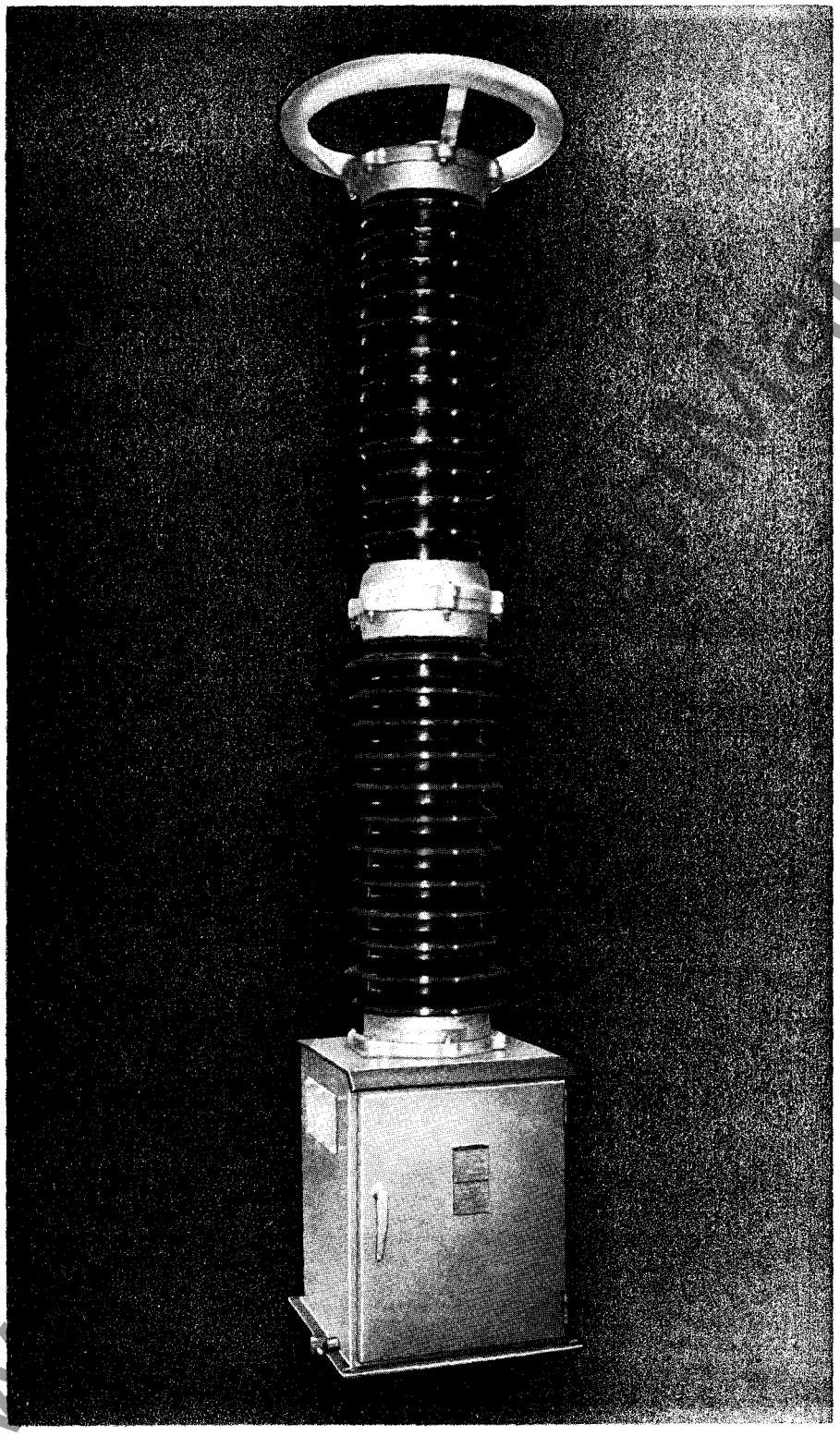
Westinghouse

Coupling Capacitor Potential Devices

High Capacitance, Factory Adjusted
Types PC-5 and PCA-5



Application

Designed to eliminate field adjustment of coupling capacitor potential devices, the PCA-5 is the most suitable source of low voltage power for the operation of relays, indicating lights, and instruments.

Elimination of the need for field adjustment makes this coupling capacitor potential device a more versatile piece of equipment allowing the user complete freedom to change burdens and still maintain 1% accuracy.

