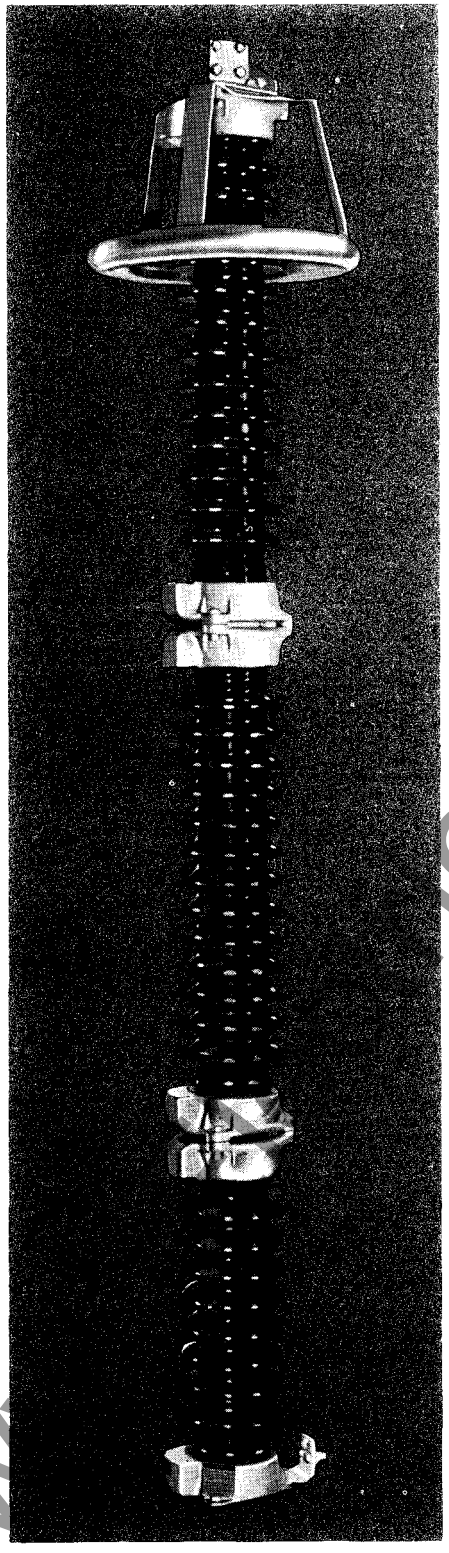
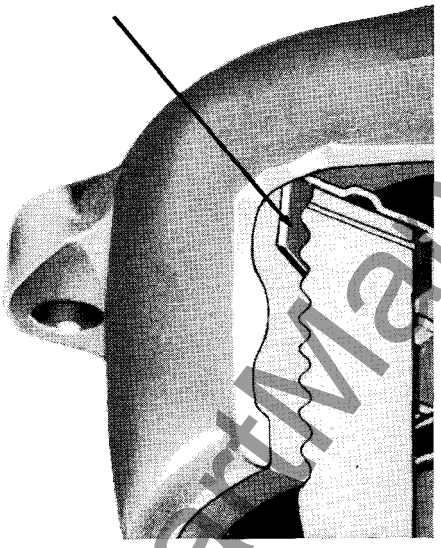
Westinghouse

Lightning Arresters

Intermediate Class, Type IVS
0 to 10,000 Feet Altitude
3 to 120 Kv Single Pole, Indoor-Outdoor



Lifetime . . . . Solder Sealed



Type IVS Arresters are the industry's only Intermediate Class Arresters with solder-sealed porcelain housings.

The solder-sealed arrester provides a sealing system far superior to conventional type gasket seals which can age, compress and permit entrance of moisture resulting in radio interference, eventual arrester failure and expensive outages.

In 1928 Westinghouse developed the method of solder-sealing metal to porcelain and has successfully proven this type sealing in service with over four million solder seals on arresters, capacitors and bushings.

Intermediate Type IVS Arresters (formerly Type LVS) have been completely solder sealed for over 27 years and, from the records, show the best performance of any arresters in the industry.

Solder sealing is a true hermetic seal obtained by the union of metal end caps with the porcelain (housing). This unique metal-to-porcelain bond is obtained by firing a platinum glaze onto the porcelain. The platinum glaze provides a medium for the fusion of the solder with the porcelain housing and the metal end cap. This hermetic solder seal is as strong as the porcelain, air and moisture proof, and provides positive and permanent protection.

Highest Creepage

Type IVS Arresters with deep porcelain skirts give the largest creepage (leakage) values available in all ratings 21 kv and higher. The greater external flashover and creepage distances are designed to assure that the arrester's insulation level of the porcelain housing is above that specified by standards and by customer requirements under both wet and dry conditions.

