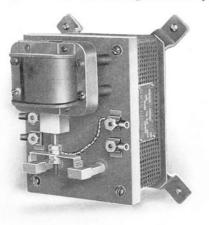
The Stator is made up of the best quality of soft steel punchings which are motors will not be greater than 200 per cent. of full load current when starting the motor under full load, while the three-lead motors require 3 to 4 times full load current when starting under full load. The clutch pulley consists of an outer shell which is free upon the shaft, and a friction band attached to the shaft, and which always revolves with it. When the rotor has attained almost full speed, the friction band of the clutch is forced against the surface of the outer shell, thereby causing both parts to gradually engage and finally to rotate as one. The shell hub is fitted with an oilless bearing and thus requires no lubrication. To the sleeve of the shell a standard pulley is fastened by means of a key and setscrew. Should it become necessary to change the pulley, it may be readily removed and replaced by one of the desired diameter or by a pinion.

STARTING BOXES

The motor is rendered self-starting by means of a starting box containing resistance and reactance, and a double-throw switch for the 1 h.p. motors and larger. The switch is first thrown to the starting position, and Single-Phase Motors, Type IS, Form KG 4545-3

when the rotor has attained almost full speed is quickly thrown over to the running position, the object being to first connect the resistance and reactance in circuit with the motor and then to disconnect it.

The starting box furnished with the $\frac{1}{4}$ h.p. and $\frac{1}{2}$ h.p. motors has a single-throw spring



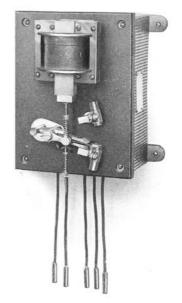
AUTOMATIC STARTING BOX FOR 1/4 AND 1/2 H.P. MOTOR

release switch. To start these motors, the operator holds the switch blades down on the lower contacts until the rotor has reached almost full speed, then upon releasing the switch handle, the blades spring up into the running position.

In motors having six leads, the winding connections are changed through the starting box at the time of throwing the switch over from the starting to the running position. By this arrangement a starting torque of approximately 150 per cent. is obtained with 200 per cent. of full load current. The smaller motors without clutch pulleys develop a starting torque of 110 per cent. of full load torque. The larger three-lead motors— $7\frac{1}{2}$, 10 and 15 h.p. sizes-develop a starting torque of 150 per cent. of full load torque with from three to four times full load current. The torque and starting current of these sizes, however, can be increased or decreased as desired for different loads by changing the connections to different taps provided on top of the starting box.

AUTOMATIC STARTING DEVICE

When the conditions of operation are such as to require the motor to start and stop automatically, as in connection with float switches governing pumps, refrigerating apparatus, etc., this company can supply an automatic starter.



AUTOMATIC STARTING BOX FOR 1 H.P. MOTOR

This device is both simple and reliable. Excepting for the $\frac{1}{4}$ and $\frac{1}{2}$ h.p. motors the automatic starter may be substituted at any time for use with motors already installed in place of the non-automatic box ordinarily furnished.

The $\frac{1}{4}$ and $\frac{1}{2}$ h.p. sizes, however, must be adapted to this purpose by the addition of a connecting lead.

TEMPERATURE AND OVERLOAD GUARANTEES

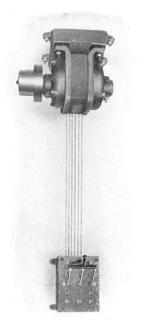
When operated continuously at full load, on circuits of the correct voltage and frequency, the temperature rise will not exceed 40° C. A continuous overload of 25% for

4545-4 Single-Phase Motors, Type IS, Form KG

two hours, or a momentary overload of 50% can be carried without excessive heating.

VOLTAGES AND FREQUENCIES

The standard motors from $\frac{1}{4}$ h.p. to 5 h.p., inclusive, are wound for 110 or 220 volts, 60 cycles. The standard winding for the larger motors is 220 volts, and although a 110 volt winding can be substituted in the larger



CEILING INSTALLATION

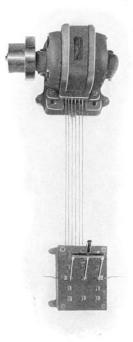
machines, it is not recommended. These motors will operate satisfactorily on circuits where the range of voltage and frequency collectively does not exceed 10 per cent. either above or below normal.

Motors of the same capacities for 50 cycle or 40 cycle circuits can be furnished to order. Machines of these frequencies are not kept in stock.

CUT-OUTS AND FUSES

Enclosed cartridge fuses should be provided for KG motors. A list of suitable cut-

Mo	otors	Fus	ės	Fuse Blocks				
H P Volts		Cat. No.	Cat. No. Amps.		No. Required			
1	110	34952	10	34367	1			
i	220	34950	5	34367	1			
14141212	110	34955	20	34367	1			
1	220	34952	10	34367	1			
1	110	34956	25	34367	1			
1	220	34954	15	34367	1			
2	110	34960	45	34376	1			
2	220	34956	25	34367	1			
3	110	34966	70	36801	1			
3	220	34958	35	34376	1			
3 5 5	110	34970	100	36801	1			
5	220	34962	55	34376	1			
$7\frac{1}{2}$	220	34966	70	36801	1			
10	220	34970	100	36801	1			
15	220	34976	150	34971	2			



WALL INSTALLATION SPEEDS

The speed of an induction motor is regulated by the frequency of the supply circuit, and is not materially affected by variations of voltage. The name-plates are stamped with synchronous speed, and motors will

outs and fuses, with catalogue numbers, follows:

Single-Phase Motors, Type IS, Form KG 4545-5

operate at full load from $3\frac{1}{2}\%$ to 5% less. On the different frequencies synchronous speeds are as follows:

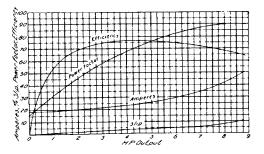
> 60-cycle motors 1800 r. p. m. 50 " " 1500 " 40 " " 1200 "

CIRCUITS AND TRANSFORMERS

The Form KG motors can be operated from the regular lighting circuits without an appreciable effect upon the lamps, providing the circuits are well laid out and supplied with sufficient transformer capacity; or, if preferred, they can be placed upon separate transformers. In either case, 1 kw. of transformer capacity should be allowed per h.p. of motors installed.

EFFICIENCY AND POWER FACTOR

An inspection of the table and the characteristic curve will readily show that the



motors have been designed properly in regard to these characteristics. It is desirable for the purchaser, when selecting motors, to procure those having as high efficiency as possible, in order to reduce kw. consumption to the minimum, while from the central station point of view it is essential that only motors of high-power factor be connected to the lines, so that the generating apparatus and distributing system may not be overloaded with wattless currents having a tendency to destroy the voltage regulation, and from which no income can be derived.

OPERATING	DATA-TY	PE	IS, FORM	KG
SINC	LE-PHASE	MO	TORS	

Type	Poles	НР	R.P.M.	Form	Volts	% Eff.	% P.F.	Full Load Speed
IS IS IS IS IS IS IS IS IS IS	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c} 1 \\ 1 \\ 1 \\ 2 \\ 3 \\ 5 \\ 7 \\ 10 \\ 15 \end{array} $	1800 1800 1800 1800 1800 1800 1800 1800	KG KG KG KG KG KG KG KG KG KG KG KG	$\begin{array}{c} 110\\ 220\\ 110\\ 220\\ 110\\ 220\\ 110\\ 220\\ 110\\ 220\\ 110\\ 220\\ 22$		$\begin{array}{c} 66\\ 66\\ 68\\ 71\\ 71\\ 74\\ 75\\ 75\\ 76\\ 76\\ 76\\ 87\\ 90\\ 89\\ \end{array}$	1710 1710 1710 1710 1710 1710 1710 1710

APPLICATIONS

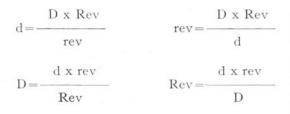
Single-phase motors are well adapted to the operation of all kinds of machinery by means of belts and gears, or to direct. connection to loads requiring only moderate starting torque, as in the case of generators, blowers, etc., to which they may be direct connected with rigid couplings. Where greater torque is required at the moment of starting, as in case of pumps under head, clutch couplings should be used. When gearing is to be employed, the ordinary pulley can be removed from the clutch sleeve and a pinion substituted; this is preferably made of rawhide in order to reduce the noise.

The low weight per horse power obtained by the riveted form of construction employed, permits of special applications heretofore not available. When necessary, modifications in standard construction may be obtained to more readily adapt motors to special applications.

RULE TO DETERMINE SIZE OF PULLEY

- D=Diameter of driver or number of teeth in pinion.
- d=Diameter of driven or number of teeth in gear.
- Rev=Revolution per minute of driver.
- rev=Revolution per minute of driven.

4545-6 Single-Phase Motors, Type IS, Form KG



To find the speed of belt in feet per min-

ute, multiply the circumference of pulley in feet by the number of revolutions per minute.

In the table given below, the amount of power that can be transmitted by single and double leather belts is shown. This calculation is on the basis of an arc of contact on the smaller pulley of 37.5% of its circumference.

POWER THAT MAY BE TRANSMITTED BY SINGLE AND DOUBLE BELTS WIDTH OF BELT

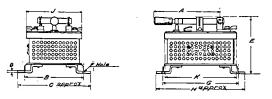
Speed in Feet per Minute	$2\frac{1}{2}''$		$3\frac{1}{2}''$ $3\frac{1}{2}''$		4″		5	5″		6″		$\frac{3}{4}''$	$9\frac{3}{4}''$		12"	
	HP S	HP D	HP S	HP D	HP S	HP D	HP S	HP D	HP S	HP D	$^{\mathrm{HP}}_{\mathrm{S}}$	HP D	HP S	HP D	HP S	HI D
400 600 800°				$2 \\ 3 \\ 4$	$2 \\ 2\frac{1}{2} \\ 3$	$2\frac{1}{2}$ $3\frac{1}{2}$ $4\frac{1}{2}$	$2\frac{1}{2}$ $3\frac{1}{2}$ $4\frac{1}{2}$	$3 \\ 4\frac{1}{2} \\ 5\frac{1}{2}$	$\frac{3}{4}$	$3\frac{1}{2}$ 5 7	$3\frac{1}{2}$ 5 $6\frac{1}{2}$	$4\frac{1}{2}$ $6\frac{1}{2}$ $8\frac{1}{2}$	$\begin{array}{c} 4\\ 6\\ 8\end{array}$	$5\frac{1}{2}$ $8\frac{1}{2}$ 11	$5 \\ 7\frac{1}{2} \\ 10$	7 10 13
1000 1500 1800	$2\frac{1}{2}$ 4 $4\frac{1}{2}$	$-\frac{3\frac{1}{2}}{5}$ 6	$ 3\frac{1}{2} \\ 5 \\ 6 $	$57\frac{1}{2}$	$\begin{array}{c} 4\\ 6\\ 7\end{array}$		$5\frac{1}{2}$ 8 9 $\frac{1}{2}$	$ \begin{array}{c} 7 \\ 10 \\ 12\frac{1}{2} \end{array} $				$ \begin{array}{c} 11 \\ 16\frac{1}{2} \\ 20 \end{array} $	$ \begin{array}{r} 10 \\ 14\frac{1}{2} \\ 17\frac{1}{2} \end{array} $	$ \begin{array}{c} 14 \\ 21 \\ 25 \end{array} $	$ \begin{array}{c} 12\frac{1}{2} \\ 18 \\ 21\frac{1}{2} \end{array} $	$ \begin{array}{c} 17 \\ 25 \\ 30 \end{array} $
$2000 \\ 2400 \\ 2800$	5 6 7	$ \begin{array}{c} 7 \\ 8\frac{1}{2} \\ 10 \end{array} $		$ \begin{array}{c} 10 \\ 12 \\ 14 \end{array} $		$11\frac{1}{2}$ $13\frac{1}{2}$ 16	$ \begin{array}{c} 10\frac{1}{2} \\ 13 \\ 15 \end{array} $	$ \begin{array}{c} 14 \\ 17 \\ 20 \end{array} $	$ \begin{array}{c} 12 \\ 15 \\ 17 \end{array} $	$ \begin{array}{c} 17 \\ 20\frac{1}{2} \\ 24 \end{array} $	$ \begin{array}{r} 16rac{1}{2} \\ 20 \\ 23 \end{array} $	$\frac{22}{26}$	$ \begin{array}{r} 19\frac{1}{2} \\ 23 \\ 27 \end{array} $	28 33 39	24 29	$ \begin{array}{c} 34 \\ 41 \\ 47 \end{array} $
3000 3500	$7\frac{1}{2}$ 9	$ \begin{array}{c} 10^{\frac{1}{2}} \\ 12 \end{array} $	$ \begin{array}{c} 10 \\ 10 \\ 12 \\ 12 \end{array} $	$14 \\ 15 \\ 17\frac{1}{2}$	$ 12 \\ 14 $	$ \begin{array}{c} 17 \\ 20 \end{array} $	$\begin{array}{c} 16 \\ 19 \end{array}$	$ \begin{array}{c} 20 \\ 21 \\ 25 \end{array} $	$ 18 \\ 21 $	$\frac{24}{26}$ 30	$\frac{25}{25}$	$\frac{31}{33}$	$\frac{27}{29}$ 34		$33\frac{1}{2}$ 36 42	
$ \frac{4000}{4500} $	$\begin{array}{c} 10 \\ 11 \end{array}$	$\begin{array}{c} 14 \\ 16 \end{array}$	$ 14 \\ 16 $	$ \begin{array}{c} 20 \\ 22\frac{1}{2} \end{array} $	16 18	$\frac{23}{26}$	$21 \\ 24$	$\frac{28}{32}$	$\frac{24}{27}$	$\frac{34}{38}$	$\frac{33}{37}$	$\frac{44}{50}$	$\frac{39}{44}$	$55 \\ 62$	$\frac{48}{54}$	68 76



FORM KG SINGLE-PHASE MOTORS, 1/4 TO 5 H.P.

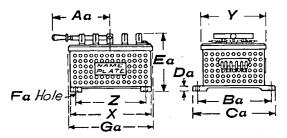
Single-Phase Motors, Type IS, Form KG 4545-7

* DIMENSIONS OF SINGLE-PHASE MOTOR STARTING BOXES-TYPE IS



SPRING RELEASE STARTING BOX

	M	ptor						Sta	rting Bo	x	,			
Туре	Poles	HP	Fre- quency	Weight	A	В	с	D	Е	F	G	н	J	к
IS IS	4 4	4	60 60	8	$7 \frac{3}{16} 7 \frac{3}{16}$	6 1 61	$\begin{array}{c} 7 \ \frac{7}{16} \\ 7 \ \frac{7}{16} \\ 7 \ \frac{7}{16} \end{array}$		55 58	$\frac{\frac{5}{16}}{\frac{5}{16}}$	$7\frac{3}{4}$ $7\frac{3}{4}$	9 9	$5\frac{3}{4}$ $5\frac{3}{4}$	7 <u>종</u> 7 종



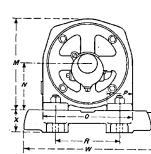
DOUBLE THROW STARTING BOX

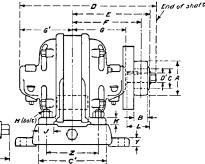
	М	otor						Starti	ng Box					
Type	Poles	HP	Speed	Weight	.x	Y	Z	Aa	Ba	Ca	Da	Ea	Fa	Ga
IS IS IS IS IS IS IS	4 4 4 4 4 4 4 4	$ \begin{array}{c} 1 \\ 2 \\ 3 \\ 5 \\ 7 \\ 1 \\ 10 \\ 15 \\ 15 \\ 10 \\ 10 \\ 15 \\ 10 \\ 15 \\ 10 \\ 10 \\ 15 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 15 \\ 10 \\ $	1800 1800 1800 1800 1800 1800 1800 1800	$27 \\ 32 \\ 40 \\ 47 \\ 60 \\ 65 \\ 75$	$ \begin{array}{c} 10\\ 10\\ 10\\ 10\\ 9\frac{1}{4}\\ 9\frac{1}{4}\\ 9\frac{1}{4}\\ 9\frac{1}{4}\\ \end{array} $		8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	65555555 6655555 6655555 714 714 714	$\begin{array}{r} 8\frac{7}{8}\\ 8\frac{7}{6}\\ 8\frac{7}{6}\\ 8\frac{7}{6}\\ 8\frac{7}{6}\\ 8\frac{7}{6}\\ 8\frac{7}{6}\\ 8\frac{7}{6}\\ 8\frac{7}{6}\\ 8\frac{7}{6}\\ 14\frac{5}{6}\\ 16\frac{5}{6}\\ 16\frac$	$ \begin{array}{c} 10\\ 10\\ 10\\ 10\\ 15\frac{1}{2}\\ 15\frac{1}{2}\\ 17\frac{1}{2} \end{array} $	7 16 7 16 7 16 7 16 38 38 38 38	$\begin{array}{c} 67\\ 67\\ 78\\ 78\\ 97\\ 8\\ 16\\ 93\\ 93\\ 93\\ 93\\ 93\\ 93\\ 93\\ 93\\ 93\\ 93$	121211211211211211211211211211211211211	$ \begin{array}{c} 10\frac{1}{2}\\ 10\frac{1}{2}\\ 10\frac{1}{2}\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10$

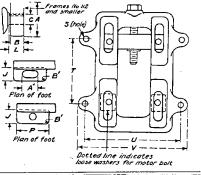
NOTE:-Boxes for motors 1-5 h.p. inclusive are arranged for six leads to motor:-- 7½-15 h.p. for three leads. * For reference only.

4545-8 Single-Phase Motors, Type IS, Form KG

*DIMENSIONS OF SINGLE-PHASE INDUCTION MOTORS TYPE IS, FORM KG, 60 CYCLES







	We	ight	 	Pulley								*					
Franie	With Base	With- out Base	A Dia.	B Face	с	D	E	ਸ	G	н	J	ĸ	L	M	N	. 0	Р
$ \begin{array}{r} 110 \\ 112 \\ 122 \\ 140 \\ 160 \\ 180 \\ 7 \\ 8 \\ 9 \\ 9 \end{array} $	130 160 210 305 380 579 625	55 70 110 140 190 270	$\begin{array}{c} 3 \\ 3\frac{1}{2} \\ 4\frac{1}{2} \\ 4\frac{1}{2} \\ 4\frac{1}{2} \\ 4\frac{1}{2} \\ 6 \\ 6 \\ 6 \\ 6 \\ \end{array}$	$ \begin{array}{c} 11\\ 12\\ 22\\ 32\\ 4\\ 4\\ 4\\ 6\end{array} $	34134128 122222 2222 2222	$11\frac{3}{127}$ $127\frac{3}{16}$ $17\frac{9}{16}$ $21\frac{3}{16}$ $23\frac{15}{16}$ $24\frac{5}{5}$ $297\frac{3}{5}$ $32\frac{3}{5}$	$\begin{array}{c} 6 \frac{7}{15} \\ 7 \frac{7}{16} \\ 10 \frac{9}{16} \\ 11 \frac{9}{16} \\ 12 \frac{7}{5} \\ 14 \frac{5}{5} \\ 15 \frac{7}{16} \\ 17 \frac{3}{4} \\ 18 \frac{1}{4} \end{array}$	$5\frac{136}{16}, 9\frac{1}{10}$ $9\frac{1}{10}$ $10\frac{1}{12}$ $12\frac{1}{10}$ 1555 165	4 156 5 76 6 76 7 76 8 76 8 76 8 76 9 76 8 76 9 76 9 76 11 55 12 15	0,00 - f01 - f01 - f01 - f01 u300 u300 c314 c314	$1\frac{1}{2}$ $1\frac{1}{2}$ $1\frac{1}{2}$ $1\frac{1}{2}$ $2\frac{1}{2}$ 3 4 4	580578034344 1 10038 1 1	$1\frac{1}{2}$ $3\frac{13}{16}$ $3\frac{16}{16}$ $4\frac{16}{5}$ $5\frac{1}{2}$ 6 6	$\begin{array}{r} 8\frac{5}{50}\\ 9\frac{3}{2}\\ 10\frac{3}{2}\\ 12\frac{3}{2}\\ 14\frac{3}{2}\\ 17\frac{5}{2}\\ 19\frac{7}{2}\\ 19\frac{7}{2}\\ 19\frac{7}{2}\\ \end{array}$	$ \begin{array}{r} 4\frac{1}{2} \\ 4\frac{1}{2} \\ 4\frac{1}{2} \\ 5\frac{1}{2} \\ 6\frac{1}{2} \\ 9 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10 \\ 10$	$\begin{array}{c} 8\frac{1}{4}\\ 9\frac{1}{4}\\ 10\frac{1}{2}\\ 12\frac{3}{4}\\ 14\frac{1}{4}\\ 17\frac{1}{4}\\ 20\\ 20\end{array}$	2214343418121212 1221212 2332 33
					Base							•					

·,															
Frame	R	S	Т	υ·	v	w	x	Y	Z	A1	Br	C1	D٢	G1	Keyway
$ \begin{array}{r} 110\\ 112\\ 122\\ 140\\ 160\\ 180\\ 7\\ 8\\ 9 \end{array} $	6 6 7 10 11 1 14 14 17 17	3년4 23년2 13년4 13년4 13년4 13년7 - 122 7년20	$7\frac{1}{2}$ $8\frac{1}{2}$ $10\frac{1}{3}$ $14\frac{2}{3}$ $14\frac{2}{3}$ 17 17	$ \begin{array}{c} 111\\ 111\\ 112\\ 141\\ 141\\ 162\\ 172 \end{array} $	$12\frac{1}{2}$ $12\frac{3}{2}$ $15\frac{3}{2}$ $15\frac{3}{2}$ $18\frac{1}{4}$ $19\frac{1}{4}$	$ \begin{array}{r} 13 & \frac{5}{14} \\ 14 & \frac{29}{32} \\ 16 & \frac{21}{32} \\ 21 \\ 25 & \frac{2}{8} \\ 28 & \frac{1}{8} \\ 28 & \frac{1}{8} \end{array} $	223434 223434 2323 33	347 87 181 141 141 121	$ \begin{array}{r} 4\frac{3}{4}\\ 5\frac{3}{4}\\ 7\\ 7\\ 9\frac{1}{2}\\ 9\frac{1}{2}\\ 11\\ 12\\ \end{array} $	11	דאין אינעראין אין אינער טענט גען איי געראין אין אין אין אין אין אין אין אין אין	$ \begin{array}{c} 61 \\ 71 \\ 83 \\ 81 \\ 81 \\ 81 \\ 81 \\ 81 \\ 113 \\ 12 \\ 14 \\ 15 \\ \end{array} $	- 343478 1 1838381 1 181 1 181	$\begin{array}{c} 4 \frac{15}{16} \\ 5 \frac{16}{16} \\ 6 \frac{16}{16} \\ 7 \frac{16}{16} \\ 8 \frac{16}{16} \\ 8 \frac{16}{16} \\ 9 \frac{3}{16} \\ 11\frac{2}{12} \\ 12\frac{1}{12} \end{array}$	lx lx1 de

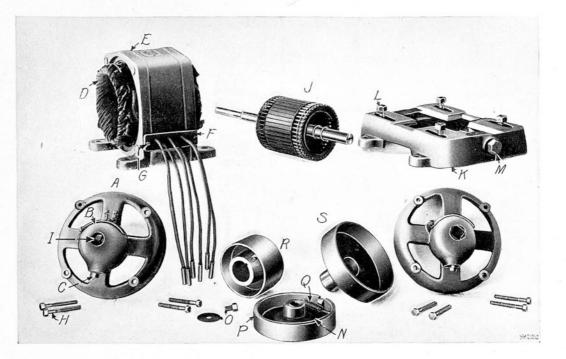
* For REFERENCE ONLY E-G = L for frames 112 and Clutch pulley not supplied v	Rating 4-5 -1800	
Leads not including connec	$6 - \frac{1}{4} - 1200$	
60 CYC	CLES	$6 - \frac{1}{2} - 1200$
Rating	Frame No.	6-1 -1200
4-1 -1800	110	6-1.5-1200
$4 - \frac{1}{2}$ -1800	112	6 - 2.5 - 1200
4-1 -1800	122	4 - 7.5 - 1800
4-2 -1800	140	4-10-1800
4-3 -1800	1,60	4-15-1800

Frame No. 180 120

 $\begin{array}{r}
 122 \\
 140 \\
 160 \\
 180 \\
 7 \\
 8
 \end{array}$

9

Single-Phase Motors, Type IS, Form KG 4545-9



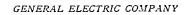
PARTS OF TYPE IS, SINGLE-PHASE INDUCTION MOTORS, FORM KG

GENERAL ELECTRIC COMPANY

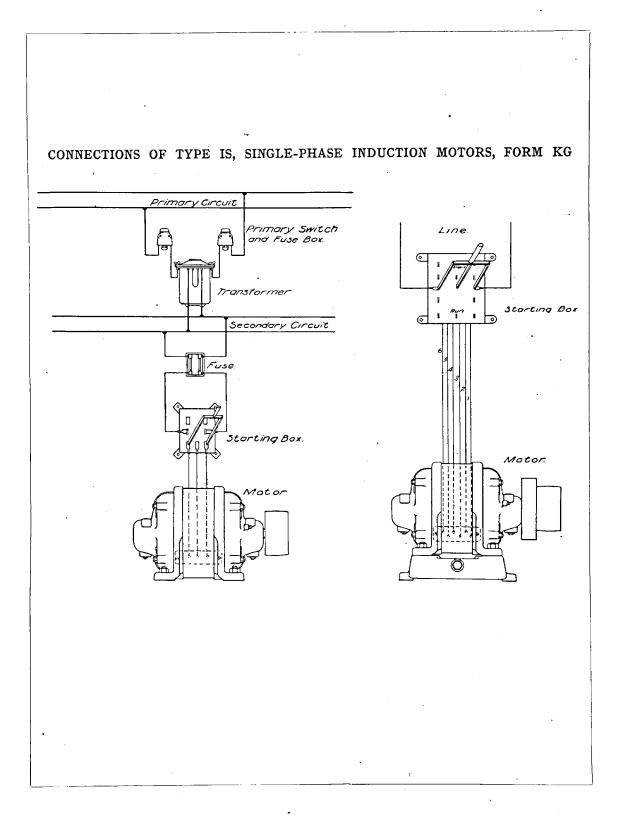
- A Bearing Bracket
- B Oil Well Cover
- C Oil Well Plug
- D Field Coils
- E Frame
- F Terminal Block
- G Terminal Block Screw
- H Cap Bolts
- I Bearing Lining
- J Rotor

- K Sliding Base
- L Float Bolt
- M Belt Tightener Screw
- N Pulley Driving Plate
- O Pulley Cap Screw with Washer
- P Pulley Friction Band
- Q Pulley Adjusting Spring
- R Removable Pulley
- S Pulley Hub

Order parts by name, omitting reference letter, and give serial number of motor as shown on name-plate.



4545-10 Single-Phase Motors, Type IS, Form KG



General Electric Company Schenectady, N.Y.

SUPPLY DEPARTMENT

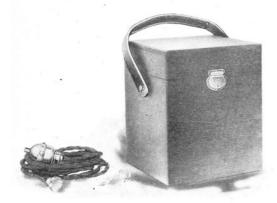
Vovember, 1907

Copyright, 1907 by General Electric Company *Bulletin No.,4549

HAN.

THOMSON HIGH TORQUE INDUCTION TEST METER, TYPE IB-2

To every central station or isolated plant he question of periodical meter calibration s of vital importance, and the customary nethod of making such tests is by the use of



THOMSON HIGH TORQUE INDUCTION TEST METER TYPE IB-2

indicating instruments. Although there is no question regarding the accuracy of this method, the rapid growth of electric lighting and power systems and the more than proportionate increase in the use of rotating meters, demand that some way be provided whereby tests may be made more quickly, and yet without decreasing their reliability in the least. Such a method is provided by the Thomson High Torque Induction Test Meter.

In using this meter it is unnecessary that the load shall be constant, as the only observations necessary are the number of disk revolutions of the meter undergoing test and the pointer indications of the standard meter before and after test. Both meters integrate

*Supersedes Bulletin No. 4420.

the instantaneous values and hence it is unnecessary to obtain the mean value or require an unvarying load. The time saved by this device will be appreciated when it is remembered that no check tests have to be made, nor need a reading, once commenced, be discontinued on account of load fluctuations.



CASE WITH COVER REMOVED SHOWING CORD AND SWITCH FOR CONTROLLING THE METER

Furthermore, the meter is so designed that one standard may be used for testing meters of different capacities covering a range from light load to full load. This further renders possible more rapid testing as no time is consumed in changing standards.

GENERAL ELECTRIC COMPANY

4549-2 Thomson High Torque Induction Test Meter, Type IB-2

Personal errors of observations are also practically eliminated as all readings may be made with precision.

The stop which may be confined solely to the testing room or laboratory, as it is not required except in checking the test meter with the primary standards.

These reasons alone are sufficient to recommend the use of the Thomson High Torque Induction Test Meter in every central station or isolated plant operating an alternating current system.

CONSTRUCTION CASE

The test meter is enclosed in a wooden carrying case provided with a substantial strap to aid in transportation. The case is made from quarter sawed oak with antique finish. It is of a convenient size, being only $9\frac{1}{2}$ in. by 8 in. by 7 in. in over-all dimensions.

The cover is provided with lock and key for the prevention of tampering by unauthorized persons.

REGISTER

The register of the Thomson High Torque Induction Test Meter is very large and easily read and is placed on top. This feature is particularly advantageous when making tests at points of installation where there is no opportunity to hang up the meter, but where it must be placed on the floor or some other place below the observer. The register is of the three pointer type. The largest pointer reads directly in disk revolutions, and as the dial is sub-divided into one hundred equal parts, the position of the pointer may be read to hundredths of a revolution. The two smaller pointers make one revolution for each ten or one hundred revolutions respectively. It is, therefore, a very simple matter to ascertain the number of revolutions made by the disk by simply noting the position of the three pointers at the beginning and end of each test. As the full load speed of the meter is less than 35 revolutions per minute, a three minute test at this load may be made before the indications repeat themselves.

CONNECTIONS

Connections to the test meter are made by

means of binding posts, conveniently located on top.