Increasing the capacitance of the PCA-5 to approximately twice that of the PCA-4 has resulted in lower insertion losses and higher signal strength as well as extending the use of wide band tuning units.

The PCA-5 represents years of development by Westinghouse of more versatile, reliable coupling capacitor potential devices. This continuing program of research was responsible for the introduction by Westinghouse of the first metering accuracy potential device, and the same furndamental design principles have been followed in developing the PCA-5.

Customer Benefits

Factory Adjusted: Absolutely no field adjustments have to be made to maintain 1% accuracy over the full 0 to 200 volt ampere burden range. This means that, unlike older style potential devices, the PCA-5 requires no time consuming recalibration every time the burden is changed.

High Capacitance: With a capacitance approximately twice that of the PCA-4, the PCA-5 offers two distinct advantages. First, a higher capacitance results in a lower signal insertion loss; and second, with this high capacitance, it is possible to use a hi-coupler instead of a resonant type line tuner. Use of the hi-coupler allows more than two carrier channels to be simultaneously coupled to the power line thus making a more flexible carrier system for telemetering and supervisory type functions.

Encapsulated Components: Both the transformer and reactor of the PCA-5 are epoxy encapsulated. This encapsulation results in components which are impervious to moisture – another result of the Westinghouse program to develop more reliable coupling capacitor potential devices.

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New Information
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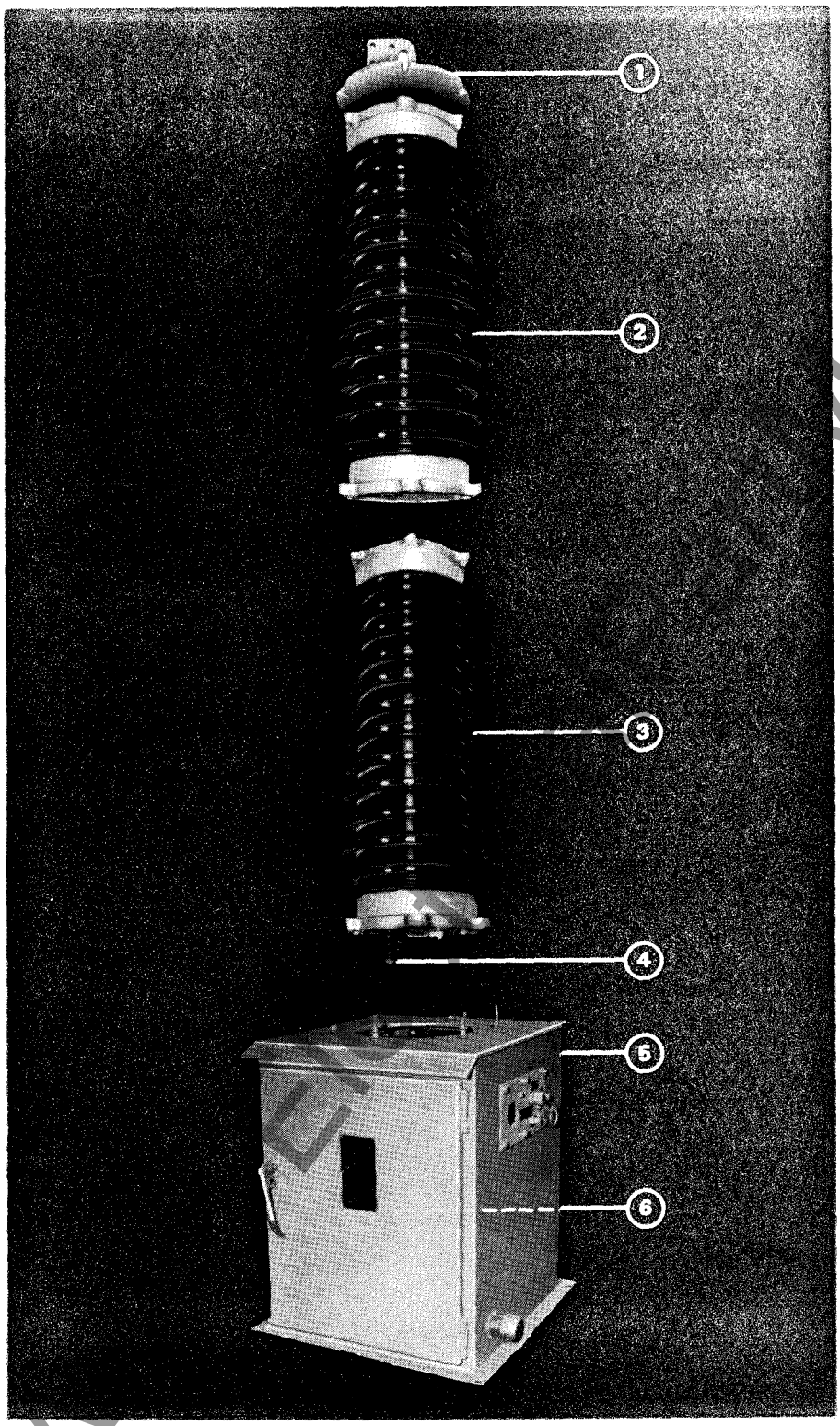