Strike and creepage distances of the Type IVS Arresters insure that the arresters will not flashover externally under any atmospheric condition before the internal gaps sparkover.

Pressure Relief Rating

The 25,000 amperes pressure relief rating of the IVS Arresters provides the largest safety margin available with any Intermediate Class Arrester. The Type IVS Arrester has been tested with fault currents in excess of 25,000 amperes RMS symmetrical with no porcelain shattering.

Arc transfer pressure relief is an important feature of the IVS design. In the remote event the arrester is damaged and fails; a unique system of exhaust ports deflect the hot ionized escaping gases toward each other and transfers the fault current arc to the outside of the arrester porcelain, thereby limiting internal pressure build-up and preventing arrester explosion.

Directing the ionized gases with the exhaust ports is required to prevent possible loss from flashover of adjacent bushings and equipment.

Another premium feature is the ability to withstand reclosing without explosion of the porcelain on an IVS Arrester which has already had a pressure relief operation. The porcelain may fracture and fall due to thermal shock (as permitted by standards), but there is no porcelain shattering within its pressure relief ratings.

Mobilarc™ Gaps

The IVS Arrester has gap elements similar to those used in the station class arrester. The Mobilarc Gap has a constant full strength magnetic field which is always present regardless of the current of the discharge and which instantly moves and motors the power follow current arc on the gap electrodes to give consistent sparkover and long arrester life.

March, 1970
Supersedes DB 38-130, dated December, 1967
E, D, C/1981/DB

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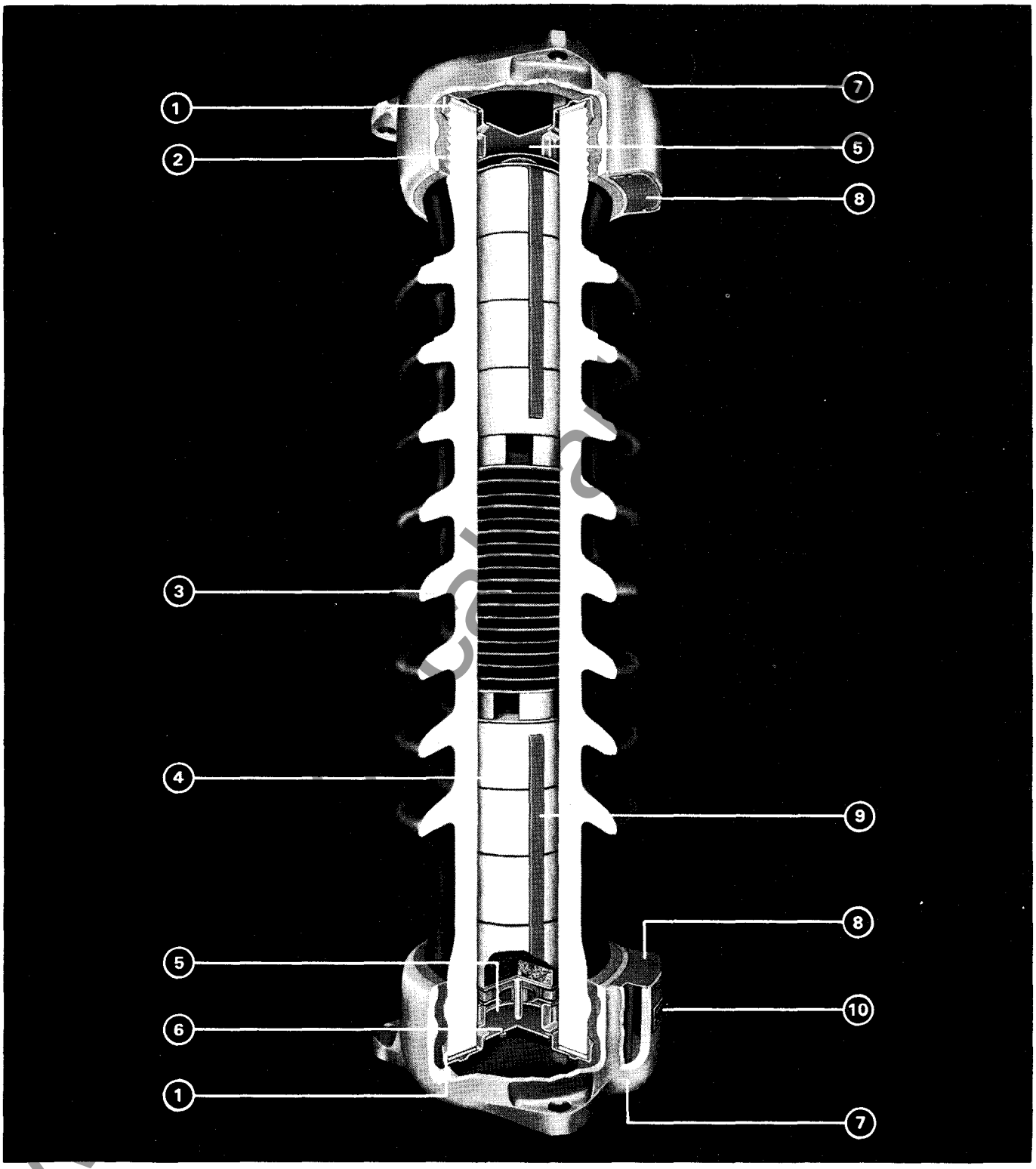