At the left of the dial is placed a plug receptacle in series with the potential circuit. In this receptacle a plug is inserted and connected by means of a lamp cord to a pendant snap switch, the opening and closing of which stops or starts the meter. The cord is of sufficient length to permit of the test meter being placed at some distance from the operator; which may be necessary, for instance, when the meter

under test is installed at such a height as to require the use of a ladder.

LOCKING DEVICE

A little to the right of the dial is placed a knurled thumb nut, by aid of which the moving element may be raised from its jewel bearing and securely locked during transportation.

FUSE

A fuse plug located at the left of the dial is in series with the one ampere winding. This protects the fine wire winding in case it should be subjected to an accidental overload. The fuse plug is of the enclosed type, thus preventing the melted fuse wire from injuring the meter.

MECHANISM OF THOMSON HIGH TORQUE INDUCTION TEST METER, TYPE IB-2

Thomson High Torque Induction Test Meter, Type IB-2 4549-3

JEWEL AND PIVOT

A meter with the highest possible accuracy both initially and throughout its entire period of usefulness, requires an indestructible bearing, and to this end the cup diamond has been adopted for the lower thrust bearing. The grinding of diamonds in a concave form has been so perfected by the General Electric Company that they are quite the equal of any other jewel bearing both in form and finish. The extreme hardness of the diamond renders it practically indestructible, and, therefore, of inestimable value in a meter with a rotating element.

The pivot is identical with that used for \cdot the ordinary sapphire bearing, consisting of a small piece of piano wire, glass hardened and highly polished, inserted in a removable brass shaft end.

ACCESSIBILITY

The entire meter may be lifted from the case by two buttons on opposite sides, thus making it easily accessible for calibration. When removed from the case, the meter will remain without support in an upright position resting upon the magnet core and central casting, to which all parts are fastened.

WINDINGS

The potential winding is suitable for use on voltages ranging ten per cent. on either side of the normal. Three current coils are employed, one end of each being connected to a common binding post, and the other ends terminating in each of the three remaining binding posts, which are properly marked for the various ampere capacities of the coils attached thereto. The capacities selected as being the most generally desirable are one, ten and twenty amperes, which are sufficient for testing meters from three to twenty-five amperes normal capacity. The ampere turns of the three windings are equal, hence the torque is constant when the meter is operating under the same percentage of full load for the individual coils. In other words, when

using the smallest winding with one ampere passing, the torque is equal to that produced by the largest coil with a current of twenty amperes. Thus, friction is entirely negligible and accuracy is obtained throughout the range. This feature will be found of the greatest importance when testing a meter on light loads, for no corrections will have to be made for possible errors in the test meter.

TORQUE

Realizing that continued accuracy is maintained by a high torque or turning movement, it is but natural that the General Electric Company should produce for its test meter one that has the highest possible torque without impairing other necessary and desirable features. This extremely high torque has been obtained solely by efficient design. Internal losses are practically negligible, and the moving element is so light that all questions of jewel wear are eliminated.

MAGNETS

The permanent magnets are the same design as those employed in the Types I, IS-2 and IS-3 single-phase induction meters. Two magnets are astatically arranged and mounted in a single shoe. Actual service has proven this design to be extremely reliable and efficient.

METHOD OF CALIBRATION

Adjustment at full load is accomplished by loosening the two clamping screws which hold the magnets and then moving the magnets bodily. Moving the magnets towards the center of the disk increases the speed while moving the magnets toward the edge of the disk decreases the speed.

Accuracy at light load is obtained in the usual way, that is, by moving a lever, at the bottom of the meter, to the right or to the left as may be required; thus shifting a small rectangular conductor situated between the disk and the potential winding. The distortion of the flux obtained by moving the position of this adjusting device alters only

4549-4 Thomson High Torque Induction Test Meter, Type IB-2

the light load accuracy of the meter without affecting the calibration at full load.

ACCURACY

Under all conditions found in central station practice, the accuracy of the Portable High Torque Induction Test Meter is exceptional. Errors for ten per cent. changes in voltage or frequency are entirely negligible, as is also the case when measuring inductive loads or operating on circuits of widely different wave forms. The three separate current windings render it possible to obtain the same accuracy on a ten watt load as on a two kilowatt load. In other words, the meter . possesses the same accuracy throughout a range of 200 to 1.

METHOD OF OPERATION

The proper current winding of the test meter is connected in series with, and between the load and the meter undergoing test. The potential coil is connected across the line between the service switch and meter to be tested. It is necessary that the meters be connected up in this way, so that neither shall record the loss in the potential or current coils of the other, which would otherwise introduce appreciable errors at light load. The potential plug is inserted in the receptacle placed at the left of the dial, and after ascer-

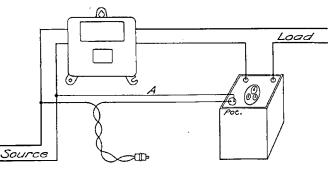
taining that the disk of the test meter is rotating counter clockwise, the test meter is stopped by opening the pendant snap switch and the reading of the pointers noted. The test meter should then be started simultaneously with the counting of disk revolutions of meter being tested, and again stopped by opening the snap switch after the required number of revolutions are taken and position of pointers again noted. The difference in the pointer indications between first and last readings gives the total number of disk revolutions of test meter. The watt hours recorded by the two meters are in each case equal to the product of disk revolutions and their respective constants, hence the relative accuracy is given by the ratio of these products. A sufficient number of revolutions should be taken to make negligible any errors of observation in reading the pointer indications.

PRICE '

Thomson High Torque Induction Test Meter, Type IB-2.

Cat. No.	Amperes	Volts	Cycles	Net Price
48988	1/10/20	110	60	\$60.00

TYPE IB-2 PORTABLE TEST METER, CONNECTED TO CHECK TYPE I INDUCTION METER, 2 WIRE 3/25 AMPERE



NOTE Wire marked "A" must be connected to source side of meter.

GENERAL ELECTRIC COMPANY, PRINCIPAL OFFICES, SCHENECTADY, N.Y.

General Electric Company Schenectady, N.Y.

SWITCHBOARD DEPARTMENT

November, 1907

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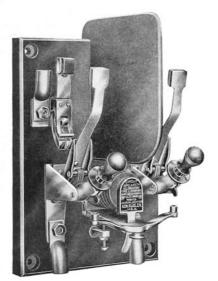
*Bulletin No. 4550

A.D.W

GENERAL ELECTRIC CARBON-BREAK CIRCUIT BREAKERS TYPE C, FORMS G, P AND K

General Electric Carbon-Break Circuit Breakers as described in the following pages typify the latest development in the art and the design represents the results of years of experiment and practical experience.

A circuit breaker is an essential in all electrical installations, its uses are manifold and important; through its medium when



DOUBLE-POLE TYPE C, FORM G CIRCUIT BREAKER, 500 VOLTS, OVERLOAD

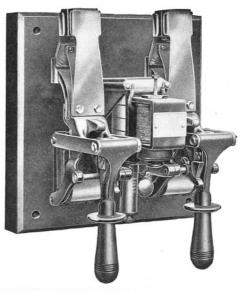
used separately or in connection with suitable auxiliary devices protection is afforded in the event of dangerous overloads, short circuits, low voltage, high voltage, reverse currents, excessive speed, etc.

A circuit breaker may be designed for motor, solenoid, float or hand operation, the

* Supersedes Bulletins 4330, 4348, 4386, 4410 and 4436.

latter type only being listed in this publication because of its relatively great popularity and because the other types in a sense are special and their construction and design are often governed by prevailing local conditions.

Circuit breakers may be used to the greatest advantage in feeder systems, with motor



DOUBLE-POLE TYPE C, FORM P CIRCUIT BREAKER, WITH LOW-VOLTAGE ATTACHMENT

driven machinery, in factories, planing mills and steel mills, on lighting systems of all kinds, in conjunction with cranes to limit the hoist or travel of the various carriages and on special circuits of unlimited variety.

The Carbon-Break Circuit Breakers made by the General Electric Company are de-4436.

550–2 General Electric Carbon-Break Circuit Breakers

signed to automatically open the circuit on overloads and short circuits under the most severe conditions to be met with. The final arc is broken on carbon-tipped tertiary and renewable metal secondary contacts. The main contact is thus protected against injury by burning and the auxiliary contacts may be readily renewed when necessary. All General Electric Circuit Breakers are conservatively rated and will carry the specified current continuously without excessive heating.

CONSTRUCTION

Ease of closing is secured by a toggle mechanism that also prevents the opening of the breaker from jarring or any other causes except those by reason of which it is designed to operate. This feature makes it possible to mount the breaker at the top of the switchboard where the arc of rupturing can do no damage to other apparatus.

A special form of laminated brush is used that secures practically an end contact on each lamination and equally distributes the pressure over the contact surface.

With this form of brush a slight rubbing motion is given the contacts each time the breaker is closed, which keeps them clean.

The use of delicate parts that will not stand continued rough usage is avoided.

No springs are used in the construction of any but the small types (Type C, Form G). In all others the spring of the laminated brush and the action of gravity open the breaker positively and quickly when it is tripped.

The breaker cannot remain in an indeterminate position, but must be fully closed or open.

All parts are readily accessible and easily renewable.

The main contact is protected by auxiliary copper and carbon contacts in shunt; the final break taking place between, and the arc being ruptured on these carbon contacts. These auxiliary contacts consisting of the secondary or "burning" contact and the tertiary or "carbon break" contact are of vital importance to the life and satisfactory operation of the breaker. Without both of

them the practical value of the circuit breaker is sacrificed.

In General Electric breakers the carbon contacts consist of solid blocks of carefully selected carbon, secured in clamping jaws without the use of countersunk screws, which would structurally weaken them and increase the probability of breakage.

The "burning" contacts are made of copper or of a highly infusible alloy, and so designed that they may be readily and quickly replaced by new ones when damaged due to long continued operation.

As far as possible, contact studs are made from one-piece drop forgings.

Any breaker can be removed from its template or temporary base and transferred to a switchboard without affecting its calibration.

All breakers will stand a high potential test between parts of opposite polarity, and between breaker and ground, of from three to five times the normal voltage rating of the breaker.

All attachments are so designed that they may be removed from or attached to the breaker without in any way affecting its calibration, or interfering with its operation as an overload device.

AN IMPORTANT CONSIDERATION

As a protective device, effectiveness is much more essential than efficiency-expressed in terms of energy lost due to temperature rise. But this rise should not exceed that guaranteed for the apparatus with which the breaker is to be used. Commercially this is all that should be expected; and beyond this point it is undesirable, from an economical standpoint, to keep down such losses by putting an excess of copper into the construction of the breaker.

RATING

General Electric Automatic Circuit Breakers are compact but temperature rise is always the determining factor in their design. They are so amply proportioned, therefore, that the temperature rise of no part will exceed

General Electric Carbon-Break Circuit Breakers 4550-3

moderate limits under normal conditions will in fact be comparable to the rise in the apparatus protected by the breaker. It is a mistake to specify certain sectional carrying capacity as in the larger types it is often necessary to exceed the cross section ordinarily called for in order to secure ample radiating surface.

Moderate temperature rise under normal conditions should always be insisted upon.

The rating of the circuit breakers is given on the name plate by two numbers. The first representing the continuous ampere carrying capacity and the second the voltage. This system is followed in the price lists given in this Bulletin.

AUTOMATIC FEATURES

The automatic operation of a circuit breaker is usually accomplished through the medium of an electro-magnet excited by current flowing through a coil of wire, or its equivalent, surrounding at least one pole of the magnetic circuit.

This coil may be wound for either current or potential, depending upon its method of connection in the circuit.

The current coil is connected in series with the circuit and designed to carry all the current flowing through that circuit.

The power of the electro-magnet depends on the amount of current flowing, and not on the voltage of the circuit.

The potential coil is connected across the line, as shown in the illustration, and only has to carry that fraction of the total current that the roltage of the system can force through its high resistance winding. The power of the electro-magnet depends upon the potential of the system, therefore, and does not in any way depend upon the total amount of current flowing in that system.

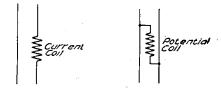
With this explanation the several methods of tripping a circuit breaker can be readily understood.

Overload and underload protection is secured by the use of current coils.

Low voltage release and shunt trip attachments are actuated by potential coils.

OVERLOAD TRIP

When the current flowing through the circuit exceeds a predetermined value, the electro-magnet of the Overload Trip is energized sufficiently to overcome the force of gravity acting on its armature; this arma-



POSITIONS OF CURRENT AND POTENTIAL COILS IN CIRCUIT

ture is forcibly *attracted* and strikes the tripping lever a hammer blow, releasing the toggle mechanism and causing the breaker to open. In all breakers up to and including 500 amperes capacity the overload tripping magnet consists of a wire or bar-wound coil. In breakers of larger capacity than 500 amperes the coil is replaced by a magnet frame encircling the lower stud, the current flowing through this stud being sufficient to secure the desired range of calibration.

UNDERLOAD TRIP

With the Underload Trip, when the current flowing through the circuit falls below a predetermined value, the energy of the electromagnet is insufficient to counteract the force of the spring acting on its armature, this armature is *released* and strikes the tripping lever a hammer blow, opening the circuit breaker.

LOW VOLTAGE TRIP ATTACHMENT

The Low Voltage Trip is designed to operate the circuit breaker when the line voltage drops to approximately 50 per cent. or less of the normal voltage.

It should be noted that its coil is always in circuit, as is the case with the overload and underload coils, and operates with the *releasing* of its armature.

It is always necessary to use a fixed amount of resistance (depending upon the voltage of

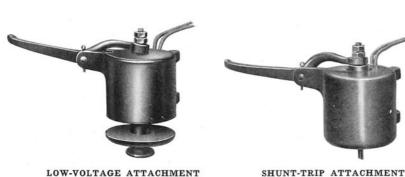
4550-4 General Electric Carbon-Break Circuit Breakers

the system) in series with the low voltage release.

The low voltage release performs the functions of a shunt trip coil when used in conjunction with a push-button, auxiliary switch or speed-limiting device, and is generally

nects it from the circuit. Whenever it is impossible to connect the shunt trip in this manner, the Circuit-Opening Auxiliary Switch should be used in connection with it.

CIRCUIT-CLOSING AUXILIARY SWITCH

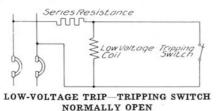


LOW-VOLTAGE ATTACHMENT

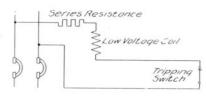
preferred to the shunt trip attachment.

SHUNT TRIP ATTACHMENT

The Shunt Trip Attachment has been designed to provide for conditions under

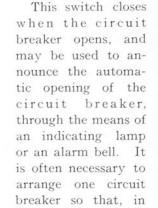


which the low voltage attachment cannot be successfully applied. It resembles the low

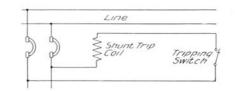


LOW-VOLTAGE TRIP-TRIPPING SWITCH NORMALLY CLOSED

voltage attachment in construction, but difers in that it trips the circuit breaker when energized. The shunt trip should be allowed to remain only momentarily in circuit; hence it should be so connected that the opening of the circuit breaker immediately discon-

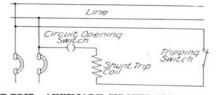


opening, it will trip others. This may be accomplished by using a Circuit-Closing Auxiliary Switch in connection with a low voltage or shunt trip attachment on the circuit breakers to be tripped.



SHUNT TRIP-COIL CONNECTED BEYOND BREAKER AND THROWN OUT OF CIRCUIT AFTER TRIPPING

The construction of this type of switch is such that it may be opened by hand after the circuit breaker opens, but it is auto-



SHUNT TRIP-AUXILIARY CIRCUIT-OPENING SWITCH TO THROW COIL OUT OF CIRCUIT AFTER TRIPPING

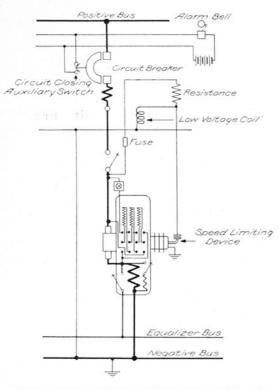
matically reset when the circuit breaker is closed.

General Electric Carbon-Break Circuit Breakers 4550-5

CIRCUIT-OPENING AUXILIARY SWITCH

when the circuit opens, and is intended to be used in connection with a shunt trip

and permitting another circuit breaker This switch opens an auxiliary circuit to remain closed only when the circuit breaker equipped with the auxiliary switch is open.



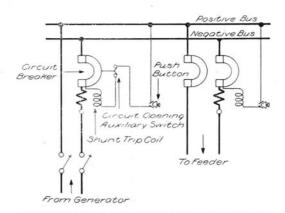
CONNECTIONS OF LOW-VOLTAGE RELEASE COIL WHEN USED WITH SPEED LIMITING DEVICE ON ROTARY CONVERTER

attachment to insure the immediate discon- COMBINED CIRCUIT-CLOSING AND CIRCUITnection of the shunt coil from the circuit.

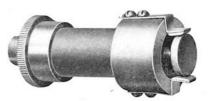


CIRCUIT-CLOSING AUXILIARY SWITCH

It may also be employed to serve other purposes, such as tripping another circuit breaker having a low-voltage attachment,



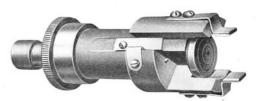
CONNECTIONS OF SHUNT TRIP COIL WITH AND WITHOUT CIRCUIT OPENING AUXILIARY SWITCH



CIRCUIT-OPENING AUXILIARY SWITCH

OPENING AUXILIARY SWITCH

As the name implies, this switch performs all the duties of both the circuit-closing and the circuit-opening switches.



COMBINED CIRCUIT-OPENING AND CIRCUIT-CLOSING AUXILIARY SWITCH

4550-6 General Electric Carbon-Break Circuit Breakers

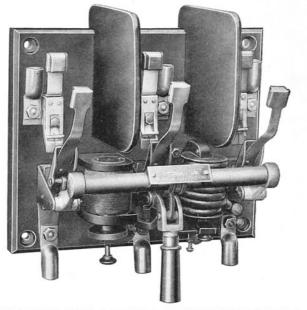
TYPE C, FORM G AUTOMATIC CIRCUIT BREAKERS

FOR DIRECT CURRENT, SINGLE- AND DOUBLE-POLE-250 AND 500 VOLTS. FOR ALTERNATING CURRENT SINGLE-, DOUBLE- AND TRIPLE-POLE-250 AND 550 VOLTS

Breaker, as manufactured by the General Electric Company meets all demands for a small, reliable, automatic, protective device for direct and alternating current systems,

The Type C, Form G Carbon-Break Circuit flexible in this respect; its time lag is appreciable and more or less dependent upon climatic conditions; it can never be absolutely relied upon to rupture at its rated capacity.

Through the use of a double-pole circuit



TRIPLE-POLE TYPE C, FORM G CIRCUIT BREAKER WITH OVERLOAD AND LOW-VOLTAGE RELEASE

and its moderate price should be a most important factor in influencing any decision involving a choice between fused switches and circuit breakers.

Aside from considerations of price, a circuit breaker possesses many obvious advantages over the combination of fuse and switch. Continuity of service is more nearly insured than when fuses are used, and the constant expense and delays involved in the replacement of these fuses are avoided.

The operation of the circuit breaker is absolutely positive, and it can be adjusted to trip at any predetermined point between its wide limits of calibration. A fuse is inbreaker with independently operated arms, the usual lever switch in series may be dispensed with, since such a circuit breaker performs the functions of both switch and single-pole breaker. Either arm may be closed and is then free to trip, and will trip instantly in response to an overload or short circuit (should such exist) when the second arm is closed.

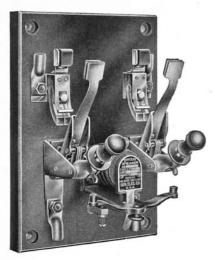
Type C, Form G Circuit Breakers, are suitable for every class of service requiring automatic protective devices.

The line consists of:

Single- and Double-Pole Breakers for Direct Current Circuits (Overload or Underload).

General Electric Carbon-Break Circuit Breakers 4550-7

Single-, Double- and Triple-Pole Breakers for Alternating Current Circuits.

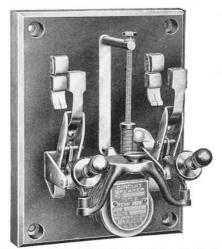


DOUBLE-POLE TYPE C, FORM G CIRCUIT BREAKER, OVERLOAD

DOUBLE-POLE TYPE C, FORM G CIRCUIT BREAKER 250 VOLTS, OVERLOAD

These breakers may be supplied mounted on slate bases, for front connection; or for back connection without bases, for mounting on switchboard panels. The slate bases have a dull black finish and the current carrying parts are of naturally finished copper and brass, buffed and lacquered.

Type C, Form G Circuit Breakers are made in all capacities up to 300 amperes. Two styles are for direct current; one for use on circuits up to 250 volts, and one for use on circuits up to 500 volts, and two for alternating current, one for 250 volts and one for 550 volts.



DOUBLE-POLE TYPE C, FORM G CIRCUIT BREAKER, UNDERLOAD

4550–8 General Electric Carbon-Break Circuit Breakers

AUTOMATIC CIRCUIT BREAKERS (OVERLOAD)

CARBON BREAK, TYPE C, FORM G, DIRECT CURRENT

SINGLE-POLE	, 250 VOLTS

CAT	. NO.		CALI	BRATION	
Front connected on Base	Back connected for 1½ in. or 2 in. Panel	*Ampere Capacity	Minimum	Maximum	List Price
39897	39909	3	1.5	5	\$12.00
39901	39913	5	3	8	12.00
39905	39917	10	5	15	12.00
35481	35505	15	10	25	12.00
35485	35509	25	15	40	13.00
35489	35513	50	25	75	14.00
35493	35517	100	50	150	17.00
35497	35521	200	100	300	25.00
35501	35525	300	200	450	30.00
		DOUBLE-POL	E, 250 VOLTS		
39898	39910	3	1.5	5	\$17.00
39902	39914	5	3	8	17.00
39906	39918	10	$\tilde{5}$	15	17.00
35482	35506	15	10	25	17.00
35486	35510	25	15	40	18.00
35490	35514	50	25	$\tilde{75}$	19.00
35494	35518	100	50	150	22.00
35498	35522	200	100	300	40.00
35502	35526	300	200	450	45.00
		SINGLE-POLE	, 500 VOLTS	· · · · ······························	
39899 [·]	39911	3	1.5	5	\$16.00
39903	39915	5	3	8	16.00
39907	39919	10	5	15	16.00
35483	35507	15	10	25	16.00
35487	35511	25	$\hat{15}$	40	17.00
35491	35515	50	25	75	18.00
35495	35519	100	50	150	21.00
35499	35523	200	100	300	30.00
35503	35527	300	200	450	35.00
		DOUBLE-POL	E, 500 VOLTS	<u> </u>	
39900	39912	3	1.5	5	\$21.00
39904	39916	5	3	8	\$21.00 21.00
39904	39910	10	5	15	21.00
35484	35508	15	10 10	$\frac{15}{25}$	
35488	$35508 \\ 35512$	15 25	10 15	40	21.00
35488 35492	35512	25 50			22.00
			25 50	75	23.00
35496	35520	100	50	150	25.00
35500	35524	200	100	300	45.00
35504	35528	300	200	450	50.00

*Ampere capacity denotes the load in amperes which the breaker will carry continuously without excessive heating. NOTE. — All circuit breakers of capacities up to and including 1200 amperes are supplied with the necessary nuts and terminals. Breakers of capacities over 1200 amperes are supplied with two nuts only on each stud and no terminals.

General Electric Carbon-Break Circuit Breakers 4550-9

AUTOMATIC CIRCUIT BREAKERS (UNDERLOAD)

CARBON BREAK, TYPE C, FORM G, DIRECT CURRENT

SINGLE-POLE, 250 VOLTS

CAT.	NO.		
Front connected on Base	Back connected for 1 ¹ / ₂ in. or 2 in. Panel	*Ampere Capacity	List Price
1.51			
37491	37515	15	\$14.00
37495	37519	25	15.00
37499	37523	50	16.00
37503	37527	100	19.00
37507	37531	200	28.00
37511	37535	300	33.00
	DOUBLE-Pe	OLE, 250 VOLTS	
37492	37516	15	\$19.00
37496	37520	25	20.00
37500	37524	50	21.00
	37528	100	24.00
37504		200	44.00
37508	37532	300	49.00
37512	37536	300	49.00
· ·	SINGLE-PO	DLE, 500 VOLTS	
37493	37517	15	\$18.00
37497	37521	25	19.00
37501	37525	50	20.00
37505	37529	100	23.00
	37533	200	33.00
$37509 \\ 37513$	37537	300	38.00
37313	01001	500	
	DOUBLE-P	OLE, 500 VOLTS	
37494	37518	15	\$23.00
37494	37522	25	24.00
	37526	50	25.00
37502		100	27.00
37506	37530	200	49.00
37510	37534		49.00 54.00
37514	37538	300	34.00

*Ampere capacity denotes the load in amperes which the breaker will carry continuously without excessive heating.

Nore. — Underload circuit breakers can be set to trip between the minimum limit of 10 per cent. and the maximum limit of 20 per cent. of their normal ampere carrying capacity.

NOTE.—All circuit breakers of capacities up to and including 1200 amperes are supplied with the necessary nuts and terminals. Breakers of capacities over 1200 amperes are supplied with two nuts only on each stud and no terminals. 4550–10 General Electric Carbon-Break Circuit Breakers

ATTACHMENTS FOR TYPE C, FORM G CIRCUIT BREAKERS DIRECT CURRENT

Cat. No. Attachment	- List	Voltage	Approx. Releasing Voltage	FOR CIRCUIT BREAKER		
		of Circuit		Amp. Capacity	Poles-,.	
37539	\$10.00	125	60	3 to 100	Single and doub	
37542	12.00	125	60	200 & 300	Single and doub	
37540	10.00	250	125	3 to 100	Single and dout	
37543	12.00	250	125	200 & 300	Single and dout	
37541	10.00	500	250	3 to 100	Single and doub	
37544	12.00	500	250	200 & 300	Single and dout	

* LOW-VOLTAGE RELEASE ATTACHMENTS

† SHUNT TRIP ATTACHMENTS

Cat. No.	List	Voltage	• FOR CIRCUIT BREAKER		
Attachment		Voltage of Circuit	Ampere Capacity	Poles	
$37545 \\ 37546$	\$8.00 10.00	125–250–500 125–250–500	3 to 100 200 & 300	Single and double Single and double	

AUXILIARY SWITCHES

CIRCUIT-	CLOSING	CIRCUIT-OPENING			COMBINED CIRCUIT-OPENING AND CIRCUIT-CLOSING		For
Cat. No.	List Price	Cat. No.	List Price	Cat. No.	List Price	Capacity of Circuit Breaker	Mounting on
37553 37554 37555 37556 37557 37558	\$5.00 5.00 5.00 5.00 5.00 5.00	37547 37548 37549 37550 37551 37552	\$5.00 5.00 5.00 5.00 5.00 5.00	37559 37560 37561 37562 37563 37563 37564	\$8.00 8.00 8.00 8.00 8.00 8.00 8.00	3 to 100 3 to 100 3 to 100 200 & 300 200 & 300 200 & 300	$1\frac{1}{4}''$ base $1\frac{1}{2}''$ pane 2 " pane $1\frac{1}{4}''$ base $1\frac{1}{2}''$ pane 2 " pane

*Release at one-half rated voltage.

† Should be allowed to remain in circuit only momentarily.

General Electric Carbon-Break Circuit Breakers 4550–11

AUTOMATIC CIRCUIT BREAKERS (OVERLOAD)

CARBON BREAK, TYPE C, FORM G, ALTERNATING CURRENT

SINGLE-POLE, 250 VOLTS

Maximum 5	Minimum	*Ampere Capacity	Back connected for 11 in. or 2 in. Panel	Front connected on Base
-				Uli Base
5	1.5	3	43350	43338
8	3	5	43354	43342
15	5	10	43358	43346
25	10	15	38166	38142
$\frac{20}{40}$	15	25	38170	38146
75	25	50	38174	38150
150	50 ²⁵	100	38178	38154
300				38154 38158
450	200	300	38182	38162
1	E, 250 VOLTS	DOUBLE-POL		
5	1.5	3	43351	43339
8				43343
15				43347
25				38143
40				38147
75	1 1			38151
150				38155
				38159
450	200	300	38185	38163
	, 550 VOLTS	SINGLE-POLE	<u> </u>	
5	1.5	3	43352	43340
8	3	5		43344
15	5	10		43348
25	10	15		38144
40	15	25		38148
75	25	50		38152
150	50	100		38156
300	100	200		38160
450	200	300	38188	38164
	E, 550 VOLTS	DOUBLE-POL		
5	1.5	3	43353	43341
8	3	5	43357	43345
15	5	10		43349
25	10	15	38169	38145
40	15	25		38149
75	25	50		38153
150	50	100		38157
300			{	38161
450	- • •			38165
5 5 3 5 6 0 <t< td=""><td>450</td><td>$\begin{array}{ c c c c c c c c c c c c c c c c c c c$</td><td>300$200$$450$DOUBLE-POLE, 250 VOLTS$3$$1.5$$4$$5$$3$$1.5$$5$$3$$1.5$$10$$5$$14$$15$$10$$24$$25$$15$$40$$50$$25$$74$$100$$50$$156$$200$$100$$300$$300$$200$$450$SINGLE-POLE, 550 VOLTS$46$$5$$3$$46$$5$$15$$40$$50$$225$$74$$10$$50$$156$$200$$100$$300$$300$$200$$450$$100$$50$$156$$10$$5$$14$$10$$5$$14$$10$$5$$14$$10$$5$$14$$10$$5$$14$$10$$50$$150$$25$$15$$44$$50$$225$$74$$100$$50$$156$$200$$100$$300$</td><td>38186 300 200 450 DOUBLE-POLE, 250 VOLTS DOUBLE-POLE, 250 VOLTS 43351 3 1.5 4 43355 5 3 8 43354 10 5 14 38167 15 10 24 38167 15 10 24 38167 15 10 24 38167 15 10 24 38171 25 15 44 38175 50 25 74 38187 300 200 450 38183 200 100 300 38187 300 200 450 43356 5 3 45 43356 5 3 45 43360 10 5 14 38172 25 15 44 38176 50 25 74 38180 100 50 156</td></t<>	450	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	300 200 450 DOUBLE-POLE, 250 VOLTS 3 1.5 4 5 3 1.5 5 3 1.5 10 5 14 15 10 24 25 15 40 50 25 74 100 50 156 200 100 300 300 200 450 SINGLE-POLE, 550 VOLTS 46 5 3 46 5 15 40 50 225 74 10 50 156 200 100 300 300 200 450 100 50 156 10 5 14 10 5 14 10 5 14 10 5 14 10 5 14 10 50 150 25 15 44 50 225 74 100 50 156 200 100 300	38186 300 200 450 DOUBLE-POLE, 250 VOLTS DOUBLE-POLE, 250 VOLTS 43351 3 1.5 4 43355 5 3 8 43354 10 5 14 38167 15 10 24 38167 15 10 24 38167 15 10 24 38167 15 10 24 38171 25 15 44 38175 50 25 74 38187 300 200 450 38183 200 100 300 38187 300 200 450 43356 5 3 45 43356 5 3 45 43360 10 5 14 38172 25 15 44 38176 50 25 74 38180 100 50 156

*Ampere capacity denotes the load in amperes which the breaker will carry continuously without excessive heating.