Construction

Type PC-5 and PCA-5

1 Top Cover

Each coupling capacitor stack has a top cover with a clamp-type connector suitable for either vertical or horizontal connection of line cable. Terminals for aluminum or copper cable are available.

When one end of a line trap is to be mounted on the top of the coupling capacitor stack, a different top cover is supplied (see figure 4, page 6) which has mounting holes on either a 3-inch or 5-inch bolt circle as specified by the purchaser.

2 and 3 Coupling Unit

Each individual coupling unit consists of a wet-process porcelain tube with fitted end castings designed to effectively seal the interior. This tube contains the capacitor element which consists of a large number of individual working sections connected in series.

The individual working sections are made up of an assembly of special Inertex paper and aluminum foil and connected in such a manner as to give negligible inductance. After assembly, the capacitor element is vacuum treated to remove all traces of moisture and then impregnated with degassed mineral oil. The characteristics of this insulating material are such as to insure minimum change in capacitance with variations in temperature.

Coupling capacitor assemblies are designed with insulation levels equivalent to similar apparatus such as circuit breaker or transformer bushings and are connected directly to the line.

The individual capacitor sections within the coupling unit are designed to withstand momentary voltages far in excess of the normal operating voltages. The outside creepage path and striking distance of the porcelain tube are so coordinated with the internal insulation that the individual capacitor sections are not damaged when the coupling unit is subjected to voltages sufficient to cause external flashover. The internal capacitance of the complete coupling stack dominates the capacitance to surrounding objects and forces a uniform voltage distribution along the coupling units. The flashover rating of the stack is, therefore, approximately the sum of the flashover ratings of the individual coupling units making up the stack. The capacitors are so designed that the application of impulse voltage will not damage the internal working

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elements or cause a change in their electrostatic capacitance.

Above 115 kv, the coupling capacitor consists of two or more coupling units bolted together to form the series capacitance between line and ground.

Upper coupling units have internal connections terminating in the end castings and external connections are made merely by bolting one unit to the bottom coupling unit and additional units to each other.

The lower coupling unit in each stack is bolted directly to the base housing. Two porcelain bushings located on the bottom of the lower coupling unit are used to connect the potential device circuit to the tap capacitor which is the supply for the potential device. Carrier accessories are also connected to these bushings.

(4) Tap Capacitor

The PCA-5 has the tap capacitor located in the lower coupling unit instead of the base housing as in earlier designs. This construction results in a ratio error which is less than that of the older type potential devices and is practically independent of temperature.

(5) Base Housing

The base housing is a weatherproof, welded steel enclosure. It serves as a mounting base for the coupling capacitor stack and a housing for the carrier accessories and/or potential device. A potential device may be added to this cabinet at any time after a coupling capacitor is installed.

Each base housing is supplied with a clamp type ground terminal suitable for #2 solid to 800 mcm copper cable and has provision for entrance of the carrier lead from either side. One side is provided with a removable plate with the carrier grounding switch and either a 1¼" threaded nipple for conduit connection when coaxial cable is used or lead-in bushing when single-conductor high impedance cable is used. A blank plate containing a breather port is mounted on the opposite side.

(6) Potential device circuitry for the PCA-5, pictured at right, is a removable tray containing components shown schematically on page 4. This tray of components and a ground switch may be added at any time to change a PC-5 to a PCA-5. The PCA-5 can then be calibrated using either another potential device or a wound potential transformer as standard, or by using the low voltage equivalent circuit method described in the instruction book.

Carrier Accessories (see Figure 1)

All PC-5 coupling capacitors include these carrier accessories and any PCA-5 coupling capacitor potential device may be ordered with them.