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Construction

1 Solder-Sealed End Caps

The exclusive Westinghouse hermetical solder-seal process of soldering stainless steel end caps to both ends of the porcelain, completely and permanently, protects all of the arresters' operating elements from moisture.

2 Mineralead Cement

Both end castings are securely cemented to the porcelain casting with the mineralead, which is a high melting point sulfur cement containing no corrosive components.

3 Mobilarc™ Gaps

The Mobilarc Series Gap contains a permanent ceramic ring magnet, radially magnetized, which is mechanically in series with the air gap. It provides a constant magnetic field in the gap which is always present at full strength regardless of the current of the discharge. Currents of over 100,000 amperes have been measured in the gaps with no effect on the retentivity of the magnets.

4 Autovalve® Blocks

All valve blocks are tested three times to insure low and consistent electrical characteristics and have the capacity to discharge lightning surges in excess of 100,000 amperes.

Two Surge Test: Every block is given a power follow test by energizing the block at 3,000 volts and then discharging two 10,000 ampere 8 x 20 surges.

Volt-Ampere Test: Each block is also given a 1,500 ampere 8 x 20 ms surge and the discharge voltage measured. Blocks which do not meet the required limits are discarded.

Durability Test: To prove durability, samples are selected at random from every batch of blocks and given a severe duty cycle test. Each sample block is energized at 3,000 volts and surged with 10,000 amperes 8 x 20 ms wave. To pass requirements, each block must withstand 30 such discharges. The samples used in the durability test are scrapped. If the test has been satisfactory, the batch of blocks is accepted; otherwise, the batch is rejected.

5 Diaphragms

A special diaphragm located at both ends of the arrester unit is one of the key elements in the Type IVS Arresters Pressure Relief System, which is tested with fault currents exceeding 25,000 amperes RMS symmetrical without porcelain shattering.

The bottom diaphragm and spark gap device assure pressure relief operation on low values of fault current by melting the diaphragm, venting the ionized gases, and relieving internal pressure.

6 Leak Test Rivet

Each IVS Arrester Unit is pressure leak tested at 15 pounds gauge dry nitrogen pressure to guarantee effectiveness of the seals.

7 Aluminum Alloy End Castings

Metal stamped in one end casting of each unit is a serial number which is coded to indicate month and year of manufacture.

8 Exhaust Port

The exhaust ports vent and divert the hot ionized gases produced in a failed arrester so that the fault current arc is transferred from inside to outside of the arrester in less than one-half cycle of fault current.

Directing the ionized gases is extremely important to prevent possible loss from flashover of adjacent arresters, bushings, bus supports, etc.

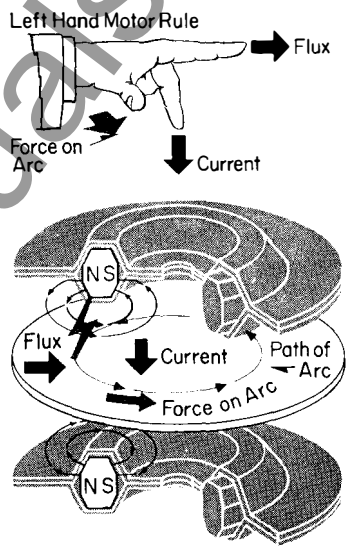
9 Stop Assemblies

The stop assemblies hold the blocks away from the porcelain and help safeguard the internal parts from shipping and handling shocks.

10 Stainless Steel Nameplate

The master nameplate identifies by type, style number, and voltage rating the complete arrester. It also shows the individual unit rating, style, and position in the pole.

Mobilarc Gap



Mobilarc Principle of Operation

The Mobilarc series gap contains permanent ceramic ring magnets which are radially magnetized. The magnets provide a constant magnetic field which is always present at full strength regardless of the current of the discharge.