NOTE. — All circuit breakers of capacities up to and including 1200 amperes are supplied with the necessary nuts and terminals. Breakers of capacities over 1200 amperes are supplied with two nuts only on each stud and no terminals.

4550–12 General Electric Carbon-Break Circuit Breakers

AUTOMATIC CIRCUIT BREAKERS (OVERLOAD AND LOW VOLTAGE)

CARBON BREAK, TYPE C, FORM G, ALTERNATING CURRENT

	RATION	CALIBR	*Ampere	. NO.	CAT
List Price	Maximum	Minimum	Capacity	Back connected for 1 ¹ / ₂ in. or 2 in. Panel	Front connected on Base
\$40.00	5	1.5	3	46280	46271
40.00	8	3	5	46281	46272
40.00	15	5	10	46282	46273
40.00	25	10	15	40322	38196
40.00	40	15	25	40323	38197
40.00	75	25	50	40324	38198
45.00	150	50	100	40325	38199
75.00	300	100	200	40326	38200
85.00	450	200	300	40327	38201
	COILS ONLY	O OVERLOAD (550 VOLTS. TV	TRIPLE-POLE.	
		70 OVERLOAD (· · · · · · · · · · · · · · · · · · ·	
\$50.00	5.	1.5	3	46277	46268
\$50.00 50.00	5. 8.	$\frac{1.5}{3}$	3 5	46277 46278	46269
	5 8 15	1.5 3 5	3 5 10	$\begin{array}{r} 46277 \\ 46278 \\ 46278 \\ 46279 \end{array}$	46269 46270
50.00	$5\\8\\15\\25$	$\begin{array}{c}1.5\\3\\5\\10\end{array}$	3 5 10 15	46277 46278 46279 38214	46269 46270 38190
50.00 50.00	$5 \\ 8 \\ 15 \\ 25 \\ 40$	1.5 3 5 10 15	3 5 10 15 25	$\begin{array}{r} 46277\\ 46278\\ 46279\\ 38214\\ 38215\end{array}$	46269 46270 38190 38191
50.00 50.00 50.00	$5 \\ 8 \\ 15 \\ 25 \\ 40 \\ 75$	$egin{array}{c} 1.5 \\ 3 \\ 5 \\ 10 \\ 15 \\ 25 \end{array}$	3 5 10 15 25 50	$\begin{array}{r} 46277\\ 46278\\ 46279\\ 38214\\ 38215\\ 38216\end{array}$	46269 46270 38190 38191 38192
50.00 50.00 50.00 50.00	$5 \\ 8 \\ 15 \\ 25 \\ 40$	$egin{array}{cccc} 1.5 & & & \ 3 & & 5 & \ 10 & & 15 & \ 25 & & 50 & \ \end{array}$	3 5 10 15 25 50 100	$\begin{array}{r} 46277\\ 46278\\ 46279\\ 38214\\ 38215\\ 38216\\ 38217\\ \end{array}$	46269 46270 38190 38191 38192 38193
50.00 50.00 50.00 50.00 50.00	$5 \\ 8 \\ 15 \\ 25 \\ 40 \\ 75$	$egin{array}{c} 1.5 \\ 3 \\ 5 \\ 10 \\ 15 \\ 25 \end{array}$	3 5 10 15 25 50	$\begin{array}{r} 46277\\ 46278\\ 46279\\ 38214\\ 38215\\ 38216\end{array}$	46269 46270 38190 38191 38192

TRIPLE-POLE, 550 VOLTS, ONE OVERLOAD COIL ONLY

TRIPLE-POLE, 550 VOLTS, ONE OVERLOAD AND ONE LOW VOLTAGE COIL

CAT. NO.						
Front connected on Base	Back connected for 12 in. or 2 in. Panel	Ampere			List Price	
Cycles,	Cycles	Capacity	Minimum	N	Dist Tilte	
25, 40 and 60	25, 40 and 60 .		mininum	Maximum		
46274	46283	3	1.5	3	\$60.00	
46275	46284	5	3	- 8	60.00	
46276	46285	10	5	15	60.00	
38202	38220	15	10	25	60.00	
38203	38221	25	15	40	60.00	
38204	38222	50 ·	25	75	60.00	
38205	38223	100	50	150	65.00	
38206	38224	200	100	300	95.00	
38207	38225	300	· 200	450	105.00	

*Ampere capacity denotes the load which the breaker will carry continuously without excessive heating.

NOTE.—All circuit breakers of capacities up to and including 1200 amperes are supplied with the necessary nuts and terminals. Breakers of capacities over 1200 amperes are supplied with two nuts only on each stud and no terminals.

General Electric Carbon-Break Circuit Breakers 4550-13 .

ATTACHMENTS FOR TYPE C, FORM G CIRCUIT BREAKERS

ALTERNATING CURRENT

) GED	* LOW	-VOLTAGE RE	ELEASE ATTACH	IMENT		
Cat. No.	List	Voltage of	Voltage of	Approximate	DESCRIPTIO	N OF CIRCUIT BREAKERS
Attachment	Price	Circuit	Releasing Voltage	Amp. Cap.	Poles	
43378	\$14.00	125	60	up to 100	Single and doubl	
43381	16.00	125	60	200 to 300	Single and doubl	
43379	14.00	250	125	up to 100	Single and doubl	
43382	16.00	250	125	200 to 300	Single and doubl	
43380	14.00	550	250	up to 100	Single and doub	
43383	16.00	550	250	- 200 to 300	Single and doub	
	······	†SHUNT TRI	P ATTACHMENT	s.		
		· ·····		DESCRIPTION OF	CIRCUIT BREAKERS	
Cat. No. Attachment	List Price	Voltage Circu	e of		······ ·	
			An	ıp. Cap.	Poles	

 \$8.00
 125–250–550
 3 to 100
 Single and double

 10.00
 125–250–550
 200–300
 Single and double

AUXILIARY SWITCHES

For Mountin	- Ampere Capacity	COMBINED CIRCUIT-OPENING AND CIRCUIT-CLOSING		CIRCUIT-OPENING		CIRCUIT-CLOSING	
on	of Circuit Breaker	List	Cat. No.	List	Cat. No.	List	Cat. No.
$1\frac{1}{4}$ " base	3 to 100	\$8.00	37559	\$5.00	37547	\$5.00	37553
$1\frac{1}{2}''$ panel	3 to 100	8.00	37560	5.00	37548	5.00	37554
2 ["] panel	3 to 100	8.00	37561	5.00	37549	5.00	37555
1¼″ base	200 to 300	8.00	37562	5.00	37550	5.00	37556
$1\frac{1}{2}''$ panel	200 to 300	8.00	37563	5.00	37551	5.00	37557
2 ["] panel	200 to 300	8.00	37564	5.00	37552	5.00	37558

*Release at one-half rated voltage.

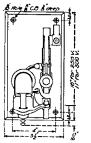
 $37545 \\ 37546$

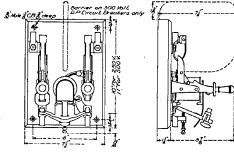
† Should be allowed to remain in circuit only momentarily.

· 4550–14 General Electric Carbon-Break Circuit Breakers

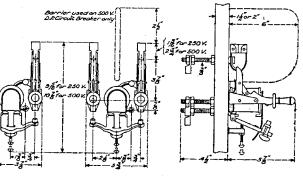
DIMENSIONS OF TYPE C, FORM G CIRCUIT BREAKERS (OVERLOAD)

3 TO 100 AMPS., 250 AND 500 VOLTS, DIRECT CURRENT



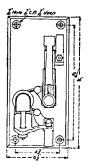


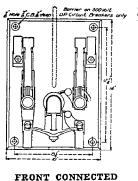
FRONT CONNECTED

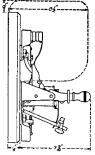


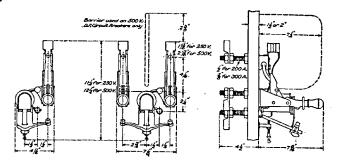
BACK CONNECTED

200 AND 300 AMPS., 250 AND 500 VOLTS, DIRECT CURRENT



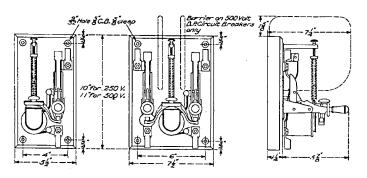




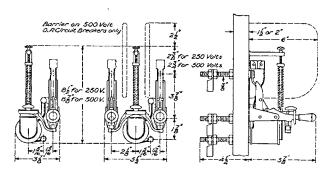


General Electric Carbon-Break Circuit Breakers 4550-15

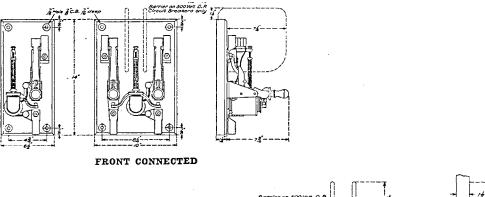
DIMENSIONS OF TYPE C, FORM G CIRCUIT BREAKERS (UNDERLOAD) 15 TO 100 AMPS., 250 and 500 VOLTS, DIRECT CURRENT

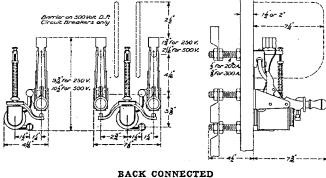


FRONT CONNECTED



BACK CONNECTED 200 AND 300 AMPS., 250 AND 500 VOLTS, DIRECT CURRENT

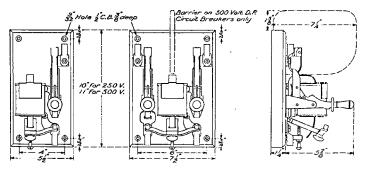




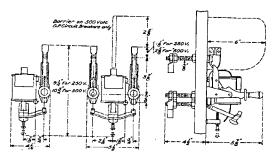
4550–16 General Electric Carbon-Break Circuit Breakers

DIMENSIONS OF TYPE C, FORM G CIRCUIT BREAKERS (OVERLOAD)

3 TO 100 AMPS., 250 AND 550 VOLTS, ALTERNATING CURRENT

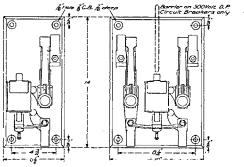


FRONT CONNECTED

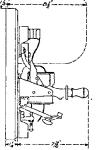


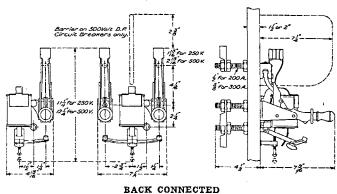
BACK CONNECTED

200 AND 300 AMPS., 250 AND 550 VOLTS, ALTERNATING CURRENT



FRONT CONNECTED



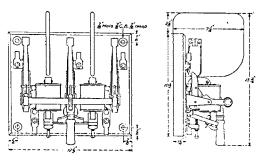


For REFERENCE ONLY

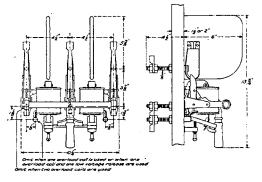
General Electric Carbon-Break Circuit Breakers 4550-17

DIMENSIONS OF TYPE C, FORM G CIRCUIT BREAKER (OVERLOAD)

3 TO 100 AMPS., 550 VOLTS, ALTERNATING CURRENT

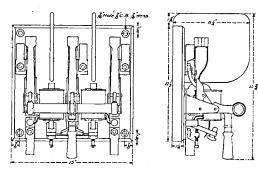


FRONT CONNECTED

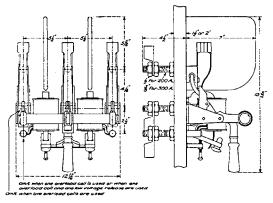


BACK CONNECTED

200 AND 300 AMPS., 550 VOLTS, ALTERNATING CURRENT



FRONT CONNECTED

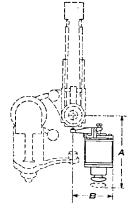


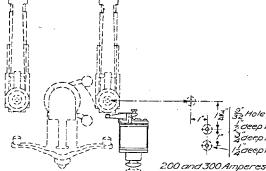
For REFERENCE ONLY

BACK CONNECTED

4550–18 General Electric Carbon-Break Circuit Breakers

DIMENSIONS OF ATTACHMENTS AND AUXILIARY SWITCHES FOR TYPE C, FORM G CIRCUIT BREAKERS—DIRECT AND ALTERNATING CURRENT







200 and 300 Amperes IO to 100 Amperes Single and Double Pole Single and Double Pole Drilling Plans Front View

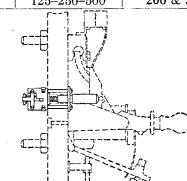
For REFERENCE ONLY

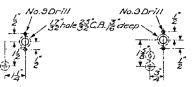
LOW-VOLTAGE RELEASE ATTACHMENTS

Cat. No.	Voltage	Approx. Re-	DESCRIPTION (DIMENS	SIONS	
of Attachment	of Circuit	leasing Voltage	Ampere Capacity	Poles	A	В
37539	125	60	Up to 100	Single & double	$3\frac{13}{16}$	$2\frac{3}{8}$
37542	125	60	200 & 300	Single & double	$4\frac{9}{16}$	$2\frac{1}{2}$
37540	250	125	Up to 100	Single & double	$3\frac{13}{16}$	$2\frac{\bar{3}}{8}$
37543	250	125	200 & 300	Single & double	$4\frac{9}{16}$	$2\frac{1}{2}$
37541	500	250	Up to 100	Single & double	$3\frac{13}{16}$	$2\frac{3}{8}$
37544	500	250	200 & 300	Single & double	$4\frac{9}{16}$	$2\frac{1}{2}$
		611	TINT TOTO ATTAC	TIMINTO	· · · · · · · · · · · · · · · · · · ·	

SHUNT TRIP ATTACHMENTS

I								
Cat. No.	Voltage	DESCRIPTION (OF CIRCUIT BREAKER	DIMENSIONS				
of Attachments	ot Circuit	Ampere Capacity	Poles	A	В			
37545	125-250-500	Up to 100	Single & double	$3\frac{13}{16}$	$\frac{2\frac{3}{8}}{2\frac{3}{8}}$			
37546	125 - 250 - 500	200 & 300	Single & double	$4\frac{9}{16}$	$2\frac{1}{2}$			





200 and 300 Amperes IO to IOO Amperes Single and Double Pole Single and Double Pole Drilling Plans Front View

For REFERENCE ONLY

Circuit-Closing Switch Cat. No.	Circuit-Opening Switch Cat. No.	Combined Circuit-Closing and Circuit-Opening Switch Cat. No.	Ampere Capacity of Circuit Breaker	For Mounting on
37553	37547	37559	Up to 100	Base $(1\frac{1}{4}'' \text{ thick})$
37554	37548	37560	Up to 100	$1\frac{1}{2}''$ panel
37555	37549	37561	Up to 100	2″ panel
37556	37550	37562	200 & 300	Base $(1\frac{1}{4}"$ thick)
37557	37551	37563	200 & 300	$1\frac{1}{2}''$ panel
37558	37552	37564	200 & 300	2'' panel

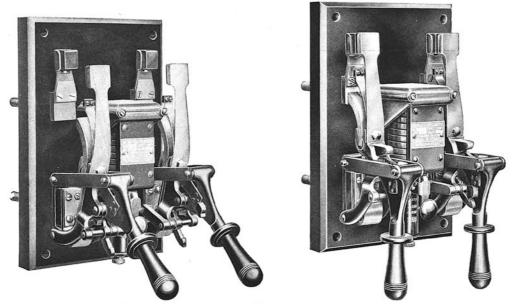
Norz.—Catalogue Numbers for D.C. Circuit Breaker Attachments only are given above. Dimensions are the same for both A.C. and D.C. Attachments.

General Electric Carbon-Break Circuit Breaker 4550-19

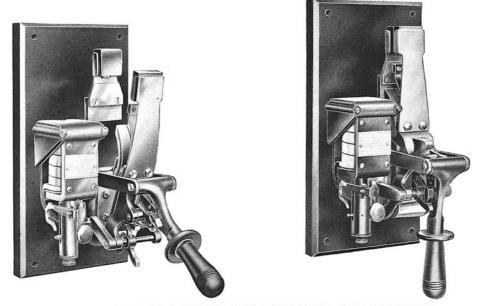
TYPE C, FORM P AUTOMATIC CIRCUIT BREAKERS

FOR DIRECT CURRENT, SINGLE- AND DOUBLE-POLE-250 AND 650 VOLTS. FOR ALTERNATING CURRENT, SINGLE- AND DOUBLE-POLE-250 AND 750 VOLTS

Type C, Form P Circuit Breakers are back with base for mounting on framework. connected and can be supplied without The overload coil of the small capacity base for mounting on a switchboard, or breaker consists of a wire wound spool.



DOUBLE-POLE TYPE C, FORM P CIRCUIT BREAKER, OPEN AND CLOSED



SINGLE-POLE TYPE C, FORM P CIRCUIT BREAKER, OPEN AND CLOSED

4550-20 General Electric Carbon-Break Circuit Breaker

Circuit breakers of intermediate capacities have polished copper cylindrical coils. On the larger sizes, 800 and 1200 amperes, this coil is replaced by a magnet frame encircling the lower stud, the current flowing through this stud being sufficient to secure the desired range of calibration. particularly adapted for use on railway and power systems which are frequently subjected to severe short circuits and heavy overload. They are made up to 1200 ampere capacity.

All current carrying parts are of polished copper, and the operating mechanism has a smooth dull black finish.

The Type C, Form P Circuit Breakers are

AUTOMATIC CIRCUIT BREAKERS (OVERLOAD) CARBON BREAK, TYPE C, FORM P, DIRECT CURRENT

	TION	CALIBR		AT. NO.	C/
List Price	Max.	Min.	* Ampere Capacity	For 1½ in.or 2 in.Panel	On Base
\$35.00	25	10	15	36231	36204
35.00	45	15	25	36234	36207
37.00	75	25	50	36237	36210
42.00	150	50	100	36240	36213
50.00	300	100	200	36243	36216
60.00	450	200	300	36246	36219
75.00	750	300	500	36249	36222
115.00	1200	500	800	36252	36225
150.00	1800	800 . ,	1200	36255	36228
· · · · · · · · · · · · · · · · · · ·	CTED	, BACK CONNI	POLE, 650 VOLTS,	SINGLE-	
\$38.00	25	10	15	36233	36206
38.00	45	15	25	36236	36209
40.00	75	25	50	36239	36212
45.00	150	50	100	36242	36215
55.00	300	100	200	36245	36218
65.00	450	200	300	36248	36221
80.00	750 .	300	500	36251	36224
120.00	1200	500	800	36254	36227
160.00	1800	800	1200	36257	36230
	ECTED	5, BACK CONN	-POLE, 250 VOLTS	DOUBLE	
\$52.00	25	10	15	36232	36205
52.00	45	15	25	36235	36208
55.00	75	$\overline{25}$	50	36238	36211
60.00	150	50	100	36241	36214
70.00	300	100	200	36244	36217
90.00	450	200	300	36247	36220
120.00	750	300	500	36250	36223
200.00	1200	500	800	36253	36226
250.00	1800	800	1200	36256	36229

SINGLE-POLE, 250 VOLTS, BACK CONNECTED

*Ampere capacity denotes the load which the breaker will carry continuously without excessive heating.

Note. —All circuit breakers of capacities up to and including 1200 amperes are supplied with the necessary nuts and terminals. Breakers of capacities over 1200 amperes are supplied with two nuts only on each stud and no terminals.

General Electric Carbon-Break Circuit Breakers 4550-21

AUTOMATIC CIRCUIT BREAKERS (UNDERLOAD)

CARBON BREAK, TYPE C, FORM P, DIRECT CURRENT

CAT. NO	·	Ampere	List Price
On 1 1 in. Base	For 1 ¹ / ₂ in.or 2 in. Panel	Capacity	List Frice
42074	42101	15	\$50.00
42077	42104	25	50.00
42080	42107	50	52.00
42083	42110	100	57.00
42086	42113	200	65.00
42089	42115	300	75.00
42092	42119	500	90.00
*42095	42113	800	140.00
*42098	42125	1200	175.00
Ş	SINGLE-POLE, 650 VOLT	S, BACK CONNECT	ED
42076	42103	15	\$53.00
42079	42106	25	53.00
42082	42109	50	55.00
42085	42112	100	60.00
42088	42115	200	70.00
42091	42118	300	80.00
42094	42121	500	95.00
*42097	42124	800	145.00
*42100	42127	1200	185.00
D	OUBLE-POLE, 250 VOLI	S, BACK CONNEC	red ·
42075	42102	15	\$67.00
42078	42105	25	67.00
42081	42108	50	70.00
42084	42111	100	75.00
	42114	200	85.00
42087	42117	300	105.00
$42087 \\ 42090$	TATT I		
$42087 \\ 42090 \\ 42093$	42120	500	135.00
42090		500 800	135.00

SINGLE-POLE, 250 VOLTS, BACK CONNECTED

NOTE. — Ampere capacity denotes the load that the breakers will carry continuously without excessive heating.

Norg. — Underload breakers can be set to trip between the minimum limit of 10% and the maximum limit of 20% of their carrying capacity.

Nore. - All circuit breakers of capacities up to and including 1200 amperes are supplied with the necessary nuts and terminals.

4550–22 General Electric Carbon-Break Circuit Breakers

ATTACHMENTS FOR TYPE C, FORM P CIRCUIT BREAKERS

DIRECT-CURRENT

DESCRIPTION OF CIRCUIT BREAKER Approx. Releasing Voltage Cat. No. of Attachment List Price Voltage of Circuit Ampere Capacity Poles Single- & double-pole 36258\$16.00 125 60 15 to 500 Single-pole 800 & 1200 3626416.00 12560 Double-pole Single- & double-pole 36261 16.00 12560 800 & 1200 15 to 500 25012536259 16.00 800 & 1200 Single-pole 250125 36265 16.00 Double-pole 3626216.00 250125800 & 1200 Single-pole 36260 16.00 650 32515 to 500 800 & 1200 Single-pole 36266 16.00 650 325

* LOW VOLTAGE RELEASE ATTACHMENTS

†SHUNT TRIP ATTACHMENTS

Cat. No.	List	Voltage of	DESCRIPTION	OF CIRCUIT BREAKER
of Attachment	Price	Circuit	Ampere Capacity Poles	
36267 36269 36268	\$12.00 12.00 12.00	$125 - 250 - 650 \\ 125 - 250 \\ 125 - 250 $	800 & 1200 Single-pole	Single- & double-pole Single-pole Double-pole

AUXILIARY SWITCHES

CIRCUIT-CLOSING		CIRCUIT	OPENING	CLOSE	D CIRCUIT- NG AND -OPENING	Ampere Capacity	For Mounting on		
Cat. No.	List Price	Cat. No.	List Price	Cat. No.	List Price	Circuit Breaker			
36270	\$6.00	36278	\$6.00	36286	\$11.00	15 to 200	Base (117 thick)		
36271	6.00	36279	6.00	36287	11.00	15 to 200	$l\frac{1}{2}''$ panel		
36272	6.00	36280	6.00	36288	11.00	15 to 200	2" panel		
36273	6.00	36281	6.00	36289	11.00	300 & 500	Base $(1\frac{1}{4}"$ thick)		
36274	6.00	36282	6.00	36290	11.00	300 & 500	1 ¹ / panel		
36275	6.00	36283	6.00	36291	11.00	300 & 500	2 ["] panel		
36276	6.00	36284	6.00	36292	11.00	800 & 1200	$1\frac{1}{2}''$ panel or base		
36277	6.00	36285	6.00	36293	11.00	800 & 1200	2" panel		

* Release at approximately one-half rated voltage.

† Should be allowed to remain in circuit only momentarily.

General Electric Carbon-Break Circuit Breakers 4550-23

AUTOMATIC CIRCUIT BREAKERS (OVERLOAD)

CARBON BREAK, TYPE C, FORM P, ALTERNATING CURRENT

	ATION	CALIBR		E NUMBER	CATALOGU
Price List	Maximum	Minimum	Ampere Capacity	For 1½ inch or 2 inch Panel	On 11 inch Base
\$40.00	25	10	15	40904	40877
40.00	45	15	25	40907	40880
44.00	75	25	50	40910	40883
50.00	150	50	100	40913	40886
60.00	300	100	200	40916	40889
70.00	450	200	300	40919	40892
90.00	750	300	50 0	40922	40895
140.00	1200	500	800	*40925	*40898
180.00	1800	800	1200	*40928	*40901
140.00	1200	500	800	†40931	,
180.00	1800	800	1200	†40934	
	TED	S, BACK CONNE	POLE, 750 VOLT	SINGLE-	,
\$44.00	25	10	15	40906	408 79
44.00	45	15	25	40909	40882
48.00	75	25	50	40912	40885
55.00	150	50	100	40915	40888
65.00	300	100	200	40918	40891
75.00	450	200	300	40921	40894
95.00	750	300	500	40924	40897
145.00	1200	500	800	*40927	*40900
185.00	1800	800	1200	*40930	*40903
145.00	1200	500	. 800	†40933	
185.00	1800	800	1200	†40936	
	CTED	TS, BACK CONNI	-POLE, 250 VOL	DOUBLE	,
\$70.00	25	10	15	40905	40878
70.00	45	15	25	40908	40878
75.00	75	$\frac{10}{25}$	50	40900	40884
80.00	150	50	100	40914	40887
90.00	300	100	200	40917	40890
110.00	450	200	300	40920	40893
140.00	750	300	500	40923	40896
230.00	1200	500	800	*40926	*40899
280.00	1800	800	1200	*40929	*40902
230.00	1200	500	800	†40932	10004
280.00	1800	800	1200	†40935	

SINGLE-POLE, 250 VOLTS, BACK CONNECTED

* For mounting on 14 inch base or panel only. † For mounting on 2 inch panel only. Nors.—Ampere capacity denotes the load that the breaker will carry continuously without excessive heating. Nors.—All circuit breakers of capacities up to and including 1200 amperes are supplied with the necessary nuts and termi-nals. Breakers of capacities over 1200 amperes are supplied with two nuts only on each stud and no terminals.

4550-24 General Electric Carbon-Break Circuit Breakers

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ATTACHMENTS FOR TYPE C, FORM P CIRCUIT BREAKERS

ALTERNATING CURRENT

*LOW-VOLTAGE RELEASE ATTACHMENTS

Cat. No.		Voltage of	Approximate	DESCRIPTION C	F CIRCUIT BREAKER
Attach.	List Price	Circuit	Releasing Voltage	Ampere Capacity	Poles
43362	\$20.00	125	60	up to 500	Single and double
43363	20.00	250	125	up to 500	Single and double
43364	20.00	750	375	up to 500	Single and double
43365	20.00	125	60	800 and 1200	Double
43366	20.00	250	125	800 and 1200	Double
43367	20.00	750	375	800 and 1200	Double
43368	20.00	125	60	800 and 1200	Single
43369	20.00	250	125	800 and 1200	Single
43370	20.00	750	375	800 and 1200	Single

† SHUNT TRIP ATTACHMENTS

Cat. No.	List Price	Voltage of		
Attach.	List Price	Circuit	Ampere Capacity	Poles
36267 36268 43371	\$12.00 12.00 12.00	125-250-750 125-250-750 125-250-750	up to 500 800 and 1200 800 and 1200	Single or double Double Single

AUXILIARY SWITCHES

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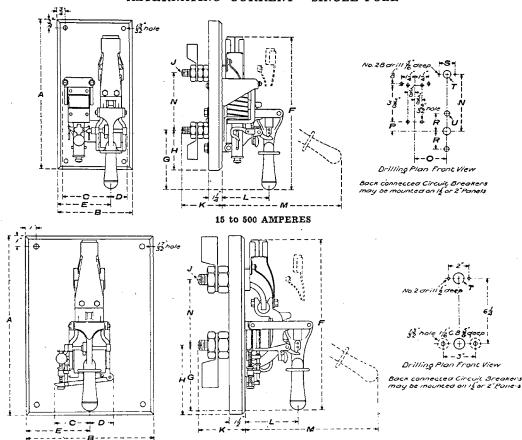
Circuit- Closing	List Price	Circuit- Opening	List Price	Combined Circuit-Closing and Circuit- Opening	List Price	Ampere Capacity of Circuit Breaker	For Mounting On
$\begin{array}{r} 36270\\ 36271\\ 36272\\ 36273\\ 36273\\ 36274\\ 36275\\ 43372\\ 43373\end{array}$	\$6.00 6.00 6.00 6.00 6.00 6.00 6.00 6.00	$\begin{array}{r} 36278\\ 36279\\ 36280\\ 36281\\ 36282\\ 36283\\ 43374\\ 43375\\ \end{array}$	\$6.00 6.00 6.00 6.00 6.00 6.00 6.00 6.00	36286 36287 36288 36289 36290 36291 43376 43377	\$11.00 11.00 11.00 11.00 11.00 11.00 11.00 11.00	15 to 200 15 to 200 15 to 200 300 and 500 300 and 500 300 and 500 800 and 1200 800 and 1200	11" base 11" panel 2 " panel 11" base 11" panel 2 " panel 2 " panel 11" b. or p. 2 " panel

* Release at approximately one-half rated voltage.