(7) Carrier Drain Coil

The drain coil is connected between the coupling capacitor and ground to provide a low-impedance path for power frequency current and, at the same time, prevent dissipation of the carrier frequency energy to ground. This coil is designed to have a minimum impedance of not less than 20,000 ohms over the carrier frequency range of 30 to 200 kHz and not over 300 ohms at power frequency.

(8) Carrier Gap

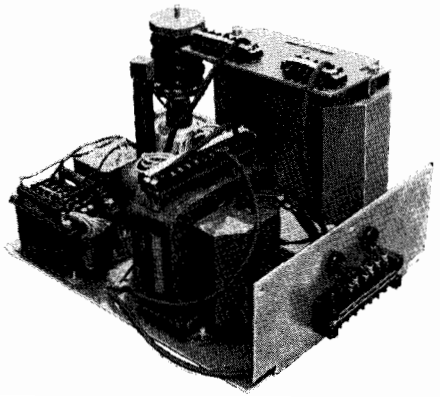
The gap is connected in parallel with the drain coil to prevent excessive surge voltage from exceeding coil ratings. The gap sparkover value is coordinated with dielectric strength of the drain coil. Gap sparkover does not interfere with operation of the potential device when used.

(9) Carrier Lead-in Bushing

Either a 1¼ inch threaded nipple or a porcelain lead-in bushing can be supplied depending on whether single conductor high impedance cable or coaxial cable will be used.

(10) Carrier Grounding Switch

The switch is normally open. During inspection and adjustments, switch is closed to remove voltage from the drain coil. The operating handle for the switch is on the outside of the base housing.



Mounting

Coupling capacitors are normally supplied for base mounting by means of six mounting holes located on the bottom casting of the coupling. A design suitable for rigid suspension mounting is also available.

Corona Ring

A corona ring is supplied with each type PC-5 and PCA-5 capacitor rated 230 kv and above.

Line Coupling Tuners

With the high capacitance of the PCA-5, either the type JZ resonant tuner or the hi-coupler may be used. In general, the hi-coupler will be used with coupling capacitors having a capacitance greater than .002 mfd and when more than two channels are to be simultaneously coupled to a power line.