The spark discharge takes place in the annular space indicated by the zigzag symbol above. When the arc is initiated it is at right angles to the magnetic field and is forced by this field to spin around on the brass electrode surfaces. Due to the rapid movement of the arc, the electrodes are not affected and maintain their original condition. Currents of over 100,000 amperes have been measured in the gaps with no effect on the retentivity of the magnets.

The gap electrodes are separated by high resistance spacers which fix the length of the air gaps and divide the voltage uniformly among the series gaps. Ceramic guard rings protect the resistance spacers from the spark discharge. In the center of each gap is a preionizing button made of rutile. At a certain threshold voltage, which is above the rated voltage but below the sparkover voltage of the gap, ionization forms between the rutile and the plate. This generates a radiation in the wave band of ultraviolet which ionizes the gap space and insures low and consistent sparkover.

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Performance Characteristics and Tests

The cathode ray oscillograms and test data shown here verify that Type IVS Arresters are in accordance with ASA, IEEE and NEMA Standards for Intermediate Class Lightning Arresters.

Routine Tests

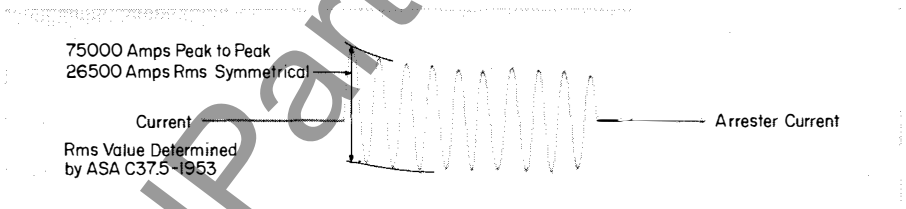
Each individual completely assembled lightning arrester unit is given the following tests:

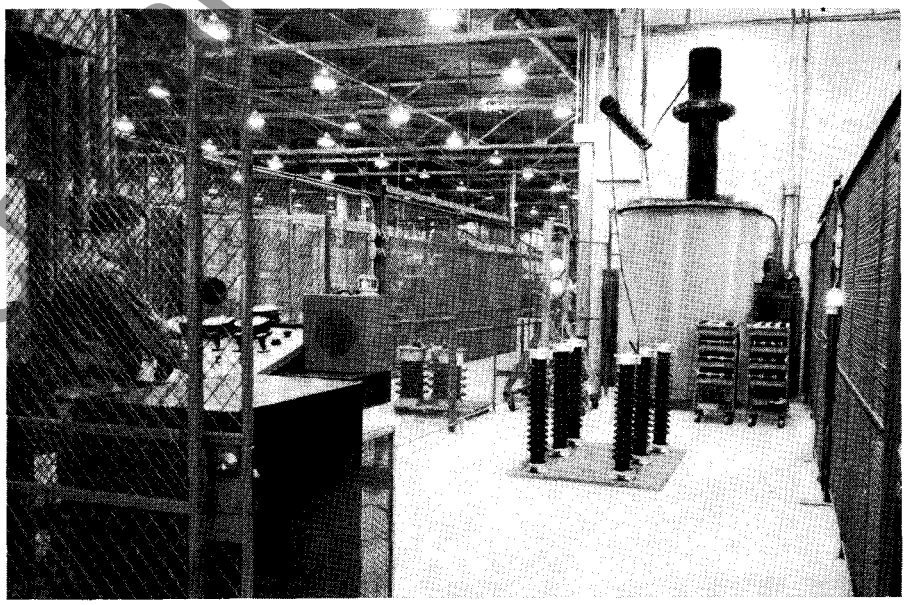
60 Cycle Sparkover Test: Each unit rating has minimum and maximum limits – the minimum limit is 1.8 times the voltage rating of the arrester unit.

Leakage Current Test: All arrester units are tested at rated voltage, and the leakage current values within specified ranges are accepted.

Radio Influence Test: Radio influence tests show that arresters will not cause objectionable radio influence when in service. Every arrester unit is checked at the radio influence test voltage as specified in NEMA Standards LA1-1965.