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† Should be allowed to remain in circuit only momentarily.

General Electric Carbon-Break Circuit Breakers 4550-25



DIMENSIONS OF TYPE C, FORM P CIRCUIT BREAKERS DIRECT AND ALTERNATING CURRENT—SINGLE-POLE

For REFERENCE ONLY

800 to 1200 AMPERES

CAT	. NO.												Í									
With Base	Without Base	Amps.	Volts	A	В	с	D	Е	F	G	н	1	к	L 	м 	N	0	Р 	R	s 	т	U
36204 36207 36210 36213	36231 36234 36237 36240	15 25 50 100	250	12	6	37	ž	43	12 <u>1</u>	4 11	3	≹-16 th'ds	·4½	31	9§	43	23	1	1 者	78	1 ⁷ 8	3
36216 36219 36222 36225	36243 36246 36249 36252	200 300 500 800	250 250 250 250	12 14 14 17	· 6 7 7 12	4 <u>1</u> 41	$1\frac{7}{16}$ $1\frac{7}{18}$ $2\frac{1}{4}$	5	121 141 141 141 1613	5½ 5½	3 31 31 61	$-13\frac{1}{2}$ " $\frac{1}{2}-11$ " $\frac{1}{2}-12$ " 1-12 "	41	4 7 18	9§ 111 111 121	53 58	3 3	쿻	1 5 1§ 1§	7 12 12 12	18 18 18 1 16	16 7 16
36228 36206 36209 36212	36255 36233 36236 36239	$1200 \\ 15 \\ 25 \\ 50$	250	17 13	12 6		2‡ 7		16 元 13 :	61 411	6‡ 3	1↓-12 " ≹-16 "	5½ 4½	5 3‡	123 91		:	1	1 38		1 <u>3</u> 16 16	
36215 36218 36221 36224	36242 36245 36248 36251	100 200 300 500	650 650 650	13 15 $\frac{1}{2}$ 15 $\frac{1}{2}$			78 1 778 1 778	43 5 5	131 1518 1518	$5\frac{1}{2}$	3 31 31	$\frac{1}{2}$ -13 " $\frac{3}{2}$ -11 " $\frac{3}{2}$ -12 "	41/2		9 11 11 11	5	21 3 3	7	1 5 1 5 1 §	동 1호 1호 1호	H	16
36227 36230	36254 36257	800 1200	650 650	18 18	12 12	-	2‡ 2‡	6 6	17호 17호		$6\frac{1}{2}$ $6\frac{1}{2}$	1 -12 " $1\frac{1}{4}-12$ "	4 <u>1</u> 5 <u>1</u>		13 1 13 1	-		_	_	<u> </u>	$1\frac{1}{16}$ $1\frac{5}{16}$	1

NOTE.—Catalogue numbers for D.C. Circuit Breakers only are given above. Dimensions are the same for both A.C. and D.C. Type C, Form P Circuit Breakers.

Base

36205

36208

36211

36214

36217

36220

36223

36226

36229

Base

36232

36235

36238

36241

36244

36247

36250

36253

36256

15

25

50

100

200

300

500

800

1200

250 12

250

250

250

250

250

12 8

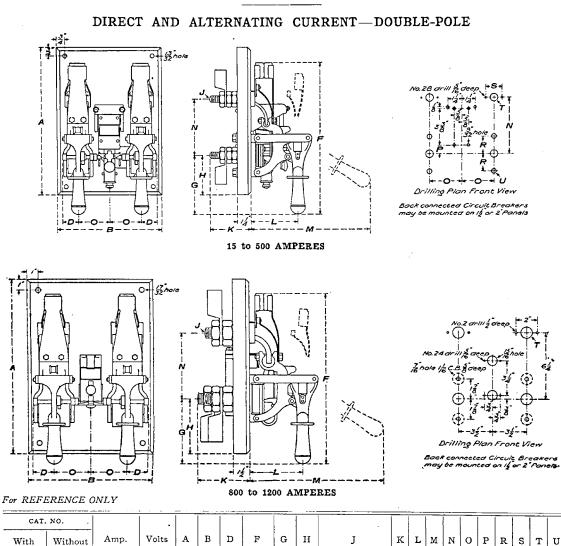
14 10 17 142

14 10 1 7 14

17 12 1 18 16 78

17 12 118 16

8 3 123



DIMENSIONS OF TYPE C, FORM P CIRCUIT BREAKERS

*The right-hand lower stud is made longer on account of the magnet yoke. The remaining three studs are three-fourths inch shorter.

4 1 3

4 11

51 31

51 31

61

61 51

3

5‡

121

7

3-16 th'ds

14

44

..

1-13 "

§-11

1-12

1 -12 "

11-12

 $4\frac{1}{2}3\frac{7}{8}$

41 37 98 47 28 1 1 18 7

*51 5

*61 5

41 4 7 111

 $4\frac{1}{2}4\frac{7}{16}11\frac{1}{4}$

98 43 28 1 1 1

121 61 31

123 61 31

53 3

5 3 3

7 16 3

1월 남 금

1 🚠

1 18

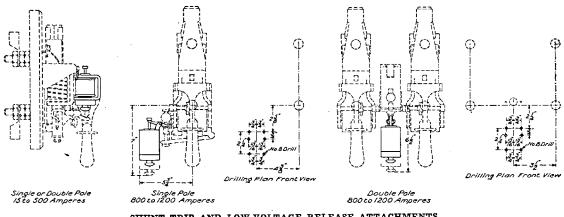
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3 1월 | 1월 1월 76

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NOTE.—Catalogue Numbers for D.C. Circuit Breakers only are given above. Dimensions are the same for both A.C. and D.C. Type C, Form P Circuit Breakers.

DIMENSIONS OF ATTACHMENTS AND AUXILIARY SWITCHES FOR TYPE C, FORM P CIRCUIT BREAKERS—DIRECT AND ALTERNATING CURRENT



For REFERENCE ONLY



AUXILIARY SWITCHES

For REFERENCE ONLY

NOTE .- For thickness of panels on which Auxiliary Switches are to be mounted see table on page 22.

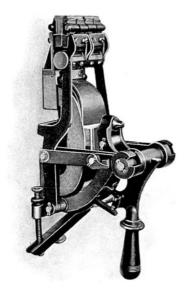
4550–28 General Electric Carbon-Break Circuit Breaker

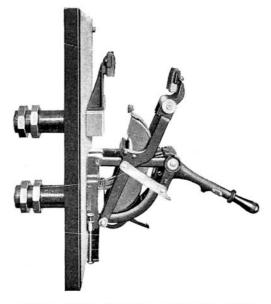
TYPE C, FORM K CIRCUIT BREAKERS

FOR DIRECT CURRENT-SINGLE-POLE-250 AND 650 VOLTS

FOR ALTERNATING CURRENT-SINGLE-POLE-250 AND 750 VOLTS

Type C, Form K Circuit Breakers especially designed for heavy service, are particularly well suited for railway work. The usual overload trip coil is omitted, the trip being accomplished by means of a horseshoe magnet placed around the lower contact stud. This magnet is provided with a swinging armature, which when pulled up-





DIRECT CURRENT TYPE C, FORM K CIRCUIT BREAKER, CLOSED

They are made in two styles, for direct current circuits up to 250 volts and for current capacities from 2000 to 6000 amperes, for 650 volt circuits for current capacities from 2000 to 10,000 amperes, and for alternating current service 250 and 750 volts with current capacities from 2000 to 4000 amperes.

TYPE C, FORM K CIRCUIT BREAKER, OPEN

ward strikes a catch, releasing the contacts and permitting the breaker to open.

Polished copper current carrying parts and toggle joints, etc., finished in smooth dull black, make the circuit breakers very handsome in appearance.

General Electric Carbon-Break Circuit Breakers 4550-29

AUTOMATIC CIRCUIT BREAKERS (OVERLOAD)

CARBON BREAK, TYPE C, FORM K, DIRECT CURRENT

SINGLE-POLE 250 VOLTS

	RATION	CALIBI	Ampere	·CATALOGUE NO.		
List Price	Maximum	Minimum	Capacity	For Mounting on 2 in. Panel	Mounted on Base	
\$225.00 400.00 650.00	4,000 10,000 15,000	1200 2000 2000	2000 4000 6000	28921 28922 *28923	29617	
<u></u>		LTS	.650 VO	1 m	······································	
\$260.00 450.00 775.00 950.00 1,500.00	4000 10,000 15,000 20,000 25,000	1200 2000 2000 2000 2000 2000	2000 4000 6000 8000 10,000	28925 28926 *28927 †28928 †28929	29619	

* For mounting on 2 inch or 2½ inch panel.
 † For mounting on 2½ inch panel only.
 NOTE.—Ampere capacity denotes the load which the breaker will carry continuously without excessive heating.
 NOTE.—Ampere capacity capacities up to and including 1200 amperes are supplied with the necessary nuts and terminals.
 Breakers of capacities over 1200 amperes are supplied with two nuts only on each stud and no terminals.

ATTACHMENTS FOR TYPE C, FORM K CIRCUIT BREAKERS-DIRECT CURRENT

*LOW-VOLTAGE RELEASE ATTACHMENTS 250 VOLTS

	CATALOGUE N Voits	· O.	List Price	Description	FOR CIRCU	IT BREAKER
32469 32468 16.00 Lo				Cat. No.	Amperes	
3246	32466 32465 \$16.00 I 32469 32468 16.00 I 32472 32471 16.00 I		Low Voltage Release Low Voltage Release Low Voltage Release	28921 28922 28923	2000 4000 6000	
				650 VOLTS		
125	250	650 				2 2
32466 32469 32472 32475 32475 32475	$\begin{array}{r} 32465\\ 32468\\ 32471\\ 32474\\ 32474\\ 32474\end{array}$	$\begin{array}{r} 32464\\ 32467\\ 32470\\ 32473\\ 32473\\ 32473\end{array}$	16.00 16.00 16.00 16.00 16.00	Low Voltage Release Low Voltage Release Low Voltage Release Low Voltage Release Low Voltage Release	28925 28926 28927 28928 28929	2000 4000 6000 8000 10,000

* Releases at approximately one-half rated voltage. Norz.—Prices on Attachments for A.C. Circuit Breakers, Type C Form K, will be quoted on application.

4550-30 General Electric Carbon-Break Circuit Breakers

ATTACHMENTS FOR TYPE C, FORM K CIRCUIT BREAKERS (Continued)

DIRECT CURRENT

*SHUNT TRIP ATTACHMENTS

250 VOLTS

CATALO	GUE NO.			FOR CIRCU	IT BREAKER
Vo	lts	List Price	Description	·	
125	250			Cat. No.	Amperes
$32456 \\ 32457 \\ 3257 \\ 32$	$32456 \\ 32457$	\$12.00 12.00	Shunt Trip Shunt Trip	28921 28922	2000 4000
32458	32458	12.00	Shunt Trip	28923	6000

650 VOLTS

125	250	650				
$2456\\2457$	$32456 \\ 32457$	$\begin{array}{c} 32456\\ 32457\end{array}$	12.00 12.00	Shunt Trip Shunt Trip	28925 28926	2000 4000
$2458 \\ 2459 \\ 2459 \\ $	$32458 \\ 32459 \\ 32459$	$\begin{array}{c c} 32458 \\ 32459 \\ 32459 \\ \end{array}$	12.00 12.00 12.00	Shunt Trip Shunt Trip Shunt Trip	28927 28928 28929	6000 8000 10,000

AUXILIARY SWITCHES 250 VOLTS

CIRCUIT-C	LOSING				CUIT-OPENING	Thickness of Panel	FOR CIRCUIT BREAKER				
Cat. No.		Cat. No.		Cat. No.	List Price	in Inches	Cat. No.	Amperes			
32496	\$6.00	32484	\$6.00	32508	\$11.00	2	28921	2000			
32497	6.00	32485	6.00	32509	11.00	2	28922	4000			
32498	6.00	32486	6.00	32510	11.00	, 2	28923	6000			
32502	6.00	32490	6.00	32514	11.00	$2\frac{1}{2}$	28923	6000			
	· · · · · · ·		·	650 VOL	TS		· · · · · · · · · · · · · · · · · · ·				
32492	\$6.00	32480	\$6.00	32504	\$11.00	2	28925	2000			
32493	6.00	32481	6.00	32505	11.00	2	28926	4000			
32494	6.00	32482	6.00	32506	11.00	2	28927	6000			
32499	6.00	32487	6.00	32511	11.00	$2rac{1}{2}$	28927	6000			
32500	6.00	32488	6.00	32512	11.00	$2\frac{1}{2}$	28928	8000			
32501	6.00	32489	6.00	32513	11.00	$2\frac{1}{2}$	28929	10,000			

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*Should be allowed to remain in circuit only momentarily. NOTE.—Prices on Attachments for A.C. Circuit Breakers, Type C, Form K will be quoted on application.

General Electric Carbon-Break Circuit Breakers 4550-31

AUTOMATIC CIRCUIT BREAKERS (OVERLOAD)

CARBON BREAK, TYPE C, FORM K ALTERNATING CURRENT

CATALOGU	E NUMBER	· .	CALIB	RATION	
On 2 inch Base	For 2 inch Panel	Amp. Cap.	Min.	Max.	List Price
40871	40872 40875	2000 4000	1200 2000	4000 10000	\$300.00 500.00
<u>.</u>	SINGLE-I	POLE, 750 VOLT	S, BACK CONN	ECTED	
40873	$\begin{array}{r} 40874\\ 40876\end{array}$	2000 4000	$\frac{1200}{2000}$	4000 10000	\$335.00 550.00

SINGLE-POLE, 250 VOLTS, BACK CONNECTED

Note.—Ampere capacity denotes the load that the breaker will carry continuously without excessive heating. Note.—All circuit breakers of capacities up to and including 1200 amperes are supplied with the necessary nuts and terminals. Breakers of capacities over 1200 amperes are supplied with two nuts only on each stud and no terminals.

NUTS AND TERMINALS FOR TYPE C, FORM K CIRCUIT BREAKERS

DIRECT AND ALTERNATING CURRENT

All circuit breakers of capacities up to and including 1200 amperes are supplied with the necessary nuts and terminals. Breakers of capacities above 1200 amperes are supplied with two nuts only, on each stud, and no terminals. The following tables give the nuts and terminals which are used with the various circuit breakers in our standard practice. If the conditions are such that the arrangement of nuts and terminals given will not meet the requirements, Bulletin No. 4360, covering nuts and terminals, should be referred to.

TERMINALS FOR CK BREAKERS-250 AND 750 VOLTS

Cat. No.	Quantity Per Stud	List Price Per 100	No. and Size of Cable (Circular Mills)	Size of Cable Hole in Inches	For Circuit Breaker Ampere Capacity
27448 27453	2 1)	\$700.00 750.00	2-1,500,000 3-2,000,000	1½ 1¾	2000 4000
27452 26950 26952	2 (4 6	800.00 800.00	4–2,000,000 6–2,000,000 Special	1 3 1 3 1 3	6000 8000 10,000

NUTS FOR CK BREAKERS-250 AND 750 VOLTS

Cat. No.	Number Required per Stud	List Price per 100	Thickness in Inches	Diam. Across Flats in Inches	Diam. of Stud in Inches	Shape	For Circuit Breaker Ampere Capacity
26972 26974 26968 26969 31745	$\begin{array}{c}1\\2\\3\\5\\6\end{array}$	\$185.00 360.00 315.00 450.00 450.00	1 1 1 1 1	3 37 45 5 35 6	$1\frac{3}{4}\\2\frac{1}{2}\\3\frac{1}{4}\\4\\4\frac{3}{4}$	Hex. Hex. Oct. Oct. Oct.	2000 4000 6000 8000 10,000

NOTE .- Prices on Attachments for A.C. Circuit Breakers, Type C, Form K will be sent on application.

4550–32 General Electric Carbon–Break Circuit Breakers

For REFERENCE ONLY

DIMENSIONS OF TYPE C, FORM K CIRCUIT BREAKERS

250 VOLTS

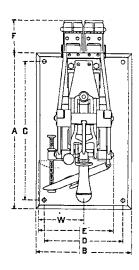
CAT. NO.	RA	FING	Description	A	в	c	ם	E	F	G	н	T	к	т.
S.P.	Volts	Amps.	Description	A				E				, 		
$29617 \\ 28921 \\ 28922 \\ 28923$	$250 \\ 250 \\ 250 \\ 250 \\ 250 \\ 250 \\ $	2000 2000 4000 6000	with 2" base for 2" panel for 2" panel for 2" or 2½" panel	18	11	16	9	83 83 10 10 11	31	$6 rac{13}{16} 6 rac{13}{16} 7 rac{1}{2} 8 rac{1}{2}$		$7\frac{1}{4} \\ 7\frac{1}{4} \\ 8\frac{1}{8} \\ 8\frac{13}{16} \\ 16$	$16\frac{3}{4}\\16\frac{3}{4}\\19\\24\frac{3}{8}$	$20\frac{1}{4}$ $20\frac{1}{4}$ $22\frac{7}{8}$ 28

<u> </u>			<u> </u>						• •				
CAT. NO.	RAI	TING	Description	м	N	0	Р	R	s	т	U	v	w
S.P.	Volts	Amps.	Description			Ŭ	•						
$29617 \\ 28921 \\ 28922$	$250 \\ 250 \\ 250 \\ 250$	2000 2000 4000	with 2″ base for 2″ panel for 2″ panel	7 <u>8</u> 7 8 9		$2\frac{3}{4}$ $2\frac{3}{4}$ $3\frac{1}{4}$	$2\frac{1}{8}$	$4\frac{1}{8}$ $4\frac{1}{8}$ $5\frac{1}{2}$	$\frac{9}{16}$	$2\frac{3}{16}$ $2\frac{3}{16}$ $2\frac{3}{16}$	$ \begin{array}{r} 1 & 7 \\ 3 & 2 \\ 1 & 7 \\ 3 & 2 \\ 1 & 7 \\ 3 & 2 \\ 1 & 3 & 2 \\ \end{array} $	$1\frac{3}{4}$ $1\frac{3}{4}$ $2\frac{1}{2}$	$5\frac{3}{16}$
28923	250	6000	for $2''$ or $2\frac{1}{2}''$ panel	105	$3\frac{11}{32}$	$4\frac{1}{4}$	$4\frac{1}{2}$	$6\frac{1}{2}$	1	43	$\left\{\begin{array}{l} \frac{3}{2} - 1 \\ \text{for } 2\frac{1}{2} \\ \text{for } 2\frac{1}{2} \\ \end{array}\right\}$	34	6 1

DIRECT CURRENT

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General Electric Carbon-Break Circuit Breakers 4550-33



For REFERENCE ONLY

DIMENSIONS OF TYPE C, FORM K CIRCUIT BREAKERS

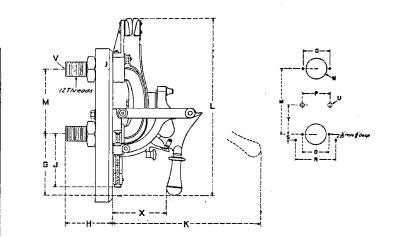
650 VOLTS

CAT. NO.	RA	TING												
S.P.	Volts	Amps.	Description .		B	C	D	E	F	G	н	J	ĸ	L
29619 28925 28926 28927 28928 28928 28929	650 650 650 650 650 650 650	2000 2000 4000 6000 8000 10000	with 2" base for 2" panel for 2" panel for 2" or 2½" panel for 2½" panel for 2½" panel	18	11	16	9	$\begin{array}{r} 8 \frac{29}{64} \\ 8 \frac{29}{64} \\ 10 \frac{21}{64} \\ 11 \frac{1}{8} \\ 11 \frac{9}{16} \\ 13 \frac{3}{64} \end{array}$		$\begin{array}{c} 6 \\ \frac{13}{16} \\ 6 \\ \frac{13}{16} \\ 7 \\ \frac{13}{16} \\ 7 \\ \frac{1}{2} \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\ $	$\begin{array}{c} 6 \\ 6 \\ 7 \\ 10 \\ 11\frac{1}{2} \\ 14 \end{array}$	$7\frac{1}{4} \\ 7\frac{1}{4} \\ 8\frac{1}{8} \\ 8\frac{13}{16} \\ 8\frac{5}{8} \\ 9\frac{1}{4} \\ 9\frac{1}{4} \\ 9\frac{1}{4} \\ 8\frac{1}{8} \\ 9\frac{1}{4} \\ 9\frac{1}{4$	$16\frac{5}{8}\\16\frac{5}{8}\\19\\24\frac{3}{8}\\26\frac{1}{2}\\29$	$\begin{array}{c} 20\frac{7}{8} \\ 20\frac{7}{8} \\ 24\frac{7}{16} \\ 30 \\ 31\frac{5}{8} \\ 34\frac{1}{4} \end{array}$

CAT. NO.	RA Volts	TING Amps.	Description	М	N	0	P	R	S	T	U	v	w
29619 28925 28926 28927 28927 28928 28929	650 650 650 650 650 650	2000 2000 4000 6000 8000 10000	with 2" base for 2" panel for 2" or 2½" panel for 2" or 2½" panel for 2½" panel for 2½" panel	$7\frac{3}{8}$ $7\frac{3}{8}$ 9 $10\frac{5}{8}$ $12\frac{1}{2}$ 14	$2\frac{9}{16}$ $3\frac{11}{32}$	$\begin{array}{c} 2\frac{3}{4}\\ 2\frac{3}{4}\\ 3\frac{1}{4}\\ 4\frac{1}{4}\\ 5\\ 6\end{array}$	$5\frac{1}{2}$	$7\frac{1}{4}$	$\frac{\frac{9}{16}}{\frac{7}{8}}$	$4\frac{3}{4}$	$ \begin{cases} \frac{1}{3} \frac{7}{2} \\ \frac{1}{10} \frac{1}{2} \\ \frac{1}{16} \\ $	$3\frac{1}{4}$	$5\frac{1}{16} \\ 5\frac{1}{16} \\ 5\frac{7}{8} \\ 6\frac{1}{8} \\ 6\frac{5}{16} \\ 7\frac{1}{8} \\ 7\frac{1}{$

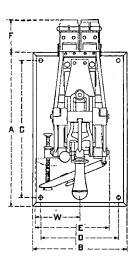
4550–34 General Electric Carbon-Break Circuit Breakers

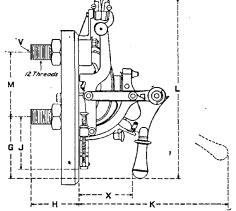
DIMENSIONS OF TYPE C, FORM K, CIRCUIT BREAKERS

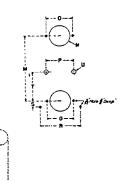


ALTERNATING CURRENT

250 VOLTS







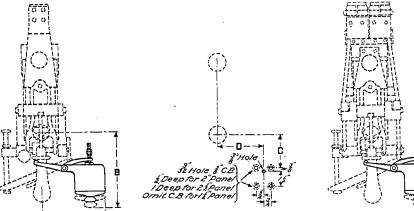
For REFERENCE ONLY

Cat. No.	Volts	Amps.	Description	A	в	с	D	Е	F	G	н	J	ĸ	L	м	N	0	Р	R	s	T	U	v	w	x
40871 40872 40875	250	2000 2000 4000	on 2" base for 2" panel for 2" panel	18	11	16	9	83 83 10	3 16	$6\frac{13}{16}$ $6\frac{13}{16}$ $8\frac{13}{5}$ $8\frac{5}{8}$	6	$6\frac{1}{8}$	$17\frac{1}{17}$ $17\frac{1}{17}$ $20\frac{3}{17}$	203	73 73 9	$1\frac{13}{16}$ $1\frac{13}{16}$ $2\frac{9}{16}$	$2\frac{34}{24}$ $2\frac{34}{4}$ $3\frac{1}{4}$	$2\frac{78}{8}$ $2\frac{78}{8}$ $5\frac{1}{2}$	$\frac{11}{45}$ $\frac{15}{52}$	9 16 16 16 78	$2\frac{3}{16}$ $2\frac{3}{16}$ $2\frac{3}{8}$	$\frac{17}{32}$ $\frac{17}{32}$ $\frac{17}{32}$ $\frac{17}{32}$ $\frac{17}{32}$	$1\frac{3}{1\frac{3}{2}}$ $2\frac{1}{2}$	$5\frac{3}{16}$ $5\frac{3}{16}$ $5\frac{3}{5}$	65 63 64
40873 40874 40876	750	2000 2000 4000	for 2" panel	18	11	16	9	$8\frac{1}{2}$ $8\frac{1}{2}$ $10\frac{11}{32}$	38	$6\frac{3}{4}$ $6\frac{3}{5}$ $8\frac{5}{8}$	6	6 Į	$17\frac{1}{4}$ $17\frac{1}{4}$ $20\frac{3}{4}$	203 203 24 1	73878	$1\frac{13}{16}\\1\frac{13}{16}\\2\frac{9}{16}$	234 234 34 34	$2\frac{78781}{2}$	$4\frac{1}{8}$ $4\frac{1}{8}$ $5\frac{1}{2}$	916 916 178	$2\frac{3}{16}2\frac{3}{16}2\frac{3}{16}2\frac{3}{8}$	$\frac{17}{327}$ $\frac{172}{327}$ $\frac{172}{327}$ $\frac{172}{327}$	$1\frac{3}{4}$ $1\frac{3}{4}$ $2\frac{1}{2}$	5 5 5 3	655 67 67

750 VOLTS

General Electric Carbon-Break Circuit Breakers 4550-35

DIMENSIONS OF ATTACHMENTS FOR TYPE C, FORM K CIRCUIT BREAKERS-DIRECT CURRENT



Drilling Plan Front View

For REFERENCE ONLY

.

SHUNT TRIP ATTACHMENTS

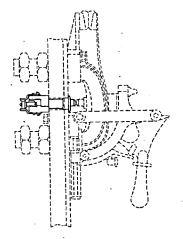
Cat. No.	Voltage of	Ampere	DIMENSIONS IN INCHES				
of Attachment	Circuit	Capacity of Circuit Breaker	A	В	С	D	
$32456 \\ 32457 \\ 32458 \\ 32459 \\ 32459 \\ 32459 \\ 32459$	$\begin{array}{r} 125-250-650\\ 125-250-650\\ 125-250-650\\ 125-250-650\\ 125-250-650\\ 125-250-650\end{array}$	2000 4000 6000 8000 10000	$\begin{array}{c} 6\frac{1}{4} \\ 7\frac{3}{8} \\ 7\frac{7}{8} \\ 7\frac{7}{8} \\ 7\frac{7}{8} \\ 7\frac{7}{8} \end{array}$	7½ 7¾ 8% 916 9¼	$3\frac{5}{3}\frac{5}{5}$ 5 5 $5\frac{3}{16}$ 5 $\frac{3}{5}\frac{3}{8}$	$4\frac{3}{58}$ $6\frac{3}{58}$ $6\frac{3}{58}$	

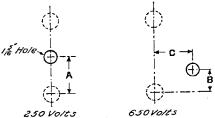
LOW-VOLTAGE RELEASE ATTACHMENTS

Cat. No. of Attachment	Voltage of Circuit Approx. Releasing Voltage	Ampere Capacity of Circuit Breaker	DIMENSIONS IN INCHES				
			A	В	с	D	
32464	650	325	2000	6^{1}_{4}	8	35	4 <u>3</u>
S2101 S2465	250	125	2000	$6\frac{1}{4}$	8	$3\frac{2}{5}$	$4\frac{1}{4}$
32466	125	60	2000	$6\frac{1}{4}$	8	$3\frac{5}{2}$	$4\frac{1}{4}$
32467	650	325	4000	$7rac{3}{8}$	$8\frac{1}{4}$	52 550 550 570 52 52 520 550 570 52 52 520	$\begin{array}{c} 4\frac{3}{4} \\ 4\frac{3}{4} \\ 4\frac{3}{4} \\ 5\frac{7}{8} \end{array}$
32468	250	125	4000	7 3	81	$3\frac{7}{8}$	$5\frac{7}{8}$
32469	125	60	4000	7흫	81	$3\frac{7}{2}$	$5\frac{1}{8}$
32470	650	325	6000	$7\frac{3}{8}$	$9\frac{3}{8}$	5 5	63
32471	250	125	6000	$7\frac{3}{8}$	- 9 3	5	$-6\frac{3}{8}$
32472	125	60	6000	7홓	9 <u>3</u>	5	$6\frac{3}{8}$
32473	650	325	8000	$7\frac{3}{8}$	$9\frac{9}{16}$	$5\frac{3}{16}$	$6\frac{3}{8}$ $6\frac{3}{8}$ $6\frac{3}{8}$ $6\frac{3}{8}$
32473	650	325	10000	7훓	$9\frac{9}{16}$	$5\frac{3}{16}$	$6\frac{3}{8}$
32474	250	125	8000	$7\frac{3}{8}$	$9\frac{9}{16}$	$5\frac{3}{16}$	6^{3}_{8}
32474	250	125	10000	7 3	93	5^{3}_{8}	$6\frac{3}{8}$ $6\frac{3}{8}$ $6\frac{3}{8}$
32475	125	60	8000	$7\frac{3}{8}$	$9\frac{3}{4}$	$5\frac{3}{8}$ $5\frac{3}{8}$	$ 6\frac{3}{8}$
32475	125	60	10000	$7\frac{3}{8}$	$9\frac{3}{4}$	$5\frac{3}{8}$	$6\frac{3}{8}$

4550-36 General Electric Carbon-Break Circuit Breakers

DIMENSIONS OF AUXILIARY SWITCHES FOR TYPE C, FORM K CIRCUIT BREAKERS-DIRECT CURRENT





Drilling Plans Front View

For REFERENCE ONLY

AUXILIARY SWITCHES

	Circuit-Closing	Circuit-Closing Cat. No. Combined Circuit- Opening and Circuit- Closing Cat. No.	CIRCUIT BREAKERS		For	DIMENSIONS IN INCHES		
			Volts	Ampere	Mounting On	A	В	
32480	32492	32504	650	2000	2 ″ panel		$2\frac{13}{32}$	$3\frac{13}{16}$
32481	32493	32505	650	4000	2 ″ panel		$3\frac{5}{16}$	47
32482	32494	32506	650	6000	2 ″ panel		$5\frac{1}{2}$	$4\frac{7}{8}$ $5\frac{3}{8}$
32484	32496	32508	250	2000	2 " panel	$3\frac{9}{16}$		Ű
32485	32497	32509	250	4000	2 ″ panel	$4\frac{1}{4}$		
32486	32498	32510	250	6000	2 ″ panel	$4\frac{1}{4}$		
32487	32499	32511	650	6000	2¼″ panel		$5\frac{1}{2}$	$5\frac{3}{8}$
32488	32500	32512	650	8000	2¼" panel		$6\frac{3}{4}$	$5\frac{3}{8}$
32489	32501	32513	650	10000	$2\frac{1}{2}''$ panel		$7\frac{3}{4}$	$6\frac{3}{8}$
32490	32502	32514	250	6000	$2\frac{1}{2}$ " panel	$4\frac{1}{4}$	-	Ŭ

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GENERAL ELECTRIC COMPANY, PRINCIPAL OFFICES, SCHENECTADY, N. Y.