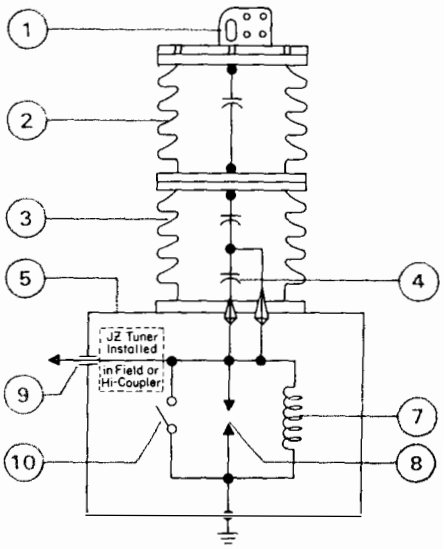


Figure 1: PC-5 Coupling Capacitor Schematic Diagram

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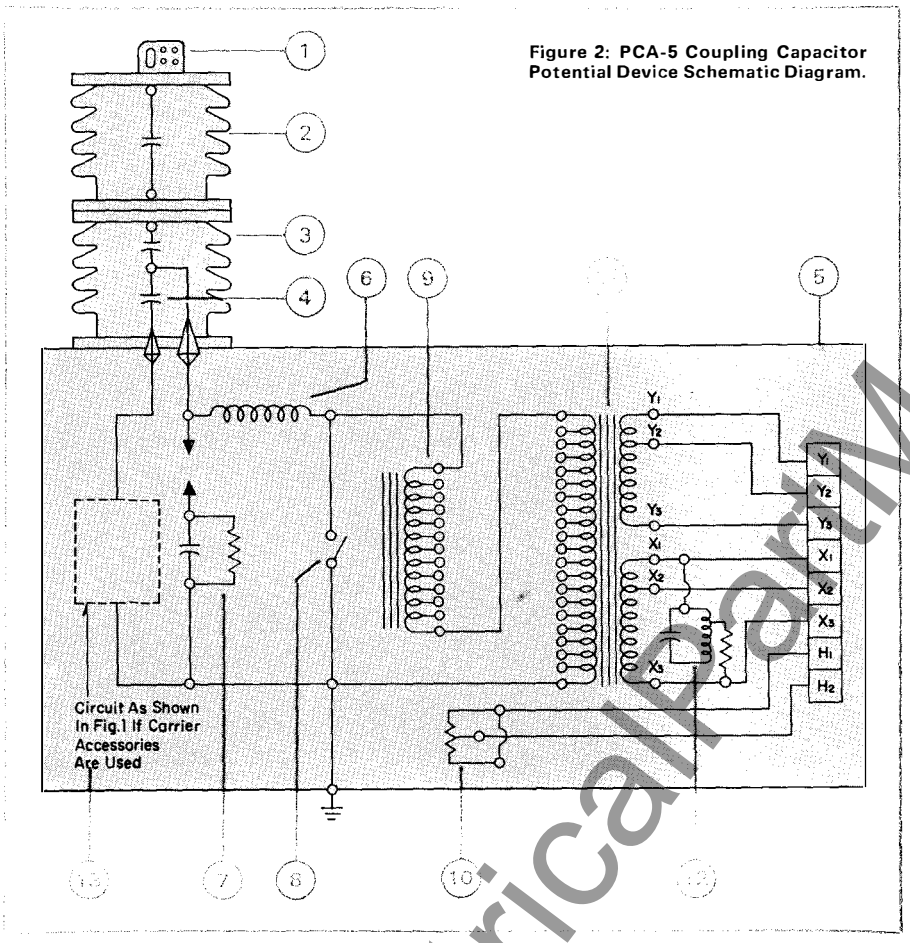

Figure 2: PCA-5 Coupling Capacitor Potential Device Schematic Diagram.

(1) Top Cover

(2) Coupling Capacitor – Upper Unit

(3) Coupling Capacitor – Lower Unit

(4) Tap Capacitor

The potential device voltage supply is a section of the stack capacitor tapped at 5 kv. The voltage across this section is brought through two porcelain bushings into the base housing. Older style potential devices developed this supply voltage across an auxiliary capacitor located in the base housing external to the porcelain housing of the stack capacitor. By locating the tap capacitor in the same housing as the stack capacitor and manufacturing them of the same material, both will be affected equally by environmental changes. This design, unlike previous designs, results in a supply voltage which is a constant ratio of the line-to-ground voltage.

(5) Base Housing

(6) Choke Coil

The choke coil is identical to the drain coil described on page 3. Both coils perform the same function; i.e. they present the carrier signal with a high impedance path while allowing 60 Hz energy to pass. A choke coil is needed only with the PCA-5 not with the PC-5.

(7) Protective Circuit

A spark gap, in series with an R-C combination, serves to protect the potential device from momentary overvoltages. This gap is set to spark over at approximately 10 kv. When the gap sparks over the capacitor-resistor combination is energized and will keep about 5 kv on the transformer primary. This will prevent false relay tripping due to a momentary disturbance on the line.

(8) Potential Ground Switch

Connected between the high voltage bushing and ground, this hookstick-operated switch is used to de-energize the potential device for maintenance. Using the ground switch permits safe servicing of the potential device without disturbing carrier coupling or de-energizing the high voltage line.

(9) Compensating Reactor

In the PCA-5 potential device the compensating reactor is located in the primary circuit of the transformer. With this circuit configuration, unlike that of older devices, it is possible to tune the compensating reactor so that its reactance equals that of the stack capacitance resulting in a voltage input to the transformer which is in phase with the line-to-ground voltage of the power line.

(10) Heater

Every PC-5 and PCA-5 is equipped with a 12.5 watt, 125/250 volt heater. The purpose of this heater is to keep moisture from condensing on the components in the base housing. The heater may be energized from the output of the potential device but if the potential device is left de-energized for a long period of time, the heater should be energized from an external source.

(11) Transformer

The transformer has two 115 volt secondary windings, X and Y, both of which have a tap at 66.4 volts. Each winding will maintain an accuracy of ±1% from zero burden to its full rated burden with no field adjustment. The X winding has a burden capability of 200 va at .80 pf, the Y winding 100 va at .80 pf with a total simultaneous burden of 200 va at .80 pf. Both the transformer and compensating reactor shown in figure 2 are epoxy encapsulated. This construction makes these components impervious to moisture resulting in a longer life, more reliable coupling capacitor potential device.