Safe Fault Current Test
Type IVS Lightning Arrester, 40 Kv, Pressure Relief Test





Testing Facilities

Lightning Arresters

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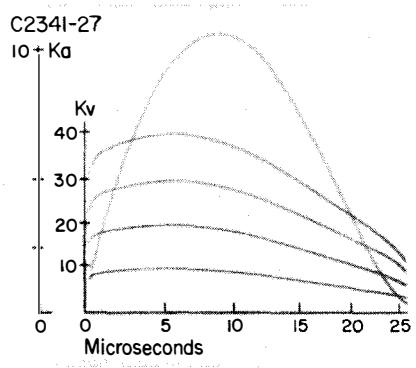
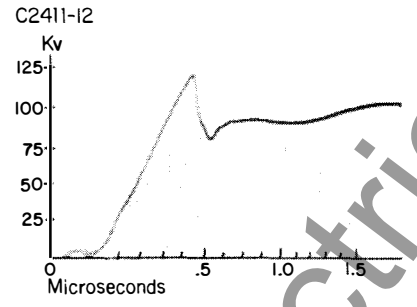
Discharge Voltage Characteristics
3-12 Kv; 10,000 Amperes
ASA Standard C62.1-7.3.2



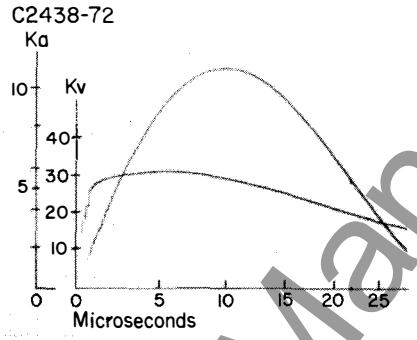
Discharge voltage characteristics for 3, 6, 9 and 12 kv arresters discharging a surge current greater than 10,000 amperes on 8 x 20 microsecond wave shape showing proportionality of characteristics to voltage ratings.

Impulse Sparkover – Front of Wave
36 Kv
ASA Standard C62.1-7.3.1

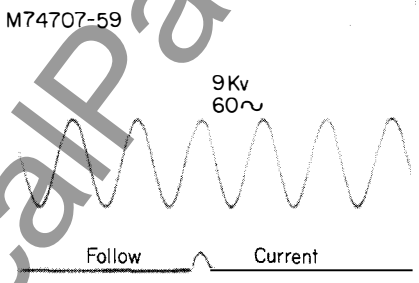


Impulse sparkover oscillogram for a 36 kv arrester on a voltage rising at a nominal rate of 100 kv per microsecond per 12 kv of arrester rating.

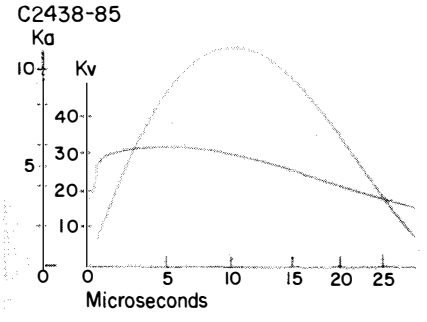
Duty Cycle Tests
9 Kv Arrester Discharge Voltage
ASA Standard C62.1-7.5



Before Test
Discharge voltage characteristics for a 9 kv arrester discharging a surge current greater than 10,000 amperes, 8 x 20 microsecond wave shape prior to duty cycle test.

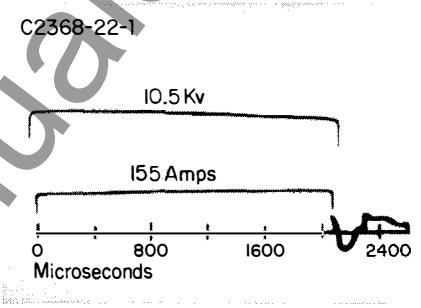


Operating Cycle
Follow current and power frequency voltage oscillogram for a 9 kv arrester under duty cycle test discharging a surge current greater than 10,000 amperes, 8 x 20 microsecond wave shape.

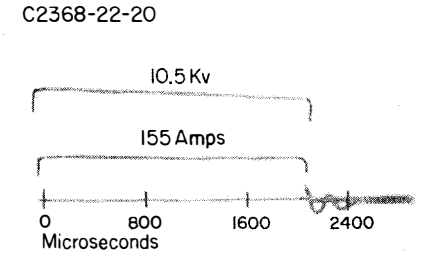


After Test
Discharge voltage characteristics for a 9 kv arrester discharging a surge current greater than 10,000 amperes, 8 x 20 microsecond wave shape after 20th duty cycle operation.

Discharge Current Withstand Tests
Low Current Long Duration Surges
ASA Standard C62.1-7.4.2

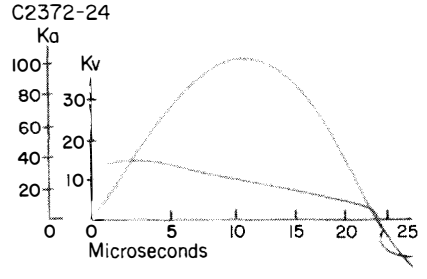


9 Kv, First Surge
Volt-time oscillogram for a 9 kv arrester discharging the first surge of a current not less than 155 amperes, 2,000 microseconds duration.