General Electric Company Schenectady, N.Y.

SUPPLY DEPARTMENT

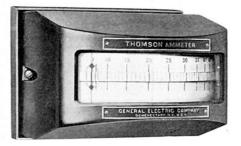
November, 1907

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*Bulletin No. 4551

THOMSON HORIZONTAL EDGEWISE INSTRUMENTS-TYPE H FOR SWITCHBOARD SERVICE

In the distribution of electrical energy for lighting and power purposes, one of the essentials of economical and satisfactory



HORIZONTAL EDGEWISE AMMETER—EXTERIOR operation is the use of instruments of the highest possible accuracy.

The Thomson Horizontal Edgewise Instruments, Type H, have for several years been recognized as the standard for alternating current service, and are undoubtedly the most accurate and attractive instruments used for switchboard work. The fact that the majority of high grade and important alternating current installations completed during the past six years have employed this type of instrument is in itself a testimonial of the highest value.

A complete line of instruments is made consisting of ammeters, voltmeters, singlephase wattmeters, polyphase wattmeters, frequency indicators and power factor indicators. All , horizontal edgewise instruments are of uniform size, thus presenting a pleasing appearance when installed. While primarily designed for alternating current service the voltmeters, ammeters and wattmeters can be used with good results on direct current.

* Supersedes Bulletin No. 4384.

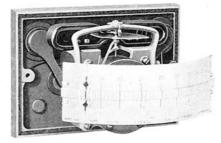
CONSTRUCTION

Wattmeters, power factor indicators and frequency indicators are constructed on the direct reading, dynamometer principle; ammeters and voltmeters on the wellknown Thomson inclined coil principle.

SUSPENSION OF MOVING ELEMENTS

The moving elements of all Horizontal Edgewise Instruments are extremely light and are firmly secured to a vertical shaft which is provided with hardened and highly polished steel pivots suspended in high grade sapphire jewels. This method of vertical suspension introduces less friction and maintains a more nearly perfect balance than horizontal suspension.

Careful attention has been given to the construction of the moving parts and jewels,



HORIZONTAL EDGEWISE AMMETER-INTERIOR

as this has the greatest influence upon the life, accuracy and permanency of indicating instruments.

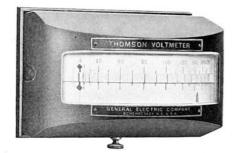
CONTROLLING FORCES

The controlling or restraining force of ammeters, voltmeters and wattmeters is obtained by the use of a highly tempered

1751-2 Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service

phosphor bronze spring accurately made from the best grade of material, thus insuring thorough reliability and permanency.

Frequency indicators and power factor indicators do not employ a spring control, the position of the armature being dependent



HORIZONTAL EDGEWISE VOLTMETER-EXTERIOR

upon the directive forces exerted by the moving element.

DAMPING QUALITIES

The indications of all Horizontal Edgewise Instruments are highly dead-beat which permits accurate and rapid readings. This effective damping quality also protects the pointer and moving element from injury or shock due to violent load fluctuations.

Damping is obtained by the effect of Foucault currents induced in an aluminum sector, as it passes, with the swinging of the pointer, between the poles and across the fields of two astatically arranged permanent magnets. This method of damping is very effective, introduces no friction, and is free from the objectionable features common to many liquid or air damping systems.

EFFECT OF STRAY FIELDS

Horizontal Edgewise Instruments are thoroughly shielded from the influence of external magnetic fields. This is accomplished by the use of a laminated soft iron shell which completely surrounds the measuring coils and also the use of a soft iron cover enclosing the entire instrument.

The instruments can be placed close

to each other without mutual interference, a feature of much importance in switchboard construction.

SCALES

The scales of all Horizontal Edgewise Instruments are very satisfactory as to length, legibility and distribution. No particular law of deflection is assumed, each instrument being carefully calibrated by comparison with a laboratory standard. Errors due to parallax are eliminated by a special construction of the scale and pointer, a fact which will be appreciated by all users of indicating instruments.

TORQUE

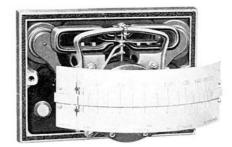
The torque or directive force of the Horizontal Edgewise Instruments is of very high value, and as the weight of the moving parts is extremely small, the friction of the bearings is very slight. The indicating pointer thus takes up a definite position showing accurately every change in current value.

ACCURACY

Horizontal Edgewise Instruments are accurate to a high degree. They may be used on circuits of any frequency, wave form or power factor, and are free from heating errors.

NORMAL INDEX

Horizontal Edgewise Voltmeters are provided with an adjustable index, which may



HORIZONTAL EDGEWISE VOLTMETER-INTERIOR

be set at any desired point on the scale, and which materially assists in maintaining the system at normal operating conditions.

Thomson Horizontal Edgewise Instruments, Type H, for Switch' oard Service 4551-3

CONNECTIONS

Horizontal Edgewise Instruments are made for back connection only, and are provided with connection studs which also serve to secure the instruments on the switchboard.

FINISH

The standard finish of all Horizontal Edgewise Instruments is dull black. This finish is pleasing in appearance and very permanent. Special finishes to match other appliances can be supplied upon order.

AMMETERS

Ammeters are made in capacities up to and including 300 amperes, for use without current transformers. All instruments for use on circuits in excess of 2300 volts or 300 amperes will be furnished with current transformers. It is recommended that current transformers be used with ammeters on circuits of more than 1150 volts, as a safeguard to the switchboard attendant. Ammeters of more than 300 amperes capacity cannot be furnished for direct current circuits.

Cat. No.	Ampere Capacity	List Price
28776	5	\$60.00
51007	10	60.00
51140	15	60.00
40634	20	60.00
40635	30	60.00
40636	40	60.00
40637	60	60.00
40638	80	60.00
51012	100	65.00
51013	150	65.00
51014	200	65.00
40639	300	85.00

Orders for instruments intended for use with transformers must always specify the frequency of the circuit.

For scales and dimensions see pages 8 to 11.

VOLTMETERS

Voltmeters are made in capacities up to and including 650 volts for use without potential transformers. When ordered with potential transformers the scales are marked in secondary volts, unless the order calls for marking in primary volts.

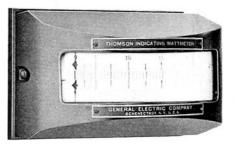
Voltmeters are always furnished with an adjustable normal running index, which may be located at any desired point on the scale.

The resistance is external in all capacities and is secured in a ventilated cage suitable for mounting on the back of the switchboard.

Cat. No.	Volt Capacity	List Price
51020	175	\$75.00
51021	350	75.00
40640	500	80.00
51022	750	80.00

Orders for instruments intended for use with transformers must always specify the frequency of the circuit.

For scales and dimensions see pages 8, 11 and 12.



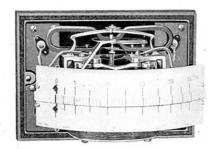
HORIZONTAL EDGEWISE SINGLE-PHASE WATT-METER-EXTERIOR

SINGLE-PHASE WATTMETERS

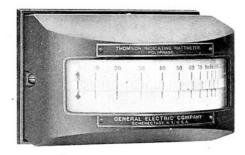
Single-phase Wattmeters are made in current capacities up to and including 200 amperes and for potentials up to and including 650 volts without transformers. Instruments for use on circuits in excess of 1150 volts or 200 amperes will be furnished with 4551-4 Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service

current transformers. Instruments for potential circuits in excess of 650 volts are always provided with potential transformers.

The resistance of the potential circuit is external in all capacities and is secured in a ventilated cage suitable for mounting on the back of the switchboard.



HORIZONTAL EDGEWISE SINGLE-PHASE WATT-METER-INTERIOR



HORIZONTAL EDGEWISE POLYPHASE WATT-METER-EXTERIOR

SINGLE-PHASE WATTMETERS 100-125 Volts

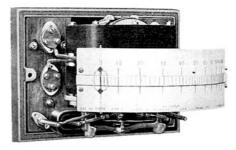
Cat. No.	Capa		List Price
	Amperes	Kilowatts	
28778	5	. 5	\$90.00
28784	10	1	90.00
51142	15	1.5	90.00
40641	20	2	90.00
40642	30	3	90.00
40643	40	4	90.00
40644	60	6	90.00
40645	80	8	100.00
51025	100	10	100.00
51026	150	15	100.00
51027	200	20	100.00

Cat. No.		Capacity	
	Amperes	Kilowatts	
28780	5	1	\$100.00
28786	10	2	100.00
51144	15	3	100.00
40646	20	4	100.00
40647	30	6	100.00
40648	40	8	100.00
40649	60	12	100.00
40650	80	16	110.00
51030	100	20	110.00
51031	150	30	110.00
51032	200 -	40	110.00

500-600 Volts

Cat. No.	Capa		List Price
	Amperes	Kilowatts	
28782	5	2.5	\$110.00
28788	10	5	110.00
51146	15	7.5	110.00
40651	20	10	110.00
40652	30	15	110.00
40653	40	20	110.00
40654	60	30	110.00
40655	80	40	120.00
51035	100	50	120.00
51036	150	75	120.00
51037	200	100	120.00

Orders for instruments intended for use with transformers must always specify the frequency of the circuit.



HORIZONTAL EDGEWISE POLYPHASE WATT-METER—INTERIOR

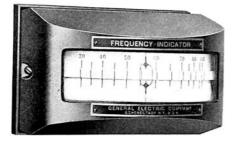
For scales and dimensions see page 8, 12, 13, 14 and 15.

200-250 Volts

Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service 4551-5

POLYPHASE WATTMETERS

The Horizontal Edgewise Polyphase Indicating Wattmeters are designed for use on balanced or unbalanced two-phase three or four-wire, and three-phase, three-wire systems. This instrument indicates on a single scale the total energy of the system, regardless of the conditions of load, a fact which will be appreciated by all users of polyphase apparatus.



HORIZONTAL EDGEWISE FREQUENCY INDICATOR-EXTERIOR

The Polyphase Indicating Wattmeter is practically a combination of two single-phase instruments symmetrically arranged under one cover so as to have the two moving elements mounted on a single shaft.

By the use of the polyphase instrument, the switchboard construction is rendered much more compact than when two or three instruments are installed, and the station attendant's work is greatly simplified.

Polyphase Indicating Wattmeters are made in current capacities up to and including 60 amperes, and potential capacities up to and including 650 volts, for use without transformers. Instruments for use on circuits in excess of 60 amperes or 650 volts, will be furnished with current transformers. Instruments for use on circuits in excess of 650 volts are always provided with potential transformers.

The resistance of the potential circuits is external in all capacities and is secured in a ventilated cage suitable for mounting on the back of the switchboard.

POLYPHASE WATTMETERS 100-125 Volts

Cat. No.	Capa Amperes	city Kilowatts	List Price
31808	5	1	\$125.00
31809	10	2	125.00
31810	15	3	125.00
40656	20	4	125.00
40657	30	6	125.00
40658	40	8	125.00
40659	60	12	125.00

200	200		
200-	250	VO	lts

Cat. No.	Capa Amperes	icity Kilowatts	List Price
31813	. 5	2	\$135.00
31814	10	4	135.00
31815	15	6	135.00
40660	20	8	135.00
40661	30	12	135.00
40662	40	16	135.00
40663	60	24	135.00

500-600 Volts

Cat. No.	Capa Amperes	icity Kilowatts	List Price
31818	5	5	\$145.00
31819	10	10	145.00
31820	15	15	145.00
40664	20	20	145.00
40665	30	30	145.00
40666	40	40	145.00
40667	60	60	145.00

Orders for instruments to be used with transformers must always specify the frequency of the circuit.

For scales and dimensions see pages 8, 12, 13, 14 and 15.

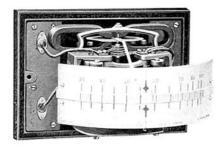
FREQUENCY INDICATORS

The Frequency Indicator shows on a direct reading scale the cycles per second of any alternating current system. The use of

4551-6 Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service

a frequency indicator enables the station attendant to note immediately any variation from the normal frequency. The advantage of such an instrument over the method of determining the frequency by means of speed indicators will at once be appreciated.

Frequency Indicators are provided with external reactances and resistances which are secured in a ventilated cage for mounting on the back of the switchboard. Means are



HORIZONTAL EDGEWISE FREQUENCY INDICATOR-INTERIOR

provided for adjusting the instrument for the characteristics of the circuit on which it is installed. Standard instruments are wound for 100-125 volt circuits only, but can be wound for circuits up to and including 650 volts if desired. Instruments for use on circuits in excess of 650 volts are always provided with potential transformers.

The normal operating point is marked at approximately the center of the scale, thus giving the advantage of very open divisions.

FREQUENCY	INDICATORS
100-123	5 Volts

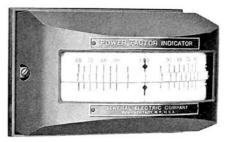
Cat. No.	Frequency in Cycles	List Price
51128	25	\$100.00
51129	40	100.00
51130	60	100.00
51131	125	100.00
51132	133	100.00

The voltage of the circuit must always be given if other than 100-125 volts.

For scales and dimensions see pages 8 and 15.

POWER FACTOR INDICATORS

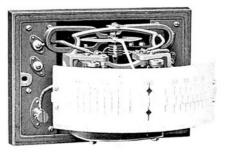
The Power Factor Indicator shows on a direct reading scale the power factor, lagging or leading, of balanced three-wire,



HORIZONTAL EDGEWISE POWER FACTOR INDICATOR-EXTERIOR

two-phase, three-wire, three-phase or fourwire, two-phase systems.

The Power Factor Indicator will be found useful in connection with generating and sub-station systems operating synchronous (rotary) converters. Heretofore it has been necessary to take simultaneous readings on two indicating wattmeters or upon one indicating wattmeter, an ammeter and a voltmeter, and by means of these readings



HORIZONTAL EDGEWISE POWER FACTOR INDICATOR—INTERIOR

determine by computations the power factor on the line under consideration. This method, however, is too complicated to admit of the frequent, accurate and rapid determination which has now become so important, and has given place to the simple method made possible by the Power Factor Indicator. This instrument is manufactured

Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service 4551-7

with one standard scale .60-1.00-.60, showing power factors as low as .60, with either leading or lagging current.

Power Factor Indicators are made with capacities up to and including 200 amperes, for use without current transformers. Instruments for use on circuits in excess of 1150 volts or 200 amperes will be furnished with current transformers. Power Factor Indicators can be furnished for any potential up to and including 650 volts, although it will be noted that indicators for 110 volts only are listed. It is anticipated that instruments for all primary circuits will be used in connection with potential transformers, and on circuits in excess of 1150 volts, in connection with current transformers.

The resistance of the potential circuits is external in all capacities and is secured in a ventilated cage suitable for mounting on the back of the switchboard.

POWER FACTOR INDICATORS FOR BALANCED SYSTEMS

Catalogue No.			List Price	
3-Phase 3-Wire	2-Phase 3-Wire	2-Phase 4-Wire	Ampere Capacity	List Price
23697	27513	23784	5	\$90.00
23698	27514	23785	10	90.00
23699	27515	23786	15	90.00
40668	40673	40678	20	100.00
40669	40674	40679	30	100.00
40670	40675	40680	40	100.00
40671	40676	40681	60	100.00
40672	40677	40682	80	100.00
23781	27519	23790	100	110.00
23782	27520	23791	150	110.00
23783	27521	23792	200	110.00

100-125 Volts

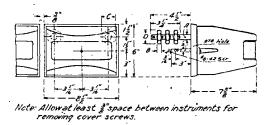
When instruments are to be used with transformers, the frequency of the circuit must always be given.

For illustration of scale see page 15 and for dimensions see page 8.

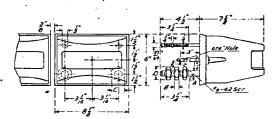
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4551-8 Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service

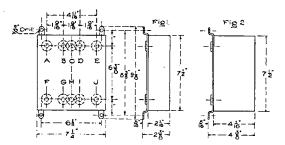
DIMENSIONS OF THOMSON HORIZONTAL EDGEWISE INSTRUMENTS—TYPE H FOR SWITCHBOARD SERVICE

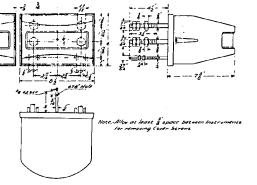


AMMETERS, 5-300 AMPS., AND VOLTMETERS

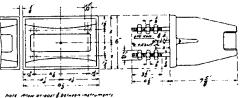


SINGLE-PHASE INDICATING WATTMETERS, 5-200 AMPS.



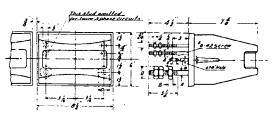


POLYPHASE INDICATING WATTMETERS

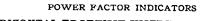


A FRANCE IND EDITOR SLIDAS

FREQUENCY INDICATOR



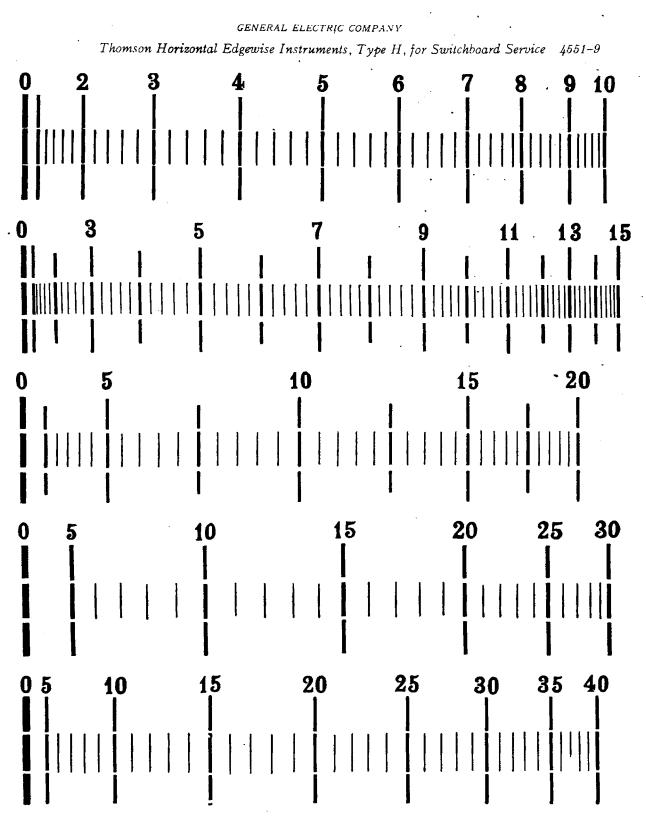
RESISTANCE BOXES—FIGS. 1 AND 2



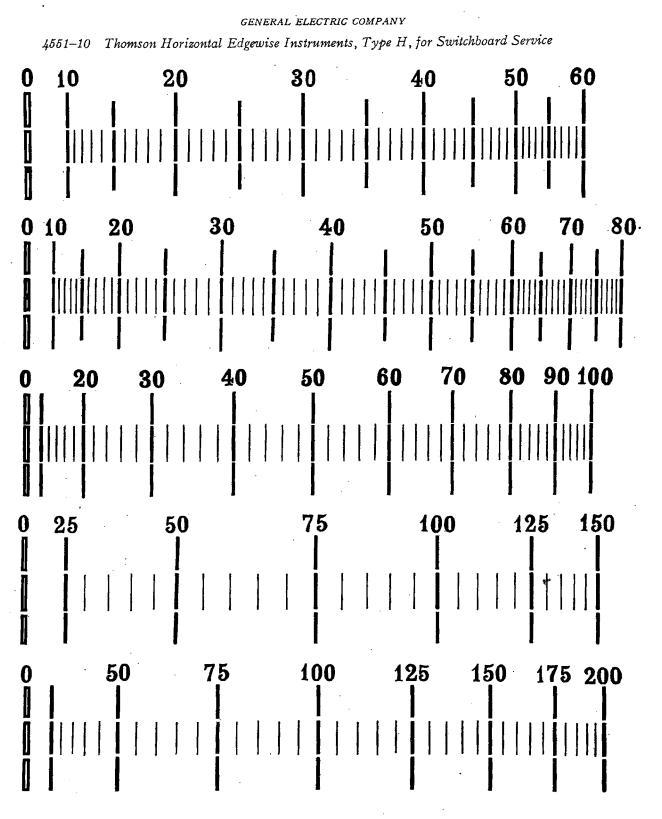
RESISTANCE BOXES USED WITH THOMSON HORIZONTAL EDGEWISE INSTRUMENTS

Voltages	Fig.	Lead Holes
A11	1	A-E
A11	1	A-E
A11	1	A-C-E
50 - 199	1	A-E-F-T
200-800	2	A-E-F-J
50 - 199	1	A-B-D-E-F-G-I-J
200-800	2	A-B-D-E-F-G-I-J
50 - 199	1	A-E-F-J
200-800	2	A-E-F-J
50 - 199	1	A-B-D-E-F-G-I-J
200-800	2	A-B-D-E-F-G-I-J
	All All All 50–199 200–800 50–199 200–800 50–199 200–800 50–199	All 1 S0-199 1 200-800 2 50-199 1 200-800 2 50-199 1

For Reference Only.



SCALES OF HORIZONTAL EDGEWISE AMMETERS

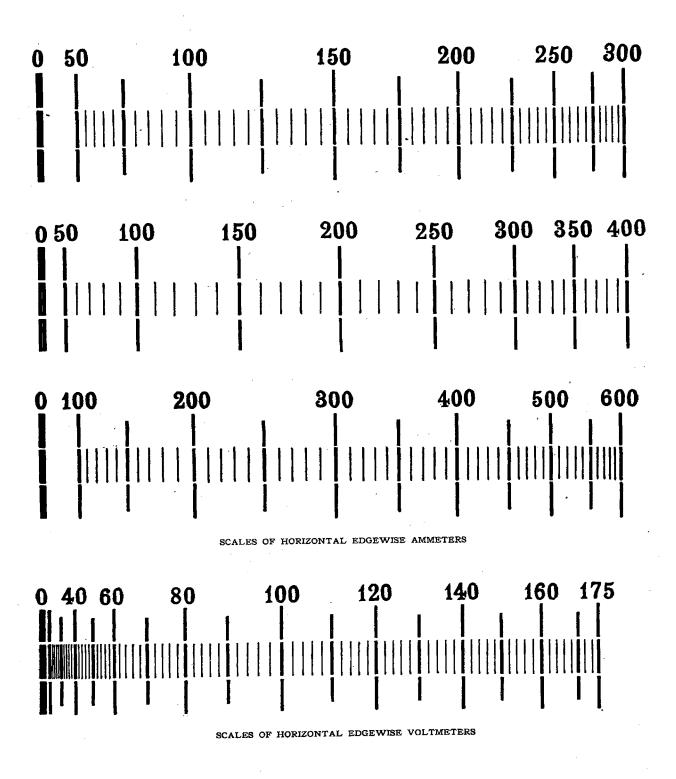


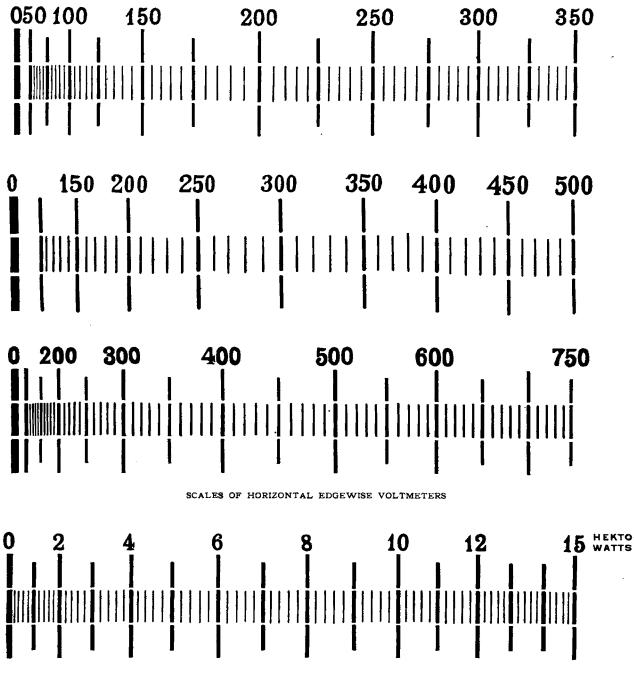
SCALES OF HORIZONTAL EDGEWISE AMMETERS

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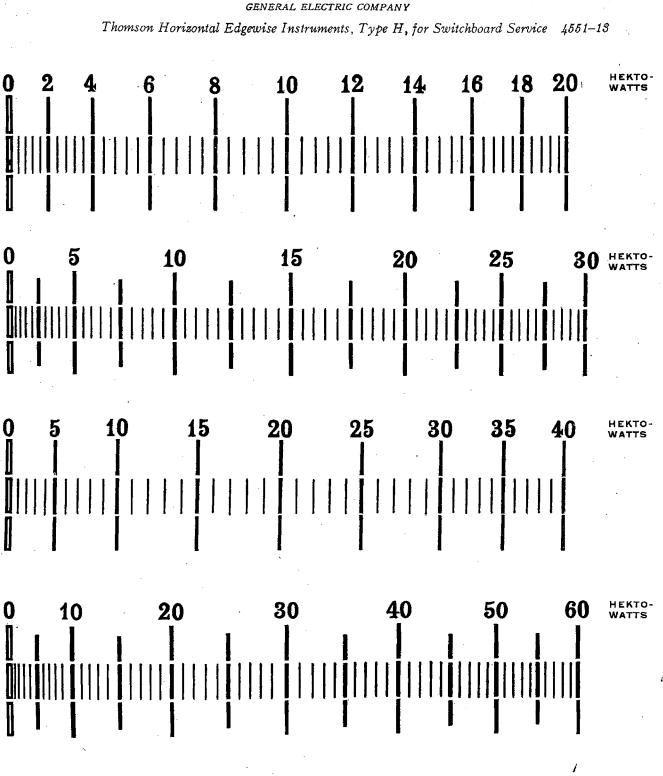
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Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service 4551-11



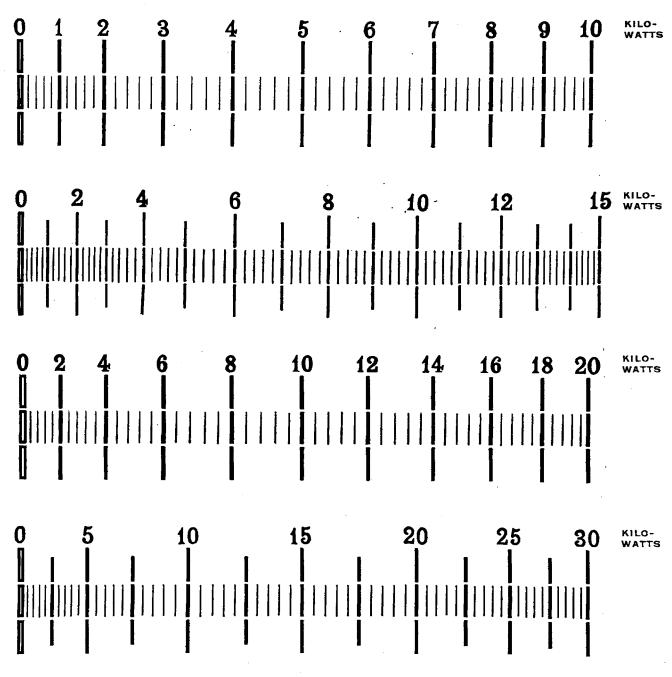


SCALES OF HORIZONTAL EDGEWISE WATTMETERS

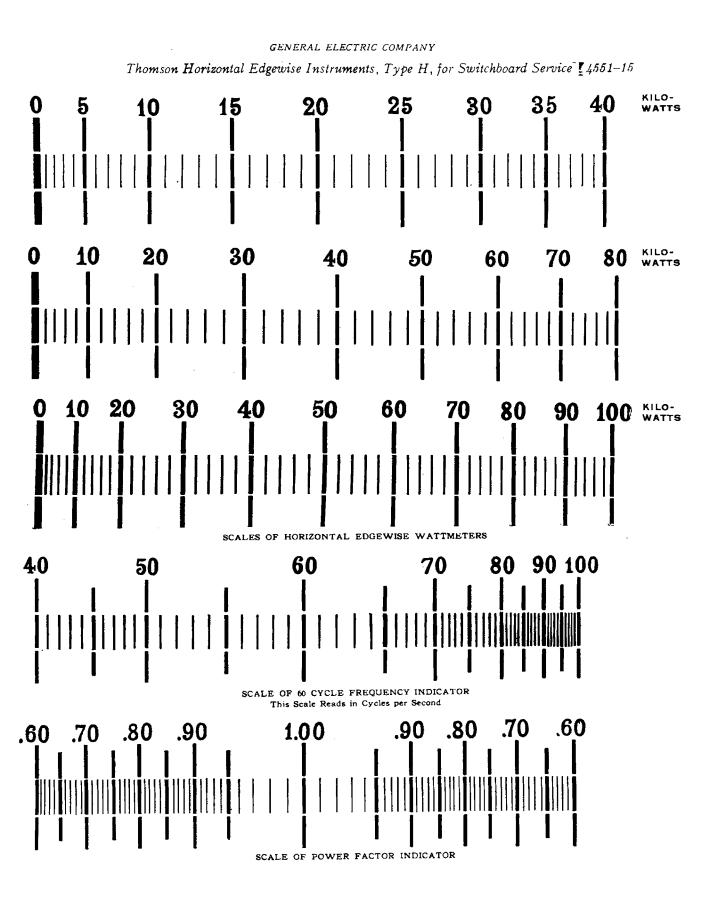


SCALES OF HORIZONTAL EDGEWISE WATTMETERS

GENERAL ELECTRIC COMPANY 4551–14 Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service



SCALES OF HORIZONTAL EDGEWISE WATTMETERS



PRINCIPAL OFFICES, SCHENECTADY, N. Y.