(12) Ferroresonant Suppression Device

The PCA-5 incorporates a tuned RLC circuit to protect the potential device from the harmful effects of ferroresonant oscillations. When the applied frequency is 60 Hz, this circuit imposes a very low burden on the potential device. If either harmonic or subharmonic frequencies are present, however, the impedance of the L-C combination drops off sharply causing the resistor to act as a large resistive burden on the potential device which effectively damps out the oscillation before any damage occurs.

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(13) Carrier Accessories

Any PCA-5 may be ordered with carrier accessories or they may be installed in the field. Carrier accessories include one each of the following: drain coil, grounding switch, spark gap, lead-in bushing, and choke coil.

Fusing

Westinghouse makes no firm recommendation concerning fusing the secondary of the PCA-5 device. Permanent secondary faults, if allowed to persist, will damage the 5 kv transformer-reactor coils.

Where protective relaying and metering are involved, local practice will dictate whether fuses are to be used or not.

If a fuse is considered desirable, 5 ampere KAW Buss Limitron Fuses are recommended. Following is the time-current characteristic curve of this fuse and the rated thermal and short circuit currents for both the 67-volt and 115-volt windings.

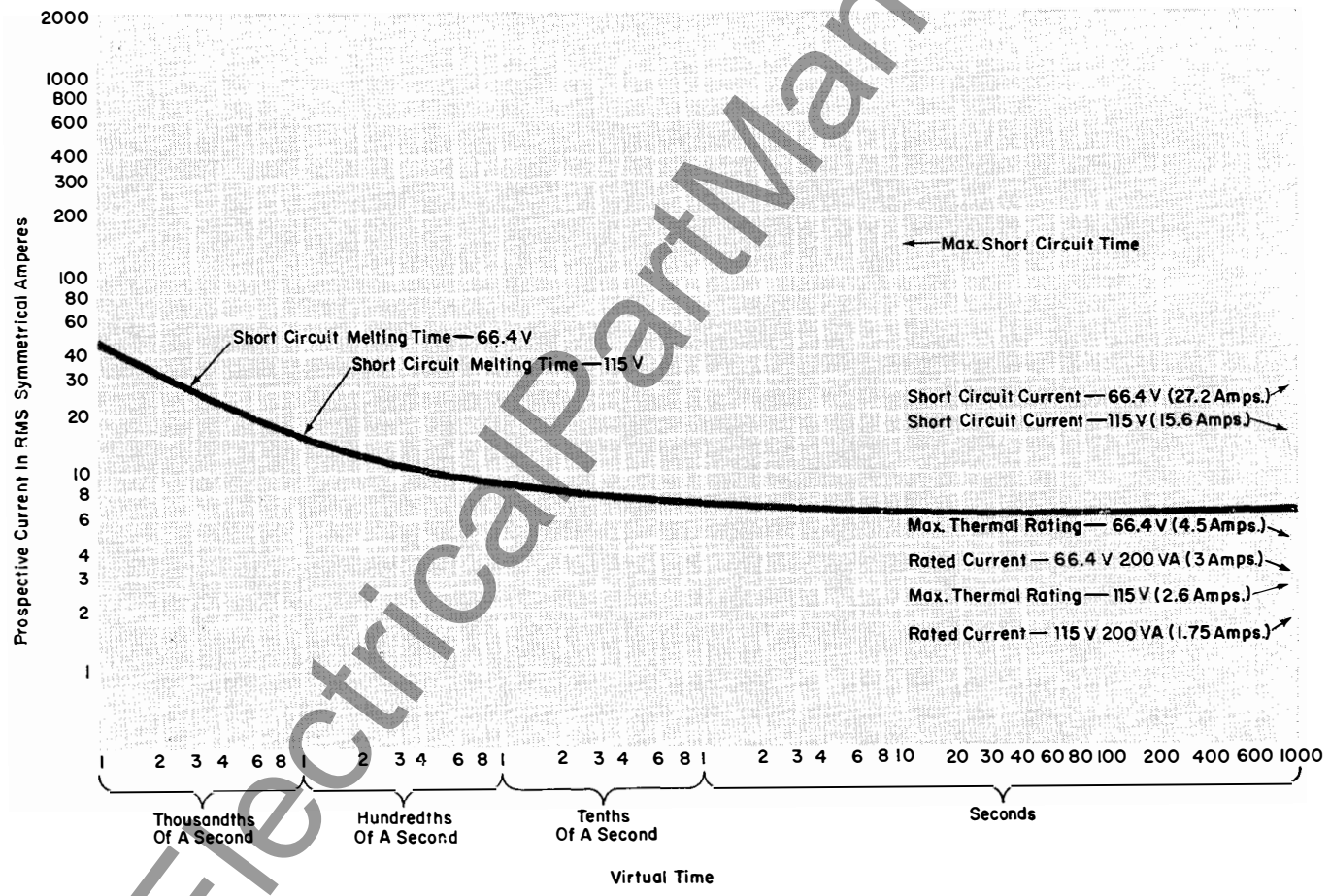

Figure 3: PCA-5 Recommended Fusing – 300 va thermal rating average melting time – current characteristic curve using KAW Buss Limitron Fuses, 5 ampere rating.

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Dimension in Inches (approximate)

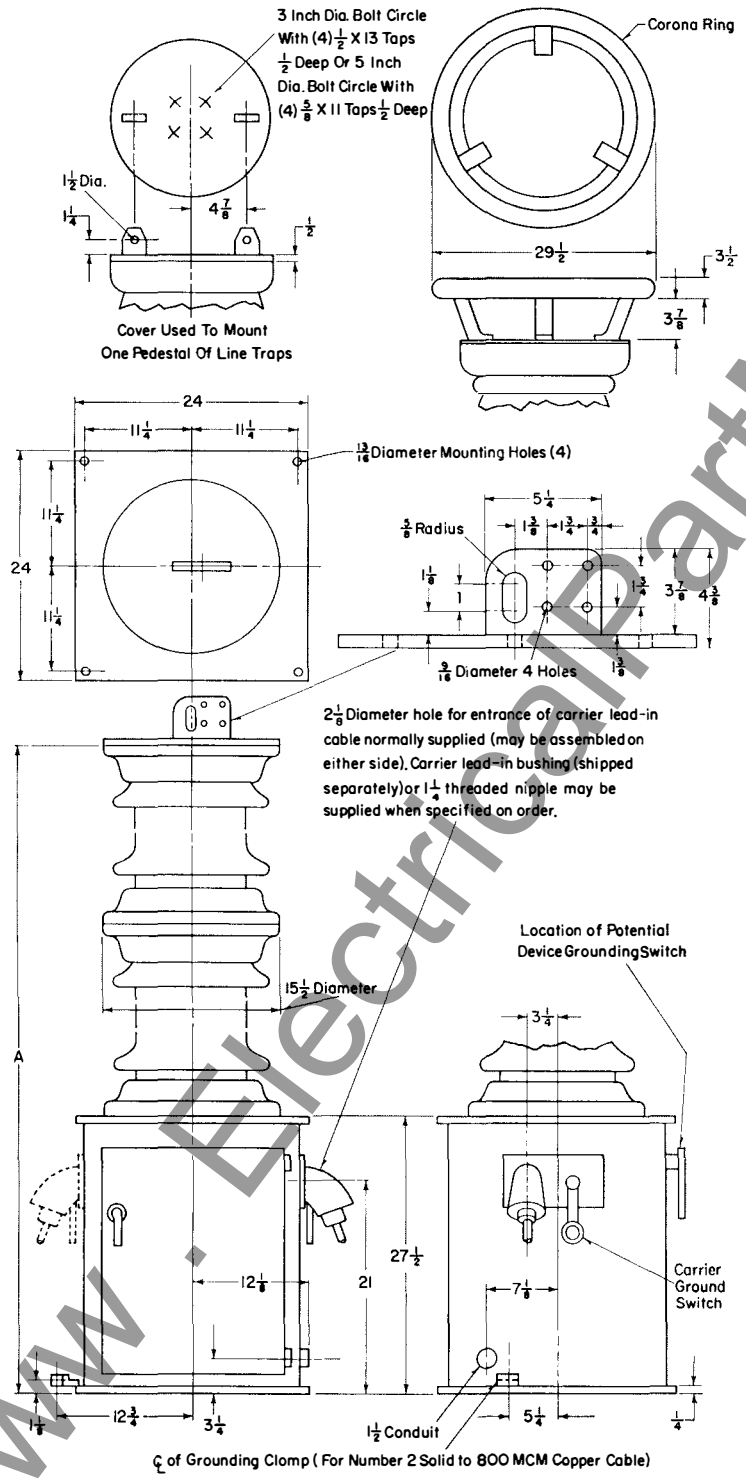

Figure 4: Outline Drawing of Type PC-5 Coupling Capacitor and Type PCA-5 Coupling Capacitor Potential Device.