9 Kv, 20th Surge
Volt-time oscillogram of a 9 kv arrester discharging the 20th surge of a current not less than 155 amperes, 2,000 microseconds duration.

High Current Short Duration Surges
ASA Standard C62.1-7.4.1



3 Kv, 100,000 Amperes
Ampere-time and volt-time oscillograms for a 3 kv arrester discharging the two current surges greater than 100,000 amperes, 8 x 20 microsecond wave shape.

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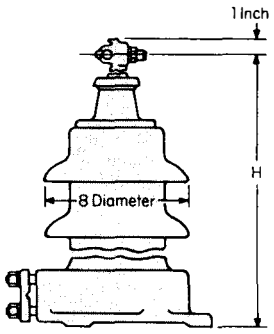
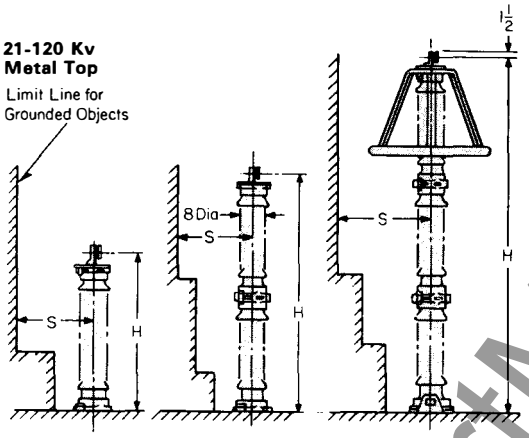
Dimensions in Inches