SALES OFFICES:

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DALLAS, TEXAS, Scollard Building.

FOREIGN.

FOREIGN DEPARTMENT, Schenectady, N. Y., and 44 Broad St., New York, N. Y. LONDON OFFICE, 83 Cannon St., London, E. C., England.

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Toronto. Ontario.



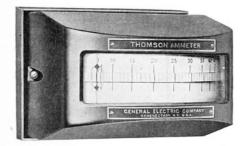
SUPPLY DEPARTMENT

April, 1909

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THOMSON HORIZONTAL EDGEWISE INSTRUMENTS TYPE H FOR SWITCHBOARD SERVICE

In the distribution of electrical energy for lighting and power purposes, one of the essentials of economical and satisfactory operation is the



HORIZONTAL EDGEWISE AMMETER-EXTERIOR -

use of instruments of the highest possible accuracy. The Thomson Horizontal Edgewise Instruments, Type H, have for several years been recognized as the standard for alternating current service, and are undoubtedly the most accurate and attractive instruments used for switchboard work. The fact that the majority of high grade and important alternating current installations completed during the past six years have employed this type of instrument is in

A complete line of instruments is made consisting of ammeters, voltmeters, single-phase wattmeters, polyphase wattmeters, frequency indicators and power factor indicators. All horizontal edgewise instruments are of uniform size, thus presenting a pleasing appearance when installed. While primarily designed for alternating current service the voltmeters, ammeters and wattmeters can be used with good results on direct current.

itself a testimonial of the highest value.

*Supersedes Bulletin No. 4384. Second Edition

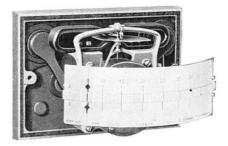
CONSTRUCTION

Wattmeters, power factor indicators and frequency indicators are constructed on the direct reading, dynamometer principle; ammeters and voltmeters on the well known Thomson inclined coil principle.

SUSPENSION OF MOVING ELEMENTS

The moving elements of all Horizontal Edgewise Instruments are extremely light and are firmly secured to a vertical shaft which is provided with hardened and highly polished steel pivots suspended in high grade sapphire jewels. This method of vertical suspension introduces less friction and maintains a more nearly perfect balance than horizontal suspension.

Careful attention has been given to the construction of the moving parts and jewels,



HORIZONTAL EDGEWISE AMMETER-INTERIOR

as this has the greatest influence upon the life, accuracy and permanency of indicating instruments.

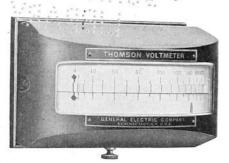
CONTROLLING FORCES

The controlling or restraining force of ammeters, voltmeters and wattmeters is obtained by the use of a highly tempered phosphor-bronze

4551A-2 Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service

spring accurately made from the best grade of material, thus insuring thorough reliability and permanency.

Frequency indicators and power factor indicators do not employ a spring control, the position of the armature being dependent upon



HORIZONTAL EDGEWISE VOLMETER-EXTERIOR

the directive forces exerted by the moving element.

DAMPING QUALITIES

The indications of all Horizontal Edgewise Instruments are highly dead-beat which permits accurate and rapid readings. This effective damping quality also protects the pointer and moving element from injury or shock due to violent load fluctuations.

Damping is obtained by the effect of Foucault currents induced in an aluminum sector, as it passes, with the swinging of the pointer, between the poles and across the fields of two astatically arranged permanent magnets. This method of damping is very effective, introduces no friction, and is free from the objectionable features common to many liquid or air damping systems.

EFFECT OF STRAY, FIELDS

Horizontal Edgewise Instruments are thoroughly shielded from the influence of external magnetic fields. This is accomplished by the use of a laminated soft iron shell which completely surrounds the measuring coils and also the use of a soft iron cover enclosing the entire instrument.

The instruments can be placed close to each

other without mutual interference, a feature of much importance in switchboard construction.

SCALES

The scales of all Horizontal Edgewise Instruments are very satisfactory as to length, legibility and distribution. No particular law of deflection is assumed, each instrument being carefully calibrated by comparison with a laboratory standard. Errors due to parallax are eliminated by a special construction of the scale and pointer, a fact which will be appreciated by all users of indicating instruments.

TORQUE

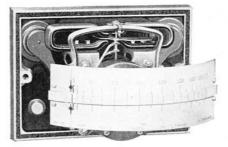
The torque or directive force of the Horizontal Edgewise Instruments is of very high value, and as the weight of the moving parts is extremely small, the friction of the bearings is very slight. The indicating pointer thus takes up a definite position showing accurately every change in current value.

ACCURACY

Horizontal Edgewise Instruments are accurate to a high degree. They may be used on circuits of any frequency, wave form or power factor, and are free from heating errors.

NORMAL INDEX

Horizontal Edgewise Voltmeters are provided with an adjustable index, which may be



HORIZONTAL EDGEWISE VOLMETER-INTERIOR

set at any desired point on the scale, and which materially assists in maintaining the system at normal operating conditions.

Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service 4551A-3

CONNECTIONS

Horizontal Edgewise Instruments are made for back connection only, and are provided with connection studs which also serve to secure the instruments on the switchboard.

FINISH

The standard finish of all Horizontal Edgewise Instruments is dull black. This finish is pleasing in appearance and very permanent. Special finishes to match other appliances can be supplied upon order.

AMMETERS

Ammeters are made in capacities up to and including 300 amperes, for use without current transformers. All instruments for use on circuits in excess of 2300 volts or 300 amperes will be furnished with current transformers. It is recommended that current transformers be used with ammeters on circuits of more than 1150 volts, as a safeguard to the switchboard attendant. Ammeters of more than 300 amperes capacity cannot be furnished for direct current circuits.

Cat. No.	Ampere Capacity	List Price
28776	5	\$60.00
51007	10	60.00
51140	15	60.00
40634	20	60.00
40635	30	60.00
40636	40	60.00
40637	60	60.00
40638	80	60.00
51012	100	65.00
51013	150	65.00
51014	200	65.00
40639	300	85.00

Orders for instruments intended for use with transformers must always specify the frequency of the circuit.

For scales and dimensions see pages 8 to 11.

VOLTMETER

Voltmeters are made in capacities up to and including 650 volts for use without potential transformers. When ordered with potential transformers the scales are marked in secondary volts, unless the order calls for marking in primary volts.

Voltmeters are always furnished with an adjustable normal running index, which may be located at any desired point on the scale.

The resistance is external in all capacities and is secured in a ventilated cage suitable for mounting on the back of the switchboard.

Cat. No.	Ampere Capacity	List Price
51020	175	\$75.00
51021	350	75.00
40640	500	80.00
51022	750	80.00

Orders for instruments intended for use with transformers must always specify the frequency of the circuit.

For scales and dimensions see page 8, 11 and 12.



HORIZONTAL EDGEWISE SINGLE-PHASE WATT-METER-EXTERIOR

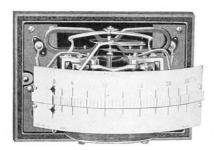
SINGLE-PHASE WATTMETERS

Single-phase Wattmeters are made in current capacities up to and including 200 amperes and for potentials up to and including 650 volts without transformers. Instruments for use on circuits in excess of 1150 volts or 200 amperes will be furnished with current transformers.

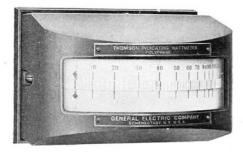
4551A-4 Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service

Instruments for potential circuits in excess of 650 volts are always provided with potenial transformers.

The resistance of the potential circuit is external in all capacities and is secured in a ventilated cage suitable for mounting on the back of the switchboard.



HORIZONTAL EDGEWISE SINGLE-PHASE WATT- METER-INTERIOR



HORIZONTAL EDGEWISE POLYPHASE WATT-METER-EXTERIOR

SINGLE-PHASE WATTMETERS 100-125 Volts

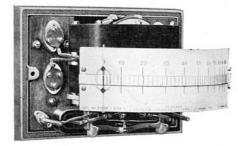
List Price	Capacity		Cat. No.
	Kilowatts	Amperes	
\$90.00	.5	5	28778
90.00	1	10	28784
90.00	1.5	15	51142
90.00	2	20	40641
90.00	3	30	40642
90.00	4	40	40643
90.00	6	60	40644
100.00	8	80	40645
100.00	10	100	51025
100.00	15	150	51026
100.00	20	200	51027

List Price	Capacity		Cat. No.	
	Kilowatts	Amperes		
\$100.00	1	5	28780	
100.00	2	10	28786	
100.00	3	15	51144	
100.00	4	20	40646	
100.00	6	30	40647	
100.00	8	40	40648	
100.00	. 12	60	40649	
110.00	16	80	40650	
110.00	20	100	51030	
110.00	30	150	51031	
110.00	40	200	51032	

500-600 Volts

Cat. No.	Capacity		List Price
Cut. 1101	Amperes	Kilowatts	List Trice
28782	5	2.5	\$110.00
28788	10	5	110.00
51146	15	7.5	110.00
40651	20	10	110.00
40652	30	15	110.00
40653	40	20	110.00
40654	60	30	110.00
40655	80	40	120.00
51035	100	50	120.00
51036	150	75	120.00
51037	200	100	120.00

Orders for instruments intended for use with transformers must always specify the frequency of the circuit.



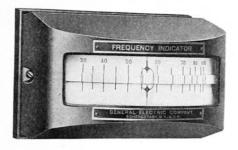
HORIZONTAL EDGEWISE POLYPHASE WATT-METER-INTERIOR

For scales and dimensions see pages 8, 12, 13, 14 and 15.

Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service 4551A-5

POLYPHASE WATTMETERS

The Horizontal Edgewise Polyphase Indicating Wattmeters are designed for use on balanced or unbalanced two-phase three or fourwire, and three-phase, three-wire systems. This instrument indicates on a single scale the total energy of the system, regardless of the conditions of load, a fact which will be appreciated by all users of polyphase apparatus.



HORIZONTAL EDGEWISE FREQUENCY INDICATOR-EXTERIOR

The Polyphase Indicating Wattmeter is practically a combination of two-single-phase instruments symmetrically arranged under one cover so as to have the two moving elements mounted on a single shaft.

By the use of the polyphase instrument, the switchboard construction is rendered much more compact than when two or three instruments are installed, and the station attendant's work is greatly simplified.

Polyphase Indicating Wattmeters are made in current capacities up to and including 60 amperes, and potential capacities up to and including 650 volts, for use without transformers. Instruments for use on circuits in excess of 60 amperes or 650 volts, will be furnished with current transformers. Instruments for use on circuits in excess of 650 volts are always provided with potential transformers.

The resistance of the potential circuits is external in all capacities and is secured in a ventilated cage suitable for mounting on the back of the switchboard.

POLYPHASE WATTMETERS 100-125 Volts

Cat. No.	Capacity		List Price
	Amperes	Kilowatts	
31808	5	1	\$125.00
31809	10	2	125.00
31810	15	3	125.00
40656	20	4	125.00
40657	30	6	125.00
40658	40	8	125.00
40695	60	12	125.00

200-250 Volts

Cat. No.	Capacity		List Price
cut. 110.	Amperes	Kilowatts	List The
31813	5	2	\$135.00
31814	10	4	135.00
31815	15	6	135.00
40660	20	8	155.00
40661	30	12	135.00
40662	40	16	135.00
40663	60	24	135.00

500-600 Volts

Cat. No.	Capacity		List Price	
Cat. 110.	Amperes	Kilowatts	20501100	
31818	• 5	5	\$145.00	
31819	10	10	145.00	
31820	15	15	145.00	
40664	20	20	145.00	
40665	30	30	145.00	
40666	40	40	145.00	
40667	60	60	145.00	

Orders for instruments to be used with transformers must always specify the frequency of the circuit.

For scales and dimensions see pages 8, 12, 13, 14 and 15.

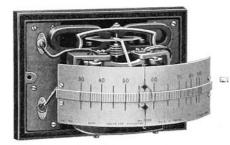
FREQUENCY INDICATORS

The Frequency Indicator shows on a direct reading scale the cycles per second of any alternating current system. The use of a frequency

4551A-6 Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service

indicator enables the station attendant to note immediately any variation from the normal frequency. The advantage of such an instrument over the method of determining the frequency by means of speed indicators will at once be appreciated.

Frequency Indicators are provided with external reactances and resistances which are secured in a ventilated cage for mounting on the back of the switchboard. Means are pro-



HORIZONTAL EDGEWISE FREQUENCY INDICATOR-INTERIOR

vided for adjusting the instrument for the characteristics of the circuit on which it is installed. Standard instruments are wound for 100-125 volt circuits only, but can be wound for circuits up to and including 650 volts if desired. Instruments for use on circuits in excess of 650 volts are always provided with potential transformers.

The normal operating point is marked at approximately the center of the scale, thus giving the advantage of very open divisions.

FREQUENCY INDICATORS 100-125 Volts

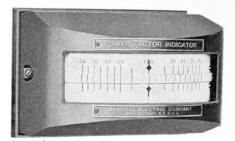
Cat. No.	Frequency in Cycles	List Price
51128	25	\$100.00
51129	40	100.00
51130	60	100.00
51131	125	100.00
51132	133	100.00

The voltage of the circuit must always be given if other than 100–125 volts.

For scales and dimensions see pages 8 and 15.

POWER FACTOR INDICATORS

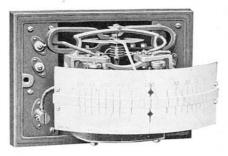
The Power Factor Indicator shows on a direct reading scale the power factor, lagging or leading, of balanced three-wire, two-phase,



HORIZONTAL EDGEWISE POWER FACTOR INDICATOR-EXTERIOR

three-wire, three-phase or four-wire, two-phase systems.

The Power Factor Indicator will be found useful in connection with generating and substation systems operating synchronous (rotary) converters. Heretofore it has been necessary to take simultaneous readings on two indicating wattmeters or upon one indicating wattmeter, an ammeter and a voltmeter, and by means of these readings determine by computations the



HORIZONTAL EDGEWISE POWER FACTOR INDICATOR-INTERIOR

power factor on the line under consideration. This method, however, is too complicated to admit of the frequent, accurate and rapid determination which has now become so important, and has given place to the simple method made possible by the Power Factor Indicator. This instrument is manufactured with one standard scale .60-1.00-.60, showing

Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service 4551A-7

power factors as low as .60, with either leading or lagging current.

Power Factor Indicators are made with capacities up to and including 200 amperes, for use without current transformers. Instruments for use on circuits in excess of 1150 volts or 200 amperes will be furnished with current transformers. Power Factor Indicators can be furnished for any potential up to and including 650 volts, although it will be noted that indicators for 110 volts only are listed. It is anticipated that instruments for all primary circuits will be used in connection with potential transformers, and on circuits in excess of 1150 volts, in connection with current transformers.

The resistance of the potential circuits is external in all capacities and is secured in a ventilated cage suitable for mounting on the back of the switchboard.

	Catalogue No.		- Ampere Capacity	List Price
3-Phase 3-Wire	2-Phase 3 Wire	2-Phase 4-Wire	Ampere Capacity	
23697	27513	23784	5	\$90.00
23698	27514	23785	10	90.00
23699	27515	23786	15	90.00
40668	40673	40678	. 20	100.00
40669	40674	40679	30	100.00
40670	40675	40680	40	100.00
40671	40676	40681	60	100.00
40672	40677	40682	80	100.00
23781	27519	23790	100	110.00
23782	27520	23791	150	110.00
23783	27521	23792	200	110.00

POWER FACTOR INDICATORS FOR BALANCED SYSTEMS 100-125 Volts

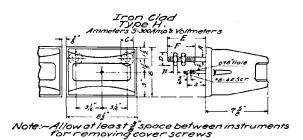
When instruments are to be used with transformers, the frequency of the circuit must always be given.

For illustration of scale see page 15 and for dimensions see page 8.

Data printed in commercial bulletins are for general information only and must not be used for contracts or for construction without confirmation.

4551A-8 Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service

DIMENSIONS OF THOMSON HORIZONTAL EDGEWISE INSTRUMENTS—TYPE H FOR SWITCHBOARD SERVICE



AMMETERS, 5-300 AMPS.. AND VOLTMETERS

SINGLE-PHASE INDICATING WATTMETERS, 5-200 AMPS.

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<u>\$</u>D1

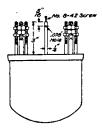
Wattmeters 5-200Amp.

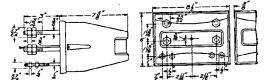
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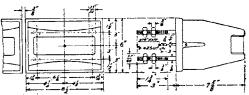
Fig 2

 $7\frac{1}{2}$



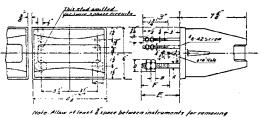


POLYPHASE INDICATING WATTMETERS Hor.Edge. Iron Clad Frequency Indicator Type H + Series Box.



Note: Allow at least & between instrum for removing corer screws,

FREQUENCY INDICATOR



RESISTANCE BOXES FIGS. 1 and 2.

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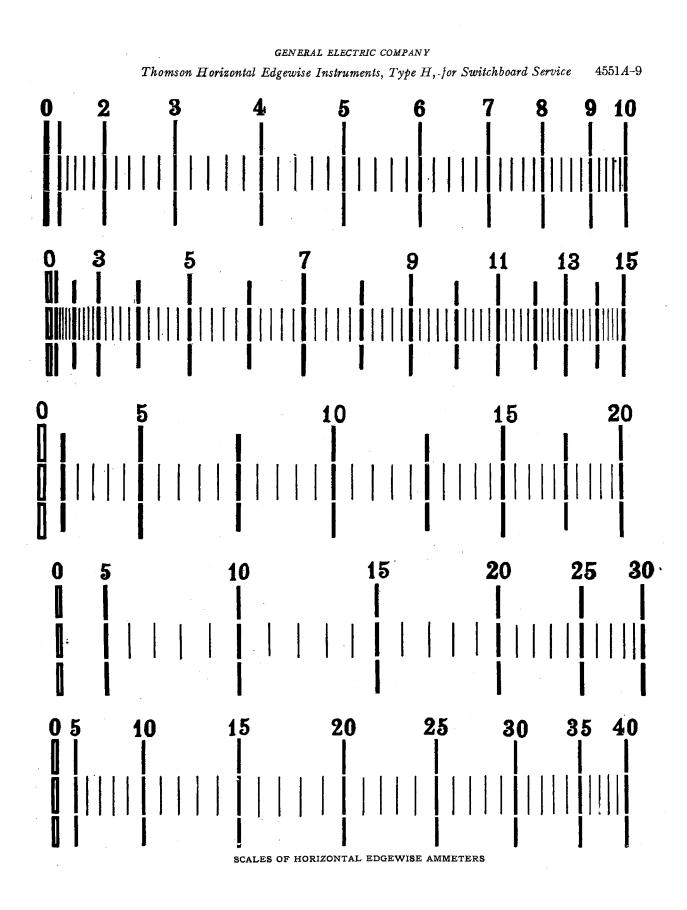
72

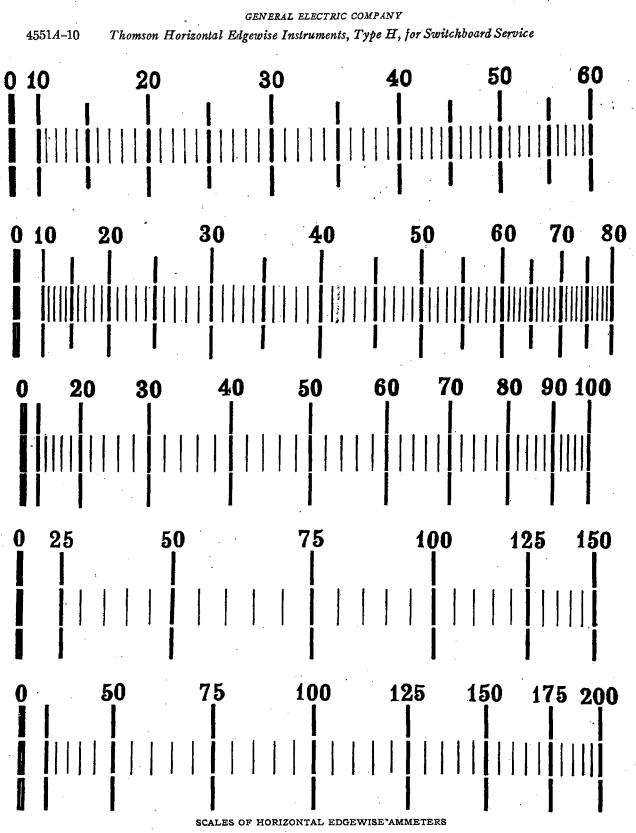
POWER FACTOR INDICATORS

RESISTANCE BOXES USED WITH THOMSON HORIZONTAL EDGEWISE INSTRUMENTS

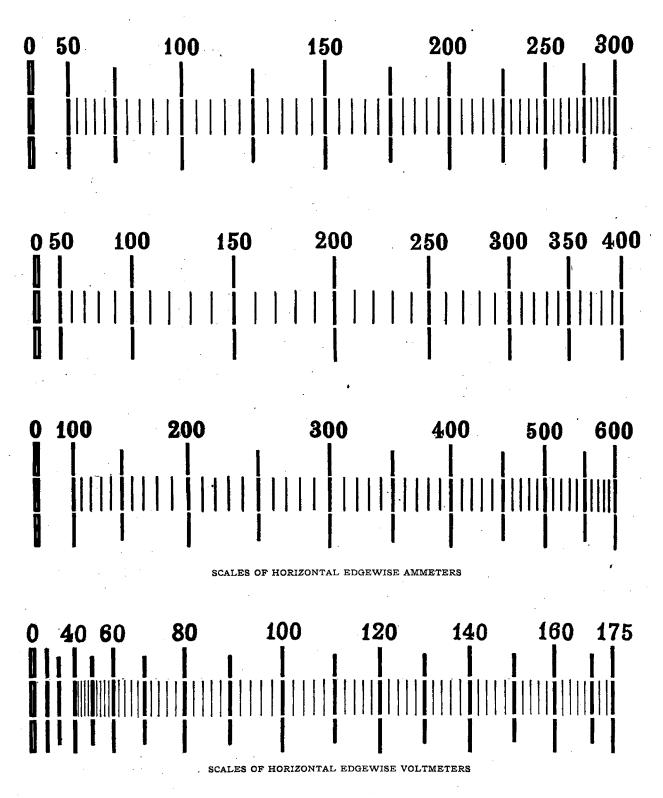
Туре	Voltages	Fig.	Lead Holes
Voltmeter	All	1	A-E
Ind. Watt. SingPh.	All	1	A-E
Ind. Watt. Bal. 3-Ph	All	1	A-C-E
Power Factor Ind., 3-Ph. and 3-W., 2-Ph.	50-199	1	A-E-F-J
Power Factor Ind., 3-Ph. and 3-W., 2-Ph.	200-800	2	A-E-F-J
Power Factor Ind., 4-W., 2-Ph.	50-199	1	A-B-D-E-F-G-I-J
Power Factor Ind., 4-W., 2-Ph.	200-800	2	A-B-D-E-F-G-I-J
Ind. Watt. Poly. 3-Wire	50-199	1	A-E-F-J
Ind. Watt. Poly. 3-Wire	200-800	2	A-E-F-J
Ind. Watt. Poly. 4-Wire	50-199	- 1	A-B-D-E-F-G-I-J
Ind. Watt. Poly. 4-Wire	200-800	2	A-B-D-E-F-G-I-J

For Reference Only.



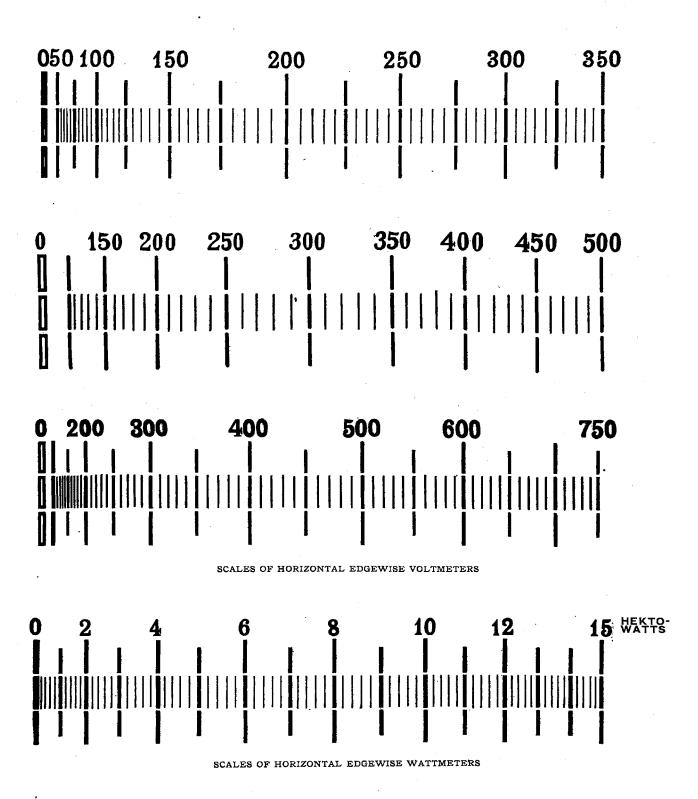


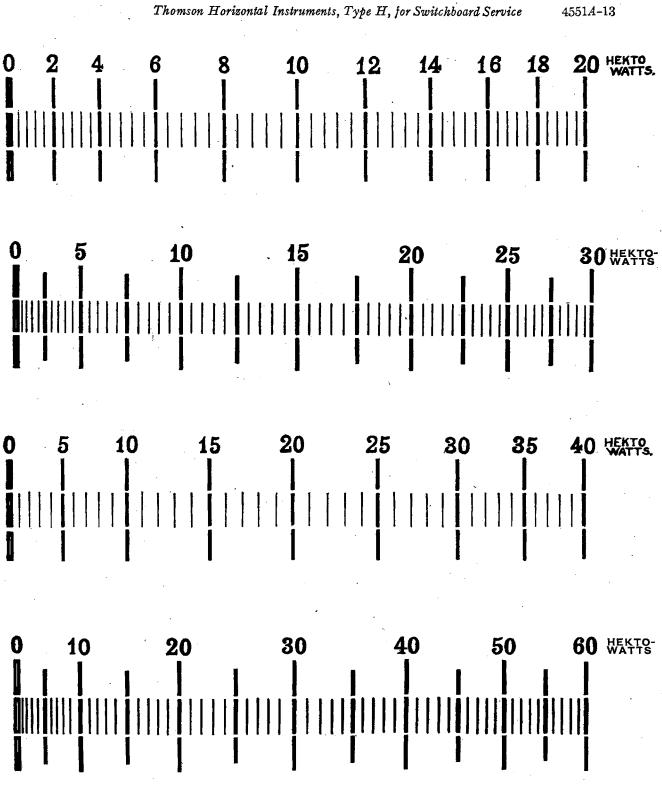
GENERAL ELECTRIC COMPANY Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service 4551A-11



4551*A*-12

GENERAL ELECTRIC COMPANY Thomson Horizontal EdgewiseInstruments, Type H, for Switchboard Service



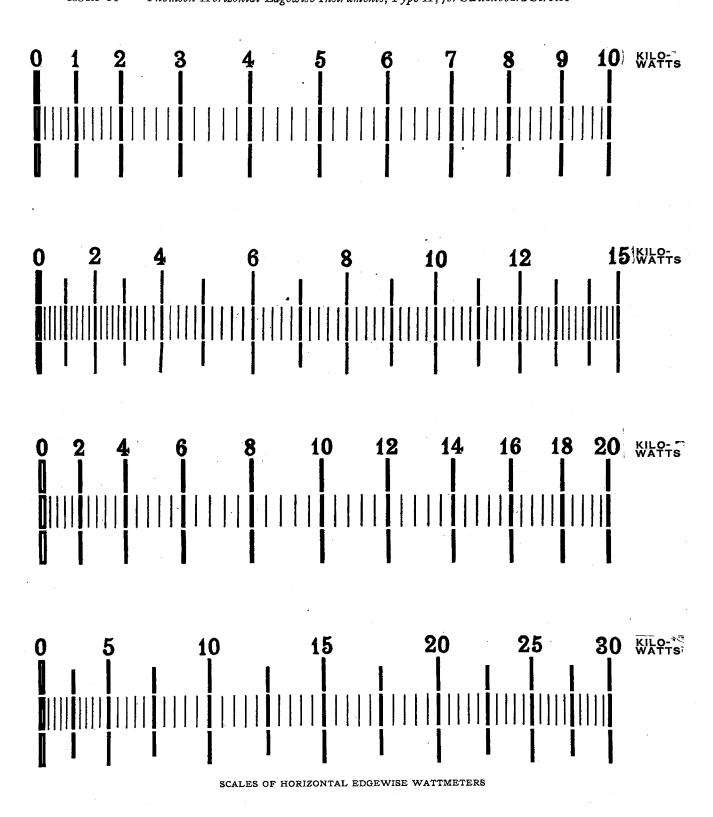


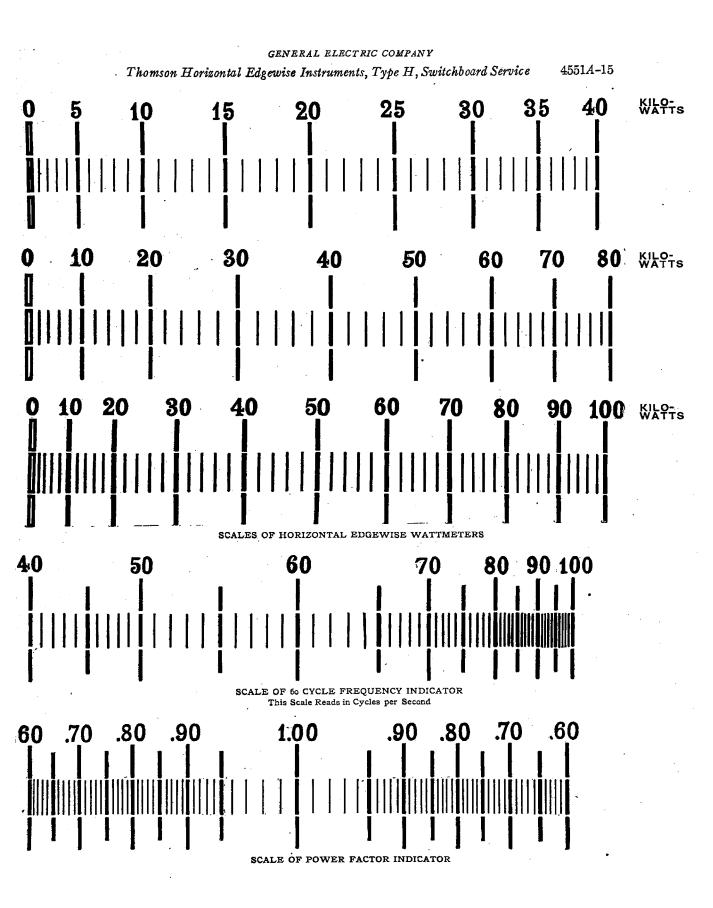
SCALES OF HORIZONTAL EDGEWISE WATTMETERS

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4551A-14

GENERAL ELECTRIC COMPANY Thomson Horizontal Edgewise Instruments, Type H, for Switchboard Service





GENERAL ELECTRIC COMPANY	
PRINCIPAL OFFICES, SCHENECTADY, N. Y.	
SALES OFFICES: T BOSTON, MASS., 84 State Street. NEW YORK, N. Y., 30 Church Street. STRACUSE, N. Y., Post, Standard Building. BUFFALO, N. Y., Ellicott Square Building. NEW HAVEN, CONN., Malley Building. PHILADELPHIA, PA., Witherspoon Bldg. BALTIMORE, MD., Continental Trust Building. CHARLOTER, N. C., Trust Building. CHARLOTER, N. C., Trust Building. CHARLOTER, N. C., Trust Building. ATLANTA, GA., Empire Building. NEW ORIEANS, LA., Hennen Building. NEW ORIEANS, LA., Hennen Building. CINCINNATI, OHIO, Perin Bldg., Fifth and Race Sts. COLUMBUS, OHIO, Columbus Savings & Trust Bldg. CLEVELAND, OHIO, Climbus Savings & Trust Bldg. CLEVELAND, OHIO, Clumbus Savings & Trust Bldg. CLEVELAND, OHIO, Clumbus Savings & Trust Bldg. CLEVELAND, OHIO, Climbus Savings & Trust Bldg. DETROIT, MICH., Majestic Bldg. (Office of Soliciting Agt.) St. LOUIS, MO., Dwight Building. OKIAHOMA CITY, OKLA, Culbertson Bldg. (Office Sol't'g Agt.) DALLAS, TEXAS, Scollard Bldg. (Office for Soliciting Agt.) HELENA, MONTANA, Power Block. DULUTH, MINN., Providence Building. MINNEAPOLIS, MINN., Phoenix Building. SAN FRANCISCO, CAL., Union Trust Building. LOS ANGELES, CAL., Delta Building. SAN FRANCISCO, CAL., Union Trust Building. SAN FRANCISCO, CAL., Union Trust Building. LOS ANGELES, CAL., Delta Building. SAN FRANCISCO, CAL., London, TS., New York, N. Y. LONDON OFFICE, 83 Cannon St., London, F. C., England. For all CANADIAN Business, Canadian General Electric Company, Ltd., Toronto, Ontario.	