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Stacking Information

Position in Stack	Coupling Capacitor Unit Style No. Brown Glaze	Coupling Capacitor Unit Style No. Light Gray Glaze	Unit Kv	Unit Lbs.	System Kv 34.5	46	69	92	115	138	161	230	287	345	500
Upper③	792C221A01	792C668A01	46	245	....	....	....	....	....	....	1	....	1	....	....
	792C221A02	792C668A02	69	280	....	....	....	....	....	1	....	....	....	....	....
	792C221A05	792C668A05	115	420	....	....	....	....	....	....	....	1	1	2	3
Lower③	792C221A10	792C668A10	34.5	200	1	....	....	....	....	....	....	....	....	....	....
	792C221A03	792C668A03	46	245	....	1	....	....	....	....	....	....	....	....	....
	792C221A04	792C668A04	69	280	....	....	1	....	....	1	....	....	....	....	....
	792C221A11	792C668A11	92	420	....	....	....	1	....	....	....	....	....	....	....
	792C221A06	792C668A06	115	420	....	....	....	....	1	....	1	1	1	1	1
Total Height Dimension A (inches)					48¼	52¼	56¼	71¾	71¾	85	96½	116	140¾	160¼	204½
Capacitance (Microfarads)					.020	.015	.010	.0075	.006	.005	.0043	.003	.0025	.002	.0015
Weight, Type PCA-5 (Pounds)③					525	570	605	745	745	885	990	1165	1410	1585	2005

② "Lower" unit is one which is mounted directly on top of base cabinet; "Upper" unit is any one which is mounted above the lower unit.

③ For PC-5, deduct 125 pounds.

Style Numbers

Rated System Voltage Kv	Capacitance in Microfarads	B. I. L. Kv Crest	PC-5 Coupling Capacitor Porcelain Lead-In	PC-5 Coupling Capacitor Conduit Connection	PCA-5 Coupling Capacitor Potential Device Without Carrier Accessories	PCA-5 With Carrier Accessories Porcelain Lead-In	PCA-5 With Carrier Accessories Conduit Connection
34.5	.020	200	507D093A25	507D093A55	507D098A85	507D098A25	507D098A55
46	.015	250	507D093A01	507D093A31	507D098A61	507D098A01	507D098A31
69	.010	350	507D093A03	507D093A33	507D098A63	507D098A03	507D098A33
92	.0075	450	507D093A05	507D093A35	507D098A65	507D098A05	507D098A35
115	.0060	550	507D093A07	507D093A37	507D098A67	507D098A07	507D098A37
138	.0050	650	507D093A09	507D093A39	507D098A69	507D098A09	507D098A39
161	.0043	750	507D093A11	507D093A41	507D098A71	507D098A11	507D098A41
230	.0030	1050	507D093A13	507D093A43	507D098A73	507D098A13	507D098A43
287	.0025	1300	507D093A15	507D093A45	507D098A75	507D098A15	507D098A45
345	.0020	1550	507D093A17	507D093A47	507D098A77	507D098A17	507D098A47
500	.0015	1800	507D093A19	507D093A49	507D098A79	507D098A19	507D098A49

Electrical and Mechanical Characteristics

Nominal System Kv (line to line)	Voltage Ratio Kv Line-to-Ground to 115 Volts Secondary	Voltage Ratio Kv Line-to-Ground to 66.4 Volts Secondary	Low Frequency Test (rms kv) 1 min. 10 sec. Dry	Low Frequency Test (rms kv) 1 min. 10 sec. Wet	Impulse Test BIL (crest kv)	Minimum Creep Distance (inches)	Nominal Capacitance Main Stack (mfd)
34.5	173/1	300/1	85	80	200	29	.020
46	231/1	400/1	110	100	250	36	.015
69	346/1	600/1	165	145	350	50	.010
92	462/1	800/1	215	190	450	86	.0075
115	577/1	1000/1	265	230	550	86	.0060
138	692/1	1200/1	320	275	650	100	.0050
161	809/1	1400/1	370	315	750	118	.0043
230	1155/1	2000/1	525	445	1050	172	.0030
287	1444/1	2500/1	655	555	1300	209	.0025
345	1732/1	3000/1	785	665	1550	258	.0020
500	2435/1	4350/1	930	830	1800	344	.0015

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Further Information

Prices: PL 39-620
Revenue Metering Device: DB 39-631

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