Arrester Units

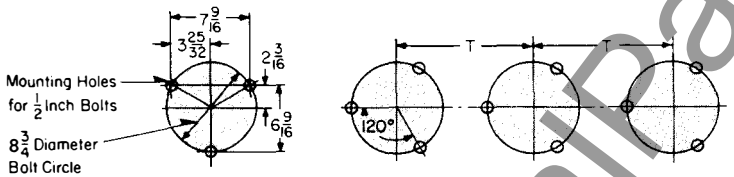
3-15 Kv Porcelain Top



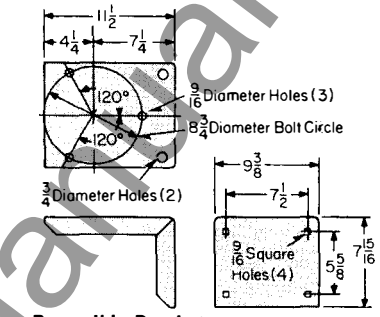
21-120 Kv Metal Top



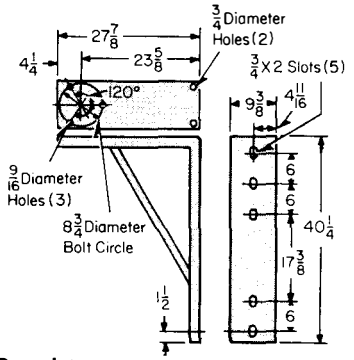
Floor Plan for Three Phase Installation



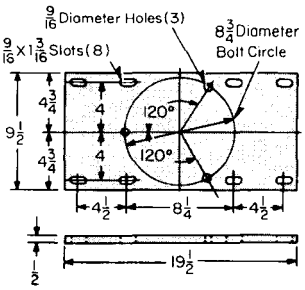
Reversible Bracket Style No. 366C544G01



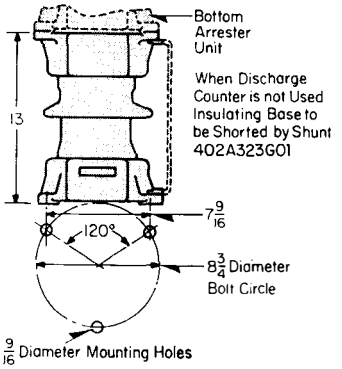
Reversible Bracket Style No. 366C542G01



Baseplate Style No. 258B891G01



Insulating Base Style No. 367C628G01



Arrester Rating Maximum Permissible Line-to-Ground Kv Rms (maximum valve off or maximum re-seal rating)	Style Number Brown Porcelain (single pole arrester)	Porcelain Creepage Distance (inches)	Approximate Net Wt., Lbs.	Approximate Height Center of Line Terminal H (inches)	Approximate Clearance to Ground Center of Arrester S (inches) ①②	Approximate Clearance Phase-to-Phase Center of Arrester T (inches) ①②
3	632A158A01	8¾	41	13¾	7	9½
6	632A159A01	16¼	44	17⅞	7	9½
9	632A160A01	16¼	49	17⅞	7	9½
12	632A161A01	25⅝	52	24¼	8½	12
15	632A162A01	25⅝	57	24¼	8½	12
3	632A571A01	8¾	46	17	10	14¾
6	632A572A01	12⅞	50	19¼	11	15
9	632A573A01	12⅞	55	19¼	11	16
12	632A574A01	17¾	59	21½	12	17¾
15	632A575A01	17¾	62	21½	13	19¼
21	632A175A01	27¾	64	25¾	15	20
24	632A176A01	35¼	72	29⅛	17½	21
30	632A177A01	45	90	34¾	18½	23
36	632A178A01	57¾	105	40½	21	25
39	632A179A01	62¾	127	43¼	21	25
48	632A180A01	70½	143	56⅝	26	33
60	632A181A01	90	189	67⅛	30	37
72	632A182A01	115½	209	79¾	36	42
90	632A665A01	135	315	100¾	48	55
96	632A183A01	150¾	330	107⅝	49	59½
108	632A184A01	173¼	355	118⅞	59	74
120	632A185A01	188¼	390	127⅛	66	79

① Add 3% for each 1,000 feet above 6,000 feet.
② Arrester exhaust ports should be directed away from the transformer and other arrester poles.

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Selector Guide

Arrester Rating① Maximum Permissible Line-to-Ground Kv Rms (maximum valve off or maximum reseal rating)	Maximum Circuit Voltage Phase-to-Phase		Style Number Brown Porcelain (single pole arrester)	Minimum 60 Cycle Spark-over	Maximum Switching Surge Spark-over	Maximum 100% 1.2 x 50 Impulse Spark-over ④	Maximum Impulse Spark-over ASA Front-of-Wave	Maximum Discharge Voltage in Kv Crest for Discharge Currents of 8 x 20 Microsecond Wave Shape with the Following Crest Amplitudes					Withstand Test Voltage of Arrester Insulation – ASA Standards		
	Ungrounded Neutral Service	Effectively Grounded Neutral Service②						1500 Amps Kv Crest	3000 Amps Kv Crest	5000 Amps Kv Crest	10000 Amps Kv Crest	20000 Amps Kv Crest	Impulse Test 1½ x 40 Full Wave Kv Crest	Alternating Current 60 Cycle Test Voltage Kv Rms	
				Kv Rms	Kv Crest	Kv Crest	Kv Crest						BIL	1 Minute Dry	10 Seconds Wet
3	3000	4500③	632A158A01	5	8	8	12	8.3	9.2	9.8	10.8	12	60	21	20
6	6000	9000③	632A159A01	11	17	17	24	16.5	18.3	19.6	21.6	24	75	27	24
9	9000	12800③	632A160A01	16	25	24	35	25	27.5	29	32	36	95	35	30
12	12000	15000	632A161A01	22	34	32	45	31	34	36	40	44	110	50	45
15	15000	18000	632A162A01	27	42	40	55	39	43	46	51	56	110	50	45
3	3000	4500③	632A571A01	5	8	8	12	8.3	9.2	9.8	10.8	12	60	21	20
6	6000	9000③	632A572A01	11	17	17	24	16.5	18.3	19.6	21.6	24	75	27	24
9	9000	12800③	632A573A01	16	25	24	35	25	27.5	29	32	36	95	35	30
12	12000	15000	632A574A01	22	34	32	45	31	34	36	40	44	110	50	45
15	15000	18000	632A575A01	27	42	40	55	39	43	46	51	56	110	50	45
21	21000	25000	632A175A01	36	56	55	72	54	59	63	70	77	150	70	60
24	24000	30000	632A176A01	45	70	65	90	65	71.5	76	84	93	150	70	60
30	30000	37000	632A177A01	54	85	80	105	77	84	90	100	111	200	95	80
36	36000	46000	632A178A01	66	104	96	125	99	109	116	129	143	200	95	80
39	39000	50000	632A179A01	72	113	104	130	107	117	125	139	154	250	120	100
48	48000	60000	632A180A01	90	141	130	155	130	143	152	169	187	250	120	100
60	60000	73000	632A181A01	108	169	160	190	154	170	180	200	222	350	175	145
72	72000	90000	632A182A01	132	206	195	230	197	215	230	255	282	350	175	145
90	90000	110000	632A665A01	160	242	228	271	232	254	274	302	333	450	225	190
96	96000	121000	632A183A01	175	257	247	294	253	280	296	328	364	450	225	190
108	108000	136000	632A184A01	195	294	266	332	292	325	338	375	415	550	280	230
120	120000	150000	632A185A01	220	323	304	370	315	348	375	415	460	550	280	230