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General Electric Company Schenectady, N.Y.

SUPPLY DEPARTMENT

November, 1907

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ASW

DIRECT CURRENT INSTRUMENTS, TYPE D

The Type D, Direct Current Instruments, manufactured by the General Electric Company are constructed upon the well known D'Arsonval principle and are designed for switchboard use. They are neat in appearance, substantial in construction, and unsurpassed in accuracy. from the shell by removing two screws which support the core and moving element in place.

DAMPING

The instruments are rendered very dead beat by means of Foucault currents which are generated in the aluminum frame on which



TYPE D AMMETER

CONSTRUCTION

A small coil of wire carrying the current to be measured, or a shunted portion of it, is wound on a light cylindrical frame of aluminum. The frame is so pivoted in jewelled bearings as to move freely in a small annular space between a soft iron core and the pole pieces of a permanent magnet. The soft iron core together with the armature and jewel supports are assembled within a soft steel shell constituting the pole pieces.

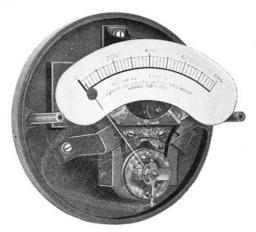
The iron core and the jewel supports, together with the armature, can be withdrawn the coil is wound, as it rotates in the field of the permanent magnet. The pointer therefore comes quickly to rest after each change in current value, enabling rapid and accurate readings. This damping quality, furthermore, prevents injury to the pointer with violent fluctuations of the load.

MAGNETS

There is no feature of a direct current instrument more vital to its continued accuracy than the permanency of its magnets, for if the magnet strength changes, serious errors

4552-2 Direct Current Instruments, Type D

will result. The magnets used by the General Electric Company are manufactured from the very best grade of magnet steel obtainable, and are subjected to special processes of hardening and aging which render them permanent throughout long continued use.



TYPE D AMMETER WITH COVER REMOVED

LIFE AND ACCURACY

Direct Current Instruments, Type D, have unusually high torque and light moving elements which features, combined with a very small air gap between the magnet pole faces and the iron core, insure long life with continued accuracy.

FREEDOM FROM EFFECT OF STRAY FIELDS

The Type D Instrument is enclosed in a round cast iron case which protects it from the effect of stray fields. It also renders the instrument dust-proof.

CAPACITIES

The ammeters are made self-contained in capacities up to and including 60 amperes; capacities in excess of 60 amperes are used with external shunts which are included in the list prices.

The voltmeters are made self-contained in capacities up to and including 750 volts.

SCALES

The scales of these instruments are uniform throughout their entire range, and are particularly legible, as will be noted by referring to the accompanying illustrations. When it is desired to read current flows in two directions, scales can be furnished without extra charge, with zero marking at the center, or at other intermediate points of the scale, *e. g.*, 100-0-100 or 200-0-1000.

CONNECTIONS

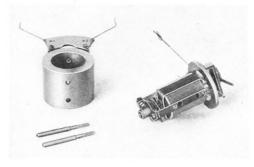
The instrument being intended for switch board use, is made "back connected," the current being conveyed from the external circuit by means of two brass studs. These studs also serve to support the instrument.

FINISH

The standard finish of Type D Instruments is dull black with raised portions polished copper. This finish is pleasing in appearance and very durable.

SHUNTS

All Type D Instruments from 80 to 3000 amperes inclusive are furnished with an external shunt known as the Form 3. These



MECHANISM OF TYPE D INSTRUMENT

shunts are made of a special alloy having practically a zero temperature coefficient. The general characteristics of the Form 3 shunt are shown in the accompanying illustration. Dimensions are shown in diagram and table on pages 5 and 6.

Direct Current Instruments, Type D 4552-3

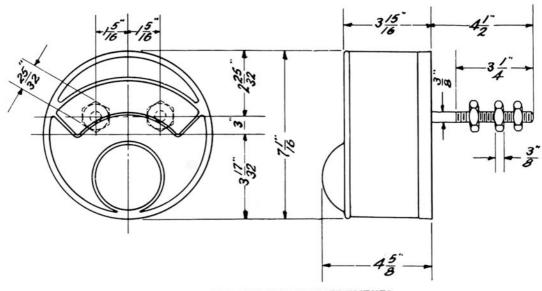
All General Electric instrument shunts in excess of 800 amperes are now provided with a thermo-electric attachment. This attachment consists of a metal strip, one end of which is electrically connected to one end of the shunt and the other placed in close thermal contact with the opposite end of the shunt, but insulated from it electrically. The leads to the ammeter are connected from the two insulated points, one being on the shunt proper, the other on the metal strip, which are in close thermal contact. This prevents the superimposing of secondary thermo-electric currents upon the primary current, due to the fall of potential in the shunt, and the amount of which fixes the value of the instrument's indication. Ammeter shunts with this attachment will be found free from temperature errors due to generation of thermo-electric current.

All shunts furnished with Type D Instruments are interchangeable, having a uniform drop of sixty (60) millivolts.

The General Electric Company does not recommend the shunting of sections of the bus-bar.



FORM 3 SHUNT



DIMENSIONS OF TYPE D INSTRUMENTS

4552-4 Direct Current Instruments, Type D

Cat. No.	Amp. Capacity	List Price	Cat. No.	Amp. Capacity	List Price
49293	5	\$40.00	49303	200	\$45.00
49294	10	40.00	49304	300	47.50
49295	15	40.00	49305	400	50.00
49296	20	40.00	49306	600	52.50
49297	30	40.00	49307	800	55.00
49298	40	40.00	49308	1000	60.00
49299	60	41.00	49309	1500	70.00
49300	80	42.00	49310	2000	80.00
49301	100	43.00	49311	3000	90.00
49302	150	44.00			ļ

AMMETERS

Above prices include shunts.

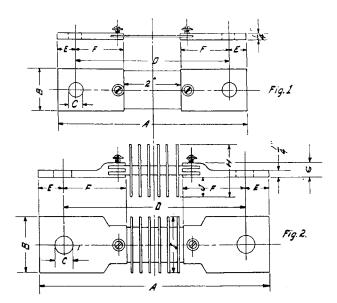
VOLTMETERS

Cat. No.	Capacity	List Price	
49312	175	\$45.00	
49313	350	50.00	
49314	500	55.00	
49315	<u>570.</u> 730	60.00	

Prices on higher capacities than those listed will be furnished on application.

Direct Current Instruments, Type D 4552-5

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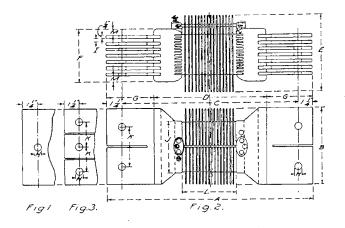


FORM 3 SHUNTS 80 TO 800 AMPERES

CAPACITY		DIMENSIONS IN INCHES										
Amps.	FIG.	А	в	с	D	E	F	G	н	I	J	
80–100	1	6^{1}_{4}	$1\frac{1}{4}$	$\frac{13}{32}$	$5\frac{1}{4}$	$\frac{1}{2}$	$1\frac{5}{8}$			· · · i		
150	1	$6\frac{3}{4}$	11/4	$\frac{1}{3}\frac{7}{2}$	$5\frac{1}{4}$	$\frac{3}{4}$	$1\frac{5}{8}$					
200	1	$6\frac{3}{4}$	11	$\frac{1}{3}\frac{7}{2}$	$5\frac{1}{4}$	$\frac{3}{4}$	$1\frac{5}{8}$	•••				
300	1	$6\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{3}\frac{7}{2}$	$5\frac{1}{4}$	3	15	•••				
400	2	$8\frac{1}{4}$	2	$\frac{1}{3}\frac{7}{2}$	$6\frac{1}{4}$	1	21/8	<u>3</u> 8	$1\frac{3}{4}$	2	$\frac{11}{16}$	
500	2	$8\frac{3}{4}$	2	$\frac{1}{3}\frac{7}{2}$	$6\frac{1}{4}$	1	21	$\frac{1}{2}$	$1\frac{3}{4}$	2	<u>5</u> 8	
600	2	$8\frac{3}{4}$	$2\frac{1}{2}$	$\frac{21}{32}$	$6\frac{1}{4}$	11	21	$\frac{1}{2}$	2	$2\frac{1}{2}$	<u>3</u> 4	
800	2	$8\frac{3}{4}$	$2\frac{1}{2}$	$\frac{2}{3}\frac{1}{2}$	$6\frac{1}{4}$	$1\frac{1}{4}$	2 1	<u>5</u> 8	2	$2\frac{1}{2}$	$\frac{11}{16}$	

Note-Above data are for general information only and must not be used for contracts or for construction without confirmation.

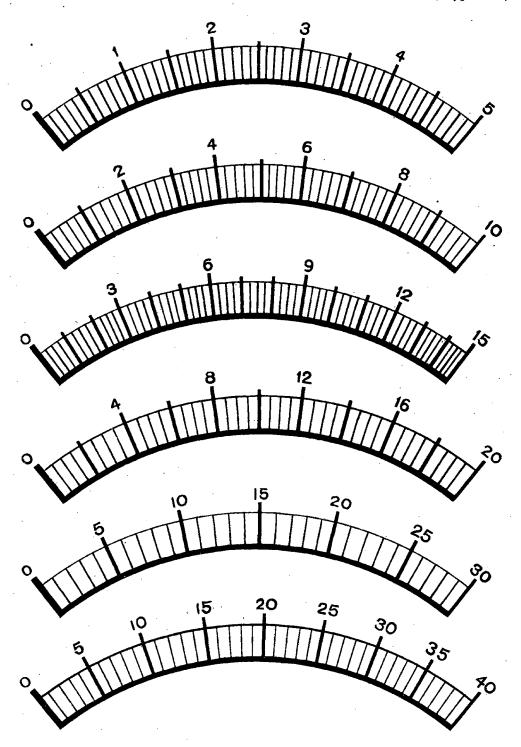
4552–6 Direct Current Instruments, Type D



FORM 3 SHUNTS 1000 TO 3000 AMPERES

CAPAC- ITY	DIMENSIONS IN INCHES											CON. STRIPS			
Amps.		A	B	с	D	E	F	G	H	I	J	ĸ	L	M	EACH END
1000	1	$10\frac{1}{4}$	3	$7\frac{3}{4}$	$4\frac{3}{4}$	$3\frac{1}{4}$	13	$2\frac{3}{4}$	$\frac{21}{32}$	34	$2\frac{1}{4}$		2	1 ⁷	2
1200	2	$10\frac{1}{2}$	3	8	$4\frac{3}{4}$	$3\frac{1}{4}$	$1\frac{3}{4}$	$2\frac{7}{8}$	$\frac{1}{3}\frac{7}{2}$	$\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$	2	1 2	2
1500	2	$10\frac{1}{2}$	3	8	$4\frac{3}{4}$	$3\frac{1}{4}$	$1\frac{3}{4}$	$2\frac{7}{8}$	$\begin{array}{c}1.7\\3.2\end{array}$	1	2^{1}_{4}	$1\frac{3}{4}$	2	14	3
2000	2	11	4	$8\frac{1}{2}$	$5\frac{1}{2}$	$3\frac{3}{4}$	$2\frac{1}{4}$	$2\frac{3}{4}$	$\frac{21}{32}$		$2\frac{9}{16}$	$2\frac{1}{2}$	$2\frac{1}{2}$	1	3
2500	2	11	4	8^{1}_{2}	$5\frac{1}{2}$	$3\frac{3}{4}$	$2\frac{1}{4}$	$2\frac{3}{4}$	$\frac{21}{32}$	$\frac{1}{4}$	23	$2\frac{1}{2}$	$2\frac{1}{2}$	1 4	4
3000	2	$11\frac{3}{4}$	4	$9\frac{1}{4}$	6	$3\frac{3}{4}$	$2\frac{1}{4}$	$2\frac{7}{8}$	$\frac{2}{3}\frac{1}{2}$	$\frac{1}{4}$	$2_{1\overline{6}}^{9}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$\frac{1}{4}$	4
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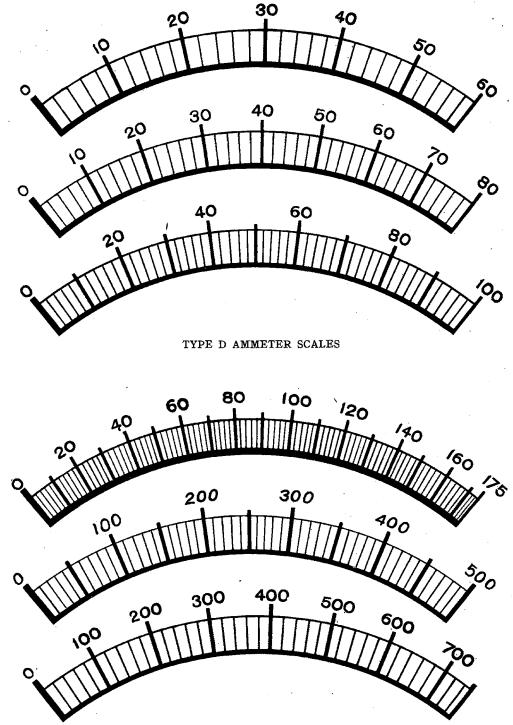
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TYPE D AMMETER SCALES

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4552-8 Direct Current Instruments, Type D



TYPE D VOLTMETER SCALES

General Electric Company Schenectady, N.Y.

SUPPLY DEPARTMENT

November, 1907

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neat carrying cases

provided with hinged

cover and snap lock.

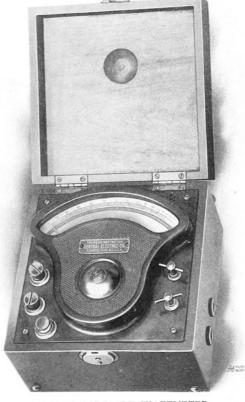
PORTABLE INSTRUMENTS-TYPE P-3

A satisfactory instrument for portable use must first of all be accurate. It is not sufficient that a portable instrument be accurate as it comes from the makers; it must be

capable of retaining this quality in service.

The accuracy of a portable instrument must also be maintained when it is subjected to disturbing influences such as external magnetic fields, variations in wave form, frequency, etc.

Mechanically, it should be rugged in construction, with a light-weight moving element, not susceptible to damage 'in transportation. Weight and size should be as small as possible consistent with the foregoing essentials, so that several instruments may be carried with The General ease. Electric Company's



TYPE P-3 PORTABLE WATTMETER

Iron Clad Portable Instrument—Type P-3 meets these requirements.

CONSTRUCTION

The voltmeters and wattmeters are constructed on the direct reading dynamometer principle, while the ammeters are constructed

on the well-known Thomson inclined coil principle. The instruments excel in mechanical construction, are neat in appearance and very substantial. They are contained in

> By the removal of the internal moulded cover and three additional screws, the entire mechanism can be taken from the case. DAMPING QUALI-TIES The pointer fluctuations are damped by means of Foucault currents set up in a thin aluminum segment attached to the

ment attached to the shaft. This segment oscillates with each movement of the pointer, in the field of two astatically arranged permanent magnets. The segment balances the pointer and there

Iron Clad Portable Instrument-Type P-3 is therefore no necessity for counter weights.

JEWELS AND PIVOTS

Careful attention has been given to the construction of the jewels and pivots, as these have great influence upon the continued accuracy of indicating instruments. The

4554-2 Portable Instruments-Type P-3

pivots are made from the best grade of steel, especially hardened and highly polished, and are suspended in high grade sapphire jewels which are practically indestructible.

FREEDOM FROM EFFECT OF STRAY

One of the severest tests of the reliability of these instruments when used for laboratory or general testing purposes is their ability



TYPE P-3 INSTRUMENT WITH MOULDED RUBBER COVER REMOVED

to give accurate indications when used in the vicinity of external magnetic fields. The coils of the Type P-3 instruments are entirely surrounded by a laminated iron shield which thoroughly protects them from errors due to this cause. This shield also serves to prevent errors caused by the projected field of the damping magnets when the instrument is used on direct current circuits.

ACCURACY

The Type P-3 instruments may be used on circuits of any frequency, wave form or power factor without appreciable error. The voltmeter and wattmeter may be used interchangeably on direct or alternating current. The ammeter although primarily an alternating current instrument, may also be used on direct current circuits by taking reverse readings—the mean being the proper indication.

CAPACITIES

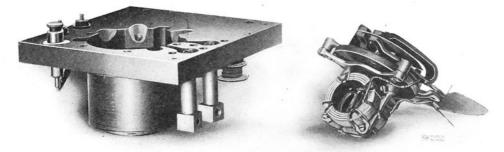
The Type P-3 ammeters are made selfcontained in capacities up to and including 30 amperes; voltmeters up to and including 750 volts and single-phase wattmeters in capacities up to and including 30 amperes and 750 volts.

SCALES

The scales of the Type P-3 instruments subtend an arc of approximately 90 degrees, and are very legible, as may be noted from reference to the accompanying illustrations.

CONNECTIONS

The binding posts are brought out at the top of the instruments, and are provided with suitable thumb-screws for securing the leads which connect the instrument to the external circuit.



MECHANISM OF P-3 INSTRUMENT

Portable Instruments—Type P-3 4554-3

PORTABLE INSTRUMENTS, TYPE P-3

VOLTMETERS

Cat. No.	Capacity	List Price
49447	150	\$100.00
49448	300	105.00
49449	600	110.00

AMMETERS

2	99	\$80.00
5	42	80.00
10	43	80.00
15	44	80.00
20	45	90.00
30	46	90.00

WATTMETERS-100-125 VOLTS

Cat. No.	19450 1.5 19451 3 19452 5 19453 10	Watts	List Price	
49450	1.5	150	\$120.00	
49451	3	300	120.00	
49452	5	500	125.00	
49453	10	1000	125.00	
49454	15	1500	130.00	
49455	20	2000	130.00	
49456	30	3000	135.00	

4554-4 Portable Instruments-Type P-3

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PORTABLE INSTRUMENTS, TYPE P-3

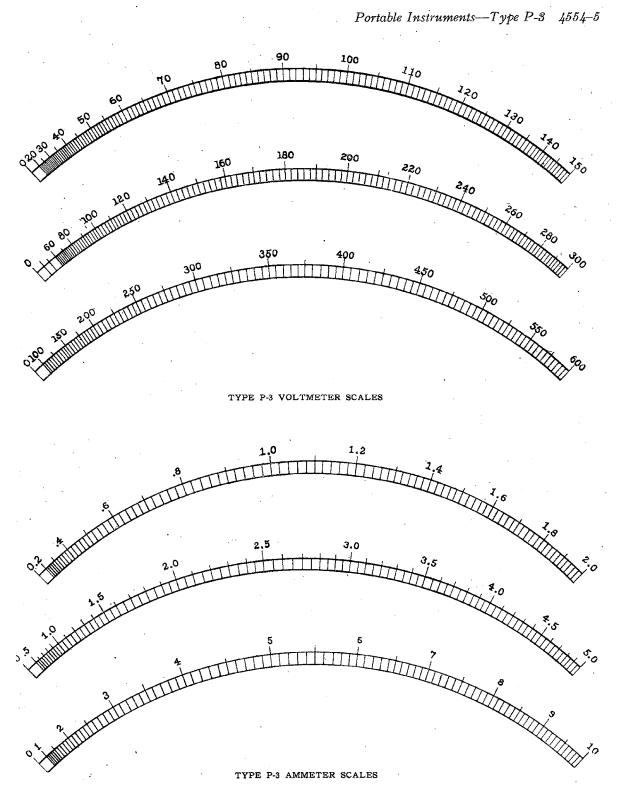
WATTMETERS-200-250 VOLTS

	Capacity									
Cat. No.	Amperes	Waits	List Price							
58417	1.5	300	\$130.00							
58418	3	600	130.00							
58419	5	1000	135.00							
58420	10	2000	135.00							
58421	15	3000	140.00							
58422	20	4000	140.00							
58423	30	6000	145.00							

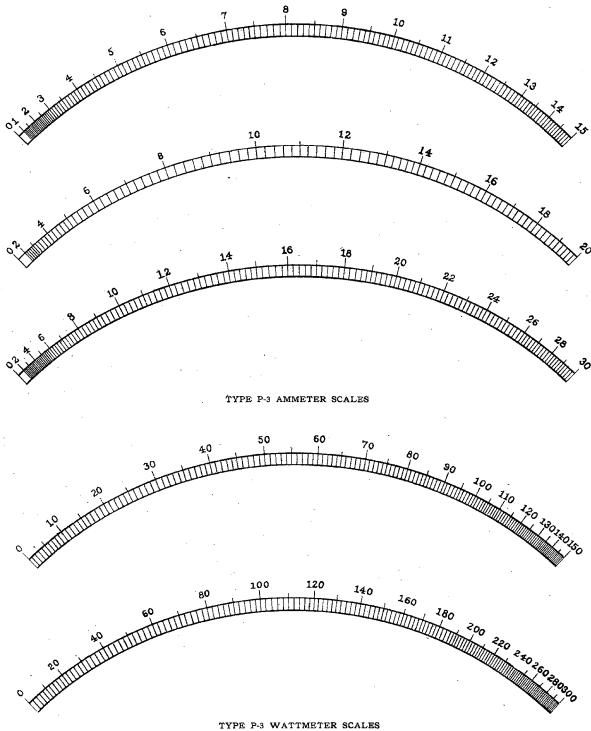
WATTMETERS-500-600 VOLTS

Capacity

Amperes	Watts .	List Price
1.5	750	\$140.00
3	1500	140.00
5	2500	145.00
10	5000	145.00
15	7500	150.00
20	10000	150.00
30	15000	155.00
	$ 1.5 \\ 3 \\ 5 \\ 10 \\ 15 \\ 20 1 $	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$

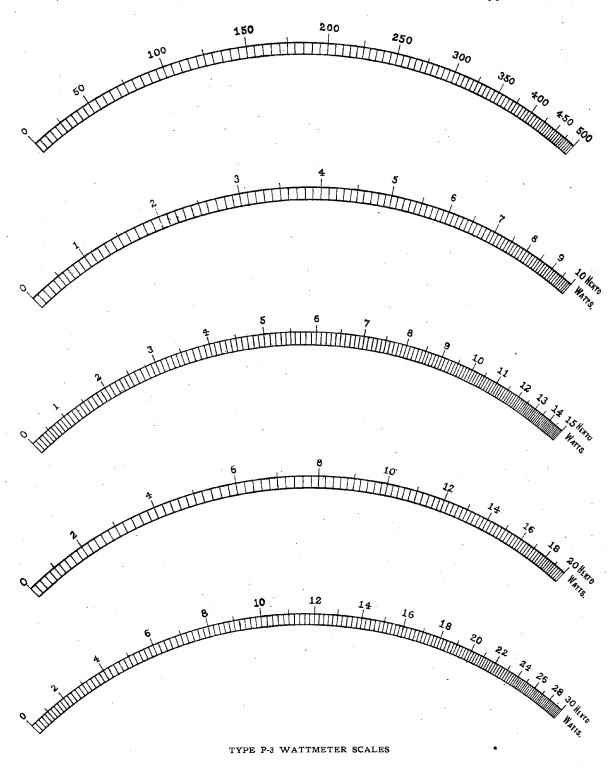


4554-6 Portable Instruments—Type P-3



TYPE P-3 WATTMETER SCALES

Portable Instruments—Type P-3 4554-7



GENERAL ELECTRIC COMPANY

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

SALES OFFICES:

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Toronto, Ontario.



POWER AND MINING DEPARTMENT

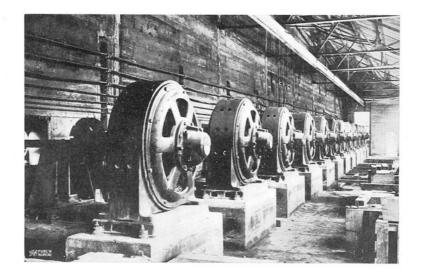
December, 1907

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ADW.

THE ELECTRIC DRIVE IN CEMENT PLANTS

It is safe to assert that there is no staple product of manufacture in the United States of which the output has increased with such rapidity as Portland Cement. In 1880, the production from 1890 to 1906. As opposed to this gain, the output of natural cement has fallen off since 1899, and mills producing this class of cement have been forced either to limit



12-I-18-100-166 2/3-K-440 volt motors driving raw material tube mills in Universal Portland Cement Co., Plant No. 4. These motors are coupled through flexible couplings to the countershafts of the mills. This necessitates only one gear reduction. The concrete wall separating the motors from the mills secures an unusually clean motor room

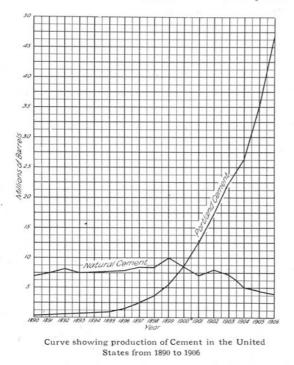
country produced 42,000 barrels of this commodity. In 1890, the output had grown to 335,000 barrels. At about that time the possibilities of reinforced concrete for building purposes began to be appreciated. New cement plants were constructed to meet the demand. The manufacture of cement was enormously stimulated, until in 1906 the United States produced 46,500,000 barrels over 1000 times the output of twenty-six years ago.

The curve on the following page illustrates graphically the steady and increasing gain in their output, or to install rotary kilns and manufacture Portland. The third class of cement, called Puzzolan, or slag, is showing a small but steady increase. The production has increased from 280,000 barrels in 1901 to 480,000 barrels in 1906. The total production of hydraulic cement in the United States in the last year was 51,000,000 barrels, 91 per cent. of which was Portland.

In spite of the astonishing growth of this industry, the demand is still unsatisfied. Our exports—never very large—dropped from 900,000 barrels in 1905, to 580,000 in 1906;

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and the imports increased in the same time, from 850,000 to 2,200,000 barrels. In view of the increasing number of building operations for which concrete is found to be pecu-



liarly adapted, including railroad, dock and harbor work, office buildings, aqueducts, bridges, canals, tunnels, factories, hotels, dwellings and many other constructions, there appears to be no probability of any diminution in the rate of growth of the cement business for many years.

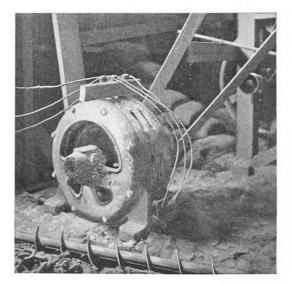
The Manufacture of Portland Cement

The essential elements of Portland cement are alumina, silica, and lime; which are ground finely, mixed in the right proportion (approximately 8% Al₃O₂, 21% SiO₂, 62%CaO, and 9% impurities impossible to eliminate commercially), and roasted at about 2800 deg. F., when it is again ground. There are many raw materials in which the necessary ingredients are found. The right proportion is generally obtained by combining two materials, in one of which lime predominates, and in the other silica and alumina. The materials used in this country are:

- (1) Cement rock and limestone,
- (2) Limestone and shale or clay,
- (3) Marl and shale or clay,
- (4) Blast furnace slag and limestone,
- (5) Caustic soda waste, and clay.

Combination No. 3 is effected by what is called the wet process. Numbers 1, 2, 4 and 5 are combined in a dry state. Of these various combinations, numbers 1 and 2 greatly predominate; 51.4 per cent. and 35.6 per cent. respectively of the entire output of Portland Cement for 1906 was made by these two combinations.

Limestone, cement rock and shale are usually quarried, while clay is dug from pits, and marl is dredged, often under water. In blasting the stone at the quarry, it is shattered as much as possible and the remaining large pieces are broken up by hand and conveyed in skips or cars to the crushers. These reduce it again to 1 to $2\frac{1}{2}$ inch cubes. This is then sent through driers until almost all



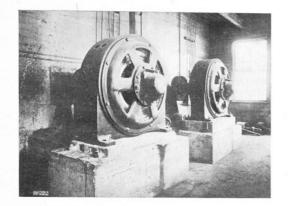
Induction Motor Covered with Thick Coating of Cement Showing Conditions of Operation

of the moisture is evaporated. In order to produce a good grade of cement, a very intimate mixture must be made, and the material

GENERAL ELECTRIC COMPANY

The Electric Drive in Cement Plants 4555-3

ground until 95 per cent. will pass a 100 mesh sieve before burning. The approved method is generally to introduce two sets of grinding machinery between the driers and the kilns, generally ball mills and tube mills. The two



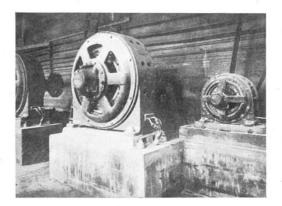
2-1-18-100-165 2/3-K-440 volt motors direct connected to countershaft of raw material tube mills through six arm flexible couplings, in Universal Portland Cement Co., Plant No. 4. These motors were started four months ago and have run continuously ever since without any shut down

materials are ground separately to pass through a 20 mesh sieve in the first set of grinders—the ball mills—and then mixed and sent through the tube mills. The output of the tube mills is sent to the rotary kilns for burning. After gradually rolling down the length of the rotary kiln, the material is discharged as cement clinker. This hot clinker is cooled, and again ground to the desired fineness, after which it is conveyed to the stock house as finished cement.

From the time the rock is fed into the crushers, it is not handled again until the cement is delivered by the weighing and packing machine into bags or barrels. All transportation from one machine to another, or to the storage bins, is accomplished by means of conveyors, either bucket, belt or screw.

Advantage of Electric Drive for This Industry

The manufacture of Portland cement has certain features which differentiate it commercially from almost any other industry. The raw materials underlie more than 20 per cent. of the entire area of the United States. Their initial cost is low, the cost of quarrying or dredging is slight, and, owing to the eager market, and more particularly, to the widespread deposits of raw materials, no successful merger can be formed to regulate the selling price. The price of the finished cement is determined almost entirely by the actual cost of the different operations through which the raw material passes. In the light of this fact, it is obvious that the most prosperous companies will be those that adopt, at the outset, the cheapest and most efficient means of operating the various machines necessary in cement manufacture.



View taken at the further end of motor annex showing I-6-20-500-K-440 volt motor belted to a conveyor. Universal Portland Cement Co., Plant No. 4

The advantage of individual electric drive in machine shops and factories, in eliminating line shafting and adding to flexibility and economy, have now been almost universally demonstrated. These general advantages apply with equal weight to cement operations. There are, however, certain inherent requirements in the manufacture of cement which completely establish the argument in favor of electric motors for this class of work.

1. Fourth of July and Christmas are the only holidays for the cement trade. For the rest of the year, twenty-four hours a day, and seven days in the week, the mill must be kept in continuous production. The shut

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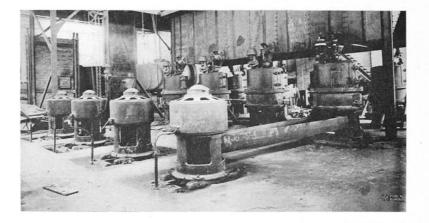
down of any one machine, or the failure of its driving power, must not affect the operation of any other machine.

2. The general layout of the plant, to be most economical, should be determined solely by the relative locations of the quarries, the storage bins, the best available place for the machinery, and the space available for future growth. The direction and distance of the power transmission should not interfere with the most efficient layout.

3. In order to keep a check on the cost of manufacture, a continuous and accurate record should be available, showing the amount of power used in each of the different departments. except the burners, are unskilled workmen. If motors are installed, they must be of a rugged type to need little attention and to operate in an atmosphere thick with stone and cement dust.

A complete electrical installation, composed of two or more General Electric engine or turbo-driven alternators, switch board, and the proper motor equipment, consisting of General Electric alternating current, Form K induction motors, will successfully meet all of the above conditions.

1. As long as the boilers produce steam, continuity of operation is ensured. Both the motors and generators will run without shut down for any desired length of time.



1-6-40-500-K-440 volt vertical motors, belted to Fuller mills, Plant No. 4, Universal Portland Cement Co. There are eight of these driven altogether. The bearings on these motors have given entire satisfaction in spite of the dust and grit that naturally tend to produce excessive wear

4. Most of the machines used in cement manufacture start under a heavy overload, and some are liable to short overloads during operation. The driving unit must be designed to give the best efficiency at the load required in normal operation, and yet have a large margin of overload capacity which can be drawn upon at starting or when necessary.

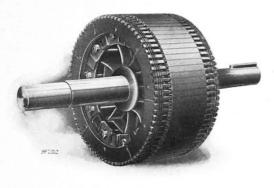
5. Above all, the prime mover must be adapted to severe service conditions. The cement machinery does not require much attention, and the driving machinery is not apt to get it. Almost all the employees, The individual electric motor drive allows for the independent shut down or starting of any one of the cement machines, without affecting the operation of any other.

2. The location of the power house need not be considered in laying out the plant. In case water power is available at some distance from the mill, the generating station may be located at the source of power and the electric power transmitted at high efficiency to the cement plant. No line shafts need be considered in designing the mill, and the machines may be placed wherever most convenient to feed or discharge. This results in a great

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saving of floor space and improvement in design.

3. The switchboard can be laid out to have a separate feeder circuit for each of the



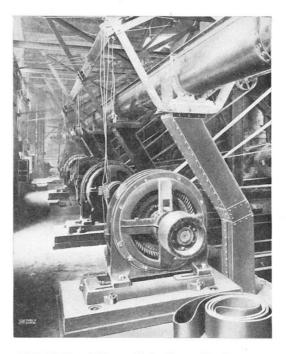
ROTOR OF FORM K MOTOR

departments, with a recording wattmeter in each feeder, and an indicating ammeter on each of the motor panels. If the board is still further equipped with a recording wattmeter on each generator panel, a complete check on all power used is obtained. Any increase or loss in efficiency of any department can be instantly noted, and the cause ascertained. This record will be found a great aid in working towards higher total efficiency and in lowering the cost of production.

4. The Form K motor, which we recommend especially for this class of work, is given the normal running horse-power rating of the machine it drives. These motors are supplied with high resistance rotors for producing a starting torque of twice normal torque if necessary. The rotor bars are bolted to the end rings instead of being soldered, which enables the motor to stand the heavy current required for starting. These motors will endure short overloads of 200 per cent. to 300 per cent. They are exactly suited to the duty, running at highest efficiency under normal load, with a large margin of overload for starting, when required.

5. The first applications of electric drive to this manufacture were made before the merits of the alternating current for power

were fully demonstrated. The General Electric Co. has installed direct current equipments in a number of plants with great success, notably in the Edison Portland Cement Co., at Stewartsville, N. J. Among the electrical apparatus at this plant, are ten 25 h.p., slow speed, variable speed motors driving rotary kilns 150 feet long, the heaviest kilns in the world. Where it is possible for the mill designer to determine the character of the power to be used, however, the best practice is to install alternating current of 25 or 60 cycles. Form K induction motors, operating on this current, are peculiarly adapted to the severe service outlined in paragraph No. 5 above. There are no sliding contacts; no current-carrying parts exposed to the air; absolutely nothing to be injured by the dust except the bearings, which are made dustproof by felt dust guards on each side. The

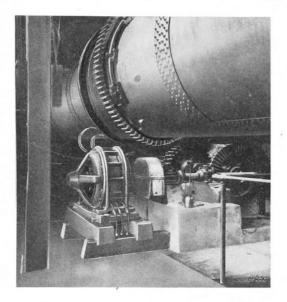


5-I-6-40-500 Form K Motors driving Kent mills. Sandusky Portland Cement Co., Dixon, Ill.

compensators for starting these motors are arranged with a latch, so that the operator cannot throw the motors directly on the line

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until they start to run; once running, they can be left all day without attention. They are protected—and in turn protect the machinery

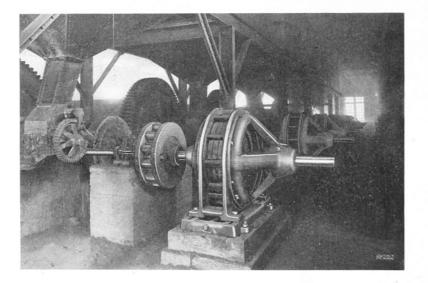


I-6-18-500 Form M Motor driving Rotary Kiln 8 by 100 ft. Sandusky Portland Cement Co., Dixon, Ill.

-against excessive overloads, by fuses or circuit breakers on the starting panel. The revolving part is nothing more than a number of copper rods, parallel to and surrounding the shaft, and embedded in an iron core, with their ends connected by rings at each end. Owing to the appearance of this rotor, it is commonly known as the "squirrel cage" type. There is nothing more complicated about it than a piece of shafting revolving between journals. Dust cannot hurt these motors. It is almost impossible to damage them. It would be hard to find any driving machinery more nearly "fool proof."

Machines Used in Cement Manufacture

ROCK CRUSHERS. With the exception of the Giant Rolls installed by Thomas A. Edison at the Edison Portland Cement Co., the almost universal type of crusher is the gyratory. The Giant Rolls consist of four pairs of corrugated steel cylinders, arranged one under the other, each pair being separately belt driven. The largest pair is on top, the cylinders being about 5 feet in diameter, and from 4 to 6 inches apart. As these rolls will crush a solid 10 ton piece of rock, no hand breaking is required, and the rock may be loaded into the skips at the quarry, directly after blasting.

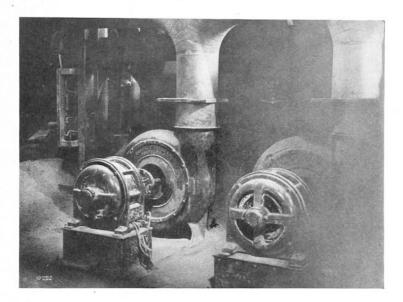


6-I-8-85-375 Form K Motors driving Tube mills through flexible couplings. Sandusky Portland Cement Co., Dixon, Ill.

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The gyratory type, which is used in almost all cement mills employing the dry process, consists essentially of a vertical spindle, on the upper end of which is mounted a chillediron crushing head that moves inside a hopper shaped top into which the rock is fed. The bottom of the spindle passes loosely through an eccentric, driven from a horizontal shaft by bevel gears. The spindle, therefore, has a gyratory motion, and may or may not rotate on its own axis. As the head, running eccentrically, approaches and recedes from the sides of the hopper, the stone is gradually to one motor, though this is not the best practice, as all crushers must be stopped when the motor is shut down. Gearing is not suitable for these machines, as the driving gear would be subject to a severe strain should the crusher become clogged with rock.

BALL MILLS. These mills take the output of the crushers or the rotary kilns and reduce it to a coarse grit, generally about No. 16 to No. 20 mesh. The mill consists of a drum having a diameter of about double its length, filled with steel balls. The drum revolves on a horizontal axis, at a speed of from 21 to



2-I-4-10-750-K-440 volt motors flexibly coupled to Buffalo blowers, used to force a mixture of air and coal dust into the slag and limestone dryers. Similar blowers are used for forcing powdered coal into the rotary kilns. The apparent fog around the right hand machine is due to the large amount of dust in the air. Universal Portland Cement Co., Plant No. 4

crushed and falls down between the crushing surfaces. The stone must be broken by hand to a convenient size to feed into the hopper. A crusher having a hopper about 40 inches in diameter and a crushing head about 20 inches will have a stroke of approximately $\frac{5}{8}$ unch.

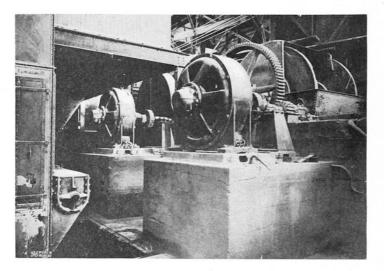
The h.p. necessary to drive, averages 1.2 times the tons of rock crushed per hour; figuring on rock of moderate hardness. A crusher of this type is suitable for individual belt drive. Sometimes two or more crushers are belted 27 revolutions per minute. The lining of the drum is made up of overlapping steel plates which form steps. As the drum, 'revolves, the balls drop over the steps, pounding the material to pieces. This mill, with the balls it contains, is very heavy and takes almost double normal torque for starting. It is adapted for either belting or gearing. In gearing to the mill, it is common practice to gear to the countershaft, making two gear reductions between the driving motor and the mill. When a low frequency alternating

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current is available, however, very good results are obtained by using a slow speed motor (about 166 r.p.m.) and coupling directly to the countershaft, thus doing away with one gear reduction. The General Electric Company has recently supplied a number of 40 and 60 h.p. motors running at this speed, to the Universal Portland Cement Co. for driving ball and tube mills.

KOMINUTERS. These are modifications of the ball mills, having drums of the same diameter and of about twice the length and capacity of the ball mills. The other modiness for finished cement or for burning. When working on raw material, it is generally necessary to crush the rock into fragments smaller than those used in feeding ball mills. The mill is driven from a pulley at the top, revolving on a vertical axis. The power is transmitted to a vertical shaft, which is hung from a universal joint inside the pulley and is free to move in any direction at the bottom. A crushing roll is rigidly connected to the bottom of the shaft.

When the pulley revolves, the crushing roll is thrown off center, and revolves against



I-18-40-1662/3-K-440 volt motors driving ball mills in the raw material mill. Universal Portland Cement Co., Plant No. 4. There are nine of these mills together, and very satisfactory results have been obtained by this type of slow speed drive, which eliminates one gear reduction

fications apply to the method of discharge and do not affect the essential features.

TUBE MILLS. The tube mill consists of a cylinder 20 to 22 feet long and 5½ to 5 feet in diameter, filled with flint pebbles, generally imported from Europe. These mills take the output of the ball mills—either raw material or clinker—and grind it to the desired fineness for burning or for finished cement. In their general features they are similar to the ball mills, and should be either belted or geared to a motor having a high starting torque.

GRIFFIN MILLS. These mills are used for grinding clinker or rock to the required finea fixed ring or die with a centrifugal force of about 6000 lbs. pressure. The grinding is done between these two surfaces. Two distinct actions on the material to be ground are obtained; the roll revolves against the die in the direction of the pulley, and this contact causes the roll and shaft to revolve around their own axis in an opposite direction. These mills are best adapted to belting, and may be driven from a vertical motor, or a horizontal motor with a quarter-turn belt.

The Griffin mill is manufactured in two sizes, 30 inch and 36 inch, designated according to the diameter of the ring against which the crushing roll revolves. A new mill has been brought out by the manufacturers, called a Three Roll Griffin mill. This is similar in its action to the standard mill, but, as the name implies, has three crushing rolls instead of one.

FULLER-LEHIGH MILLS. These are commonly called Fuller mills. They are used on the same material as the Griffin mill described above, and the grinding is done by four unattached chilled-iron balls about 9 inches in diameter, that are propelled by four equidistant horizontal arms or pushers radiating from a vertical central shaft. The orbit is a circular die against which the balls exert great pressure, since they weigh about 112 lbs. each and revolve at about 210 r.p.m. The main shaft is driven from a pulley mounted at the bottom, below the grinding level.

This mill, like the Griffin, may be belted to a vertical motor, or to a horizontal motor with a quarter-turn belt.

KENT MILLS. These mills will grind clinker to the required fineness for finished cement, or they may be set to give a coarser output for use in connection with tube mills for further grinding. When used on raw material, they will grind to the required fineness for burning. The output of an ordinary crusher is generally further reduced in size before feeding into the Kent mill.

The essential features of this mill consist of a ring revolving on a horizontal axis, with three rolls revolving inside, pressed by springs against its inner surface. Centrifugal force carries the material to be ground in a layer about an inch thick around the inner face of the ring, where it passes between the ring and the rolls.

These mills are driven from two pulleys, one at each end, and are very well adapted to belting to a motor that has two pulleys and an outboard bearing; and which is provided with a sliding base under the motor and outboard bearing so that the slack of both belts can be taken up simultaneously. The Kent mill is also furnished with one pulley if desired.

ROTARY KILNS. The raw material, properly mixed, is fed into rotary kilns and burned. These kilns vary from 60 to 170 feet in length but it is doubtful if any future installation will contain kilns shorter than 100 feet.

In its usual form, the kiln consists of a cylinder 6 to 8 feet in diameter, constructed of sheet steel $\frac{1}{2}$ to $\frac{4}{16}$ inches thick, lined with fire brick. The cylinder is supported at a slight angle from the horizontal on two or more rolled steel tires, each of which revolves on four heavy cast steel rollers mounted in pairs on a rocker.

The fuel used is generally powdered coal, which is forced into the lower end of the kiln by compressed air. The flame passes through the entire length of the kiln and the gases are discharged into a stack at the upper end. The raw material is fed into the upper end of the kiln by a water-jacketed screw conveyor, and gradually rolls down the entire length, being discharged at the lower end into a rotary clinker cooler, or directly into a bucket conveyor.

The speed of the kiln varies from $\frac{1}{2}$ to 3 r.p.m. in the various sizes. In the 150 ft. kilns in the Edison Portland Cement Company's plant, the material takes about $1\frac{1}{2}$ hours to pass through. Rotary kilns are driven by a circular rack situated generally at the middle, and connected by a train of gears either to a pulley to which the driving motor is belted, or to a pinion on the motor shaft.

A rotary kiln is the only machine of any importance in a cement plant which requires two or more speeds. The general practice is to use variable speed Form M induction motors, with a drum controller and resistance, capable of operating continuously at any speed between $\frac{1}{2}$ and normal. In a number of plants a constant speed, Form K motor is used to drive the kiln line shaft, to which all the rotaries are connected. A clutch and gear shaft is installed with each kiln, so that any

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one of the kilns can be connected or disconnected independently of the others and operated at either of two fixed speeds. Another method is to use constant speed motors for driving, interposing a mechanical speedchanger between the driving shaft and the kiln.

MISCELLANEOUS. The machines described above perform the most important of the cement operations. In addition to these, however, there are numerous auxiliary operations. Among the other machines are the belt, bucket and screw conveyors, fans, air compressors, coal crushers and pulverizers (a good many of the machines used in grinding cement are suitable for grinding coal), pumps, driers and rotary coolers. The driers and coolers are generally built on the same plan as the rotary kilns. All of these auxiliary machines are perfectly adapted to electric motor drive.

The Power Station

In the present stage of the cement industry, it is doubtful if any new plant can be profitably operated with a capacity of less than 1500 barrels per day. Results obtained from a great many cement plants, indicate that the horse-power necessary to operate varies from 0.8 to 1.2 h.p. per barrel per day. For the smallest practicable plant, this would indicate about 1500 h.p. Unless electric power can be bought at an exceptionally low price, it will be found cheaper in the end to install a complete generating plant to furnish this power. Besides the factor of economy, this will eliminate all chances of a shut down of the plant resulting from exterior causes.

The load of a cement mill is steady, and its load factor high, in fact in many cases the average horse-power developed is greater than the normal capacity of the generating units. For industrial conditions, when the load is steady and can be closely calculated, it is a decided economy to install generators rated according to the maximum output. The General Electric Co. is prepared to furnish turbine units rated on this principle. For a 1500 barrel plant, 2 ATB 750 kw. 1800 r.p.m. 440 volt 60 cycle turbo generators will be ample, and will be worked constantly at their highest efficiency. These generators are a modification of the 500 kw. unit of the same rating, and sell at a small advance over the standard 500 kw. price. They are designed especially for the low power factor load caused by induction motors and will give the rated output continuously at 80 per cent. power factor.

The General Electric Company has lately equipped with turbo generators the Fordwick Cement Company, the United States Portland Cement Company and the York Portland Cement Company. From Mr. Elbert Walker Shirk, the owner of the U. S. Portland Cement Company, the following unsolicited statement has been received.

"The 800 kw. turbine, now in operation, is giving splendid satisfaction, and there is no question in my mind but that this type of power equipment is far and away the best for cement mill practice. We have had absolutely no difficulty of any kind or description in starting, or operating this machine, and from our experience so far we are inclined to think that when once properly adjusted, the Curtis turbine will practically run without mechanical attention indefinitely."

The best guarantee for any apparatus is a satisfied customer. There is probably no one in this country interested in the cement business who is not familiar with the chain of plants in the United States and Canada known as the "Cowham System." These plants, which comprise the following, have been financed, installed and operated by Mr. W. F. Cowham of Jackson, Mich., through the Cowham Engineering Company, of which he is President:

Southern States Portland Cement Co., Rockmart, Ga.

Peninsular Portland Cement Co., Cement City, Mich.

Western States Portland Cement Co. Independence, Kan.

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Northwestern States Portland Cement Co., Mason City, Iowa.

National Portland Cement Co., Durham, Ontario.

International Portland Cement Co., Hull, Quebec.

These plants have all been installed throughout with General Electric apparatus, the Canadian plants being equipped through the Canadian General Electric Company. To the four plants in the United States only, the General Electric Company has supplied over 10,000 h.p. in motors and over 8000 kw. in generators, besides switchboards and cable. In giving us a list of this apparatus, Mr. W. J. Maytham, Chief Engineer of the Cowham Engineering Company, says:

"We have had excellent results with all the apparatus mentioned above, especially considering the extremely severe use to which it has been subjected. As you know, we run our mills 24 hours a day and seven days a week, and sometimes run a machine weeks without stopping. We believe your apparatus to be the best obtainable."

TABLE OF HORSE-POWER, OUTPUT AND SPEED

(For some of the figures contained in the following table, we are indebted to Mr. Richard K. Meade's treatise on Portland Cement.)

	1		Revs. F	Per Min.		Output	in Tons		ur	
Туре	Size	H.P. to Drive	Pulley	Main Shaft	Hard Lime.	Cmt. Rock	Mari Clay	Clin- ker	Coal	Remarks
Gyratory Crusher *	5D	25-40	400-450	200	20-30	25-35				Vertical shaft, horizontal driving pulley, output passing 1 in, screen
Gyratory Crusher * Ball Mill †	6D 7		400-450 125	200 2123	30-40 3-5	30–50 4−6		2] -3		Horizontal; fed from crusher or kiln, output passing No. 16 mesh
Ball Mill †	8	40-50	125	21-23	4–7	5-8		3] -5	!	Horizontal: fed from ball mill.
Tube Mill †	5'x22'		180	21-27	3-4	4-6	8-12	$2\frac{1}{3}$ -3	2 2+	95% output passing No. 100 mesh
Tube Mill † Kominuter †	51/x20' No. 66		180 160-175	21-27	4-6 5-7	58 6-8	10–15	51-7	23	Similar to ball mill
Griffin Mill ‡	30″	25-28	190–200	190–200	11-21	2–3		2– 3	11-2	Vertical; fed $\frac{1}{2}''$ crush. rock or clinker, 95% output passing No.
Griffin Mill ‡	36″	30-35	135-150	135–150		1				100 mesh
Griffin 3 Roll ‡	30″	40	150	150	4–5	5-6			4-6	
Fuller Lehigh Mill ‡		30-50	210	210	3-3 1	$3\frac{1}{2}-4$			21	Vertical; feed and output same as Griffin mill
Kent Mill ‡		25-30	180-220	180-220	3-4	3] -4		31-4	3-4	Horizontal; feed and output same as Griffin mill
Type	Length	H.P. to Drive	Revs. I	Per Min.	(Output i	n Barre	ls Per D	ay	
Rotary Kiln §	60 ft.	10-15	1-	-3			250			
Rotary Kiln §	80 ft.	10-15	1-	-3			300			
Rotary Kiln §	100 ft.	15-20	1.	-2			450			
Rotary Kiln §	120 ft.	15-25	1.	-2			580			
Rotary Kiln §	150 ft.	2025	1	-1			740			
Rotary Kiln §	170 ft.	20-30	1	-1			860			

* Starts light when empty; overload torque at starting if hopper contains rock.

† 80 to 100 per cent, overload torque necessary for starting.

1 Starts light.

\$ Starts with 50 to 70 per cent. overload torque.

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Company	Class *	No. Motors	H.P.	No. Generators	Kw.
Etna Portland Cement Co., Fenton, Mich.	D. 220	5	230	3	280
Lipha Portland Cement Co., Alpha, N. J.	D. 125	· ·		2	57
Alpena Portland Cement Co., Alpena, Mich.	D. 117	1	10	2	45
tlas Portland Cement Co., Northampton, Pa.	D. 500	4	185	1	225
		T	100	1	120
Blanc Stainless Cement Co., Allentown, Pa.	D. 500	~	127.5	I ▲	120
Sonneville Portland Cement Co., Siegfried, Pa.	D. 500	5			
Buckhore Portland Cement Co., Manheim, W. Va.	D. 250	1	25	1	75
California Portland Cement Co., Colton, Cal.	A. 440–50	7	250		
Continental Portland Cement Co., St. Louis, Mo.	A. 440–26	13	1625		
Coplay Cement Co., Coplay, Pa., Mill "B"	D. 500	8	485		
Coplay Cement Co., Saylors, Pa., Mill "C"	D. 500	7	355		
Dexter Portland Cement Co., Nazareth, Pa.	D. 250	9	277.5	3	275
Idison Portland Cement Co., Stewartsville, N. J.	D. 250-500	41	911	4	2580
fordwick Cement Co., Fordwick, Va.	A. 440-25	1	50	4	1670
erman American Portland Cement Co., La Salle, Ill.	A. 220-60	34	390		
terman ministrant i orthand cement ool, Da cane, m.	D. 115 }	0.2		3	154
Hens Falls Portland Cement Co., Glens Falls, N. Y.	A. 550-40	21	892	, v	
Heat Northern Portand Cement Co., Marlborough, Mich.	D. 230	75	1190		
Helderberg Cement Co., Howes Cave, N. Y. (Switchboard)	A. 440-60				
Hudson Portland Cement Co., Hudson, N.Y.	D. 250	3	450		
llinois Steel Co., S. Chicago, Ill. (old "Rookery" plant)	D. 250	2	13		
			13		
ola Portland Cement Co., Dallas, Texas	A. 400-25	2			000
chigh Portland Cement Co., Ormrod, Pa., Mill "A"	D. 250	3	255	1	220
chigh Portland Cement Co., Ormrod, Pa., Mill "D"	D. 250	3	271	1	250
chigh Portland Cement Co., Mitchell, Ind., Mill "G"	A. 550-40	4	675	1	500
ehigh Portland Cement Co., Fogelsville, Pa., Mill "H"	A. 550-40	11	885	1	600
os Angeles Aqueduct Cement Co., Los Angeles, Cal.	A. 440-60		1	2	1500
lichigan Alkali Co., Wyandotte, Mich.	D. 110			1	40
Jazareth Cement Co., Nazareth, Pa.	A. 550-60	36	1557	3	1000
Vewaygo Portland Cement Co., Newaygo, Mich.	A. 440-25	24	625	1	300
Northwestern States Portland Cement Co., Mason City, Ia.	A. 550-25	80	4105	3	3000
Pacific Portland Cement Co., Solano Co., Cal.	A. $2080 \\ 440 $ 60	49	3520		
			1635		1405
Peninsula Portland Cement Co., Cement City, Mich.	A. 550-25	39	1000	3	. 1425
Pennsylvania Cement Co., Bath, Pa.	D. 250			1	50
Portland Cement Co. of Utah, Salt Lake City, Utah	A. 2080–60	9	753		
andusky Portland Cement Co., Bay Bridge, Ohio, Plant No.1				1	30
Sandusky Portland C. Co., Syracuse, Ind. Plant No. 2.	A. 440–25	2	20		
Sandusky Portland Cement Co., Dixon, Ill., Plant No. 3.	A. 440–25	84	3500	ļ	
San Juan, Portland Cement Co., Chittenden, Cal.	A. 550-60	45	3280		
Southern California Portland Cement Co., Crestmore, Cal.	A. 440-50	48	2610	ι Ι	
Southern States Portland Cement Co., Rockmart, Ga.	A. 550-25	45	1850	2	1360
. B. Speed, Louisville, Ky.	D. 220				45
Superior Portland C. Co., Seattle, Wash. (3-375 Kw. trans.)	A. 440-60			4	1250
J. S. Cement Co., Bedford, Ind.	A. 440-25	4	120	2	1200
J. S. Portland Cement Co., Florence, Col.	A. 440-30	19	482	1	1900
Jniversal Portland C. Co., Buffington, Ind., Plant No. 4.	A. 440-25	140	_		
			5740		
Jniversal Portland C. Co., Pittsburg, Pa., Plant No. 5.	A. 440-25	108	3533		
Western States Portland Cement Co., Independence, Kan.	A. 550-25	58	2750	3	2600
fork Portland Cement Co., Portsmouth, Ohio	A. 440–60	31	1315	1	500

GENERAL ELECTRIC APPARATUS SOLD TO DOMESTIC CEMENT MANUFACTURERS TO DATE

* Under the heading "Class," the symbols have the following meanings: D-Direct Current. A-Alternating Current. 3-Phase. First Number-Voltage. Second Number-Frequency.

GENERAL ELECTRIC COMPANY

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

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