① Selection of an arrester rating is based on the maximum circuit voltage and the extent of neutral grounding; however, because of other characteristics of various systems, operating experience and good engineering judgment should be considered in the application. Refer to Appendix A of NEMA Standards Publication No. LA1-1965 and DB 38-120.
② Grounded neutral circuits are defined by EEI-NEMA Publication No. 117, Appendix B, dated May, 1949; ASA Publication C84.1, dated 1954.
③ Multi-grounded neutral circuits
④ IEC Standard 99-1.

Terminals

Porcelain Top: 3 kv through 15 kv ratings have clamp type line and ground terminals for No. 6 to 250 mcm cable (conductor size 0.162-0.580 inch diameter).

Metal Top: 3 kv through 120 kv ratings have clamp type line and ground terminals for No. 6 to 400 mcm cable (conductor size 0.162-0.750 inch diameter).

Terminals are suitable for copper or aluminum.

Lightning Arresters

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Application

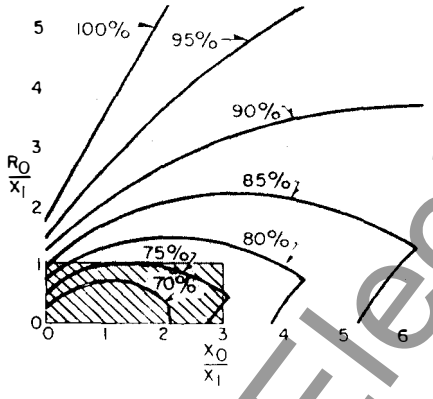
Lightning arresters are given a maximum voltage rating which means that, at any power voltage across the arrester not exceeding the arrester rating, the follow current will be interrupted following a surge discharge. Should the power voltage be above the arrester rating, it is questionable if interruption will take place. Therefore, the highest power voltage that can appear from line to ground during unbalanced faults and loss of system grounds determines the safe arrester rating. If the voltage under these conditions is not known for industrial substations, it should be checked with the electric utility.

It is desirable to use the lowest safe arrester rating, as that arrester limits the surge voltage to the greatest degree. However, the power voltage under any condition must not exceed the arrester rating.

Ungrounded Neutral Service

Electrical systems which have the system neutral ungrounded, or grounded through an impedance, and those having only some of the transformer neutrals solidly grounded, generally require arresters rated at maximum line-to-line voltage.

Effectively Grounded Neutral Service



Maximum line-to-ground voltage in percent of line-to-line voltage during fault conditions (small shaded area indicates the impedance ratio limits for effectively grounded neutral systems).

Systems which have the transformer neutrals grounded such that the voltage line to ground during faults on another phase does not exceed 80 percent of line-to-line voltage, are called effectively grounded systems. Reduced rating arresters can be applied to such systems. These may be applied when:

1. The system neutral is solidly grounded at every source of supply of short circuit current.

2. The system neutral is solidly grounded or is grounded through reactors at a sufficient number of the sources of supply of short circuit current so that the ratio of the fundamental frequency, zero sequence reactance, X_0, to the positive sequence reactance, X_1, as viewed from the point of fault, lies between values of 0 to +3.0 for a ground fault at any location in the system, and for any condition of operation.

Approximations of this relationship occur when:

(a) The line-to-ground fault current is not less than 60 percent of the three phase fault current at any fault location.

(b) At every point of supply of short circuit current, the sum of the kva ratings of the solidly grounded neutral power transformer banks is not less than one-third of the total kva of the transformers supplying short circuit current. This applies only to systems having no directly connected synchronous machines. If special grounding transformers are used, their equivalent continuous kva rating should be used in applying this rule.

(c) The arrester cannot remain energized from ungrounded sources of power after the solidly grounded neutral sources of power have been disconnected to clear a single line-to-ground fault.

Furthermore, it is necessary to have low system neutral ground resistance. The ratio of the zero sequence resistance, R_0, to the positive sequence reactance, X_1, as viewed from a ground fault at any location, should be less than +1.0.

Further Information

Prices: PL 38-220

Instruction: IL 38-130-1A

Application: Westinghouse Lightning Arrester Data Book
"Lightning Protection for Electric Systems" by Edward Beck
AIEE Paper No. 58-1226: "Application of Arresters for Complete Lightning Protection of Substations"

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