



power
circuit
breakers

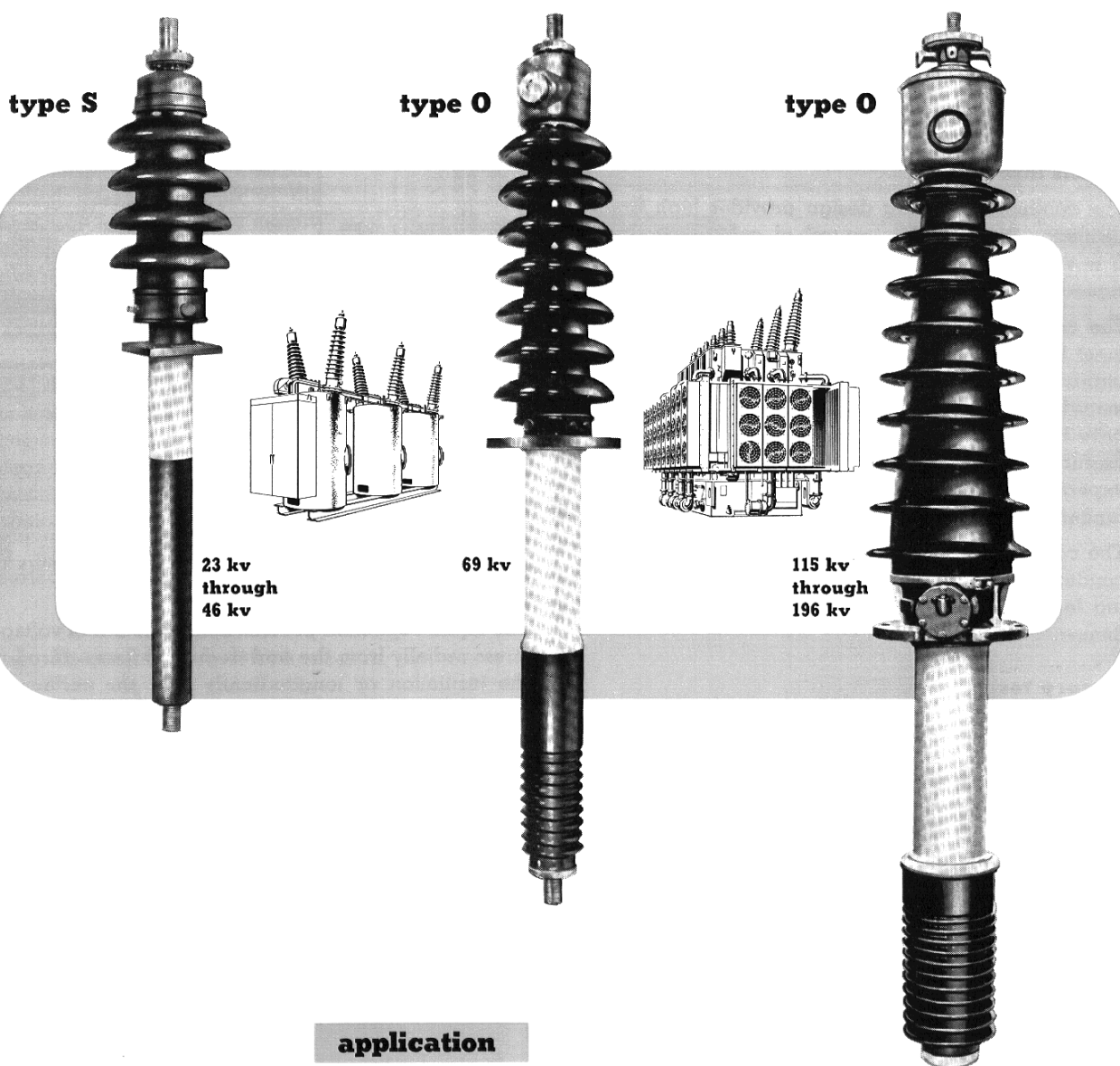
condenser bushings types S and O • 15 to 345 kv

descriptive
bulletin

33-354

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for power circuit breakers and large
power transformers • indoor • outdoor



application

Westinghouse condenser bushings for incoming and outgoing power lines provide high grade insulation from grounded metal structures.

All IC (interchangeable) bushings are interchangeable between circuit breakers and transformers of Westinghouse design and other manufacturers' equipment.

advantages

uniform voltage stress • low power factor • radio and television interference free • high safety factor • great cantilever strength • high puncture strength • light weight

February, 1963

supersedes descriptive bulletin 33-354, dated August, 1957
mailed to: E/1139/DB; D/811/DB; C/333/DB



introduction

Insulation, moisture, voltage stress, power factor, cantilever strength and size are inseparably tied together in the problem of isolating high-voltage conductors from ground.

The condenser bushing design provides high grade insulation by scientific control of voltage gradient. It is small in size with high cantilever strength, designed and built to prevent moisture penetration.

The condenser bushing is a Westinghouse development first used in 1907. Since that time, outstanding improvements have been made in structural design, manufacturing processes and materials. Factory tests have been made more and more severe. The modern bushing is the result of manufacturing and operating experience gained from many years service, with the fundamental theory of the bushing design unchanged.

The condenser bushing is a series of equal capacity condensers spaced concentrically around a conducting lead, this lead being the innerplate of the condenser.

factory tests

Tests and inspections listed below are made on each bushing. These are in addition to many production tests on paper, foil, porcelain and metal parts before assembly.

1. Visual inspection during manufacture to insure uniformity of material and workmanship.
2. Outdoor condensers up to 46 kv, after varnishing and pressing on flange, are tested for tightness with high pressure air.
3. All complete outdoor bushings are given dry nitrogen pressure test to insure tightness of seals.
4. All bushings are given one minute 60 cycle withstand test in line with ASA standards.
5. All bushings are given power factor test to insure proper quality control and low dielectric losses in the bushings.
6. All bushings given capacitance test to insure adherence to calculated design.
7. Check made on voltage tap ratio (92 kv and above).
8. Power factor tap on 69 kv and below are tested for electrical connection and insulation.

The above are routine tests to check materials and workmanship. Each design has been verified by exhaustive electrical, mechanical and life tests.

type IC interchangeable bushings

kv class	kv BIL	ampere rating	creepage distance inches minimum	60 cycle withstand		catalog number
				dry 1-min	wet 10-sec	
23/25	150	1200	17	70	70	2312C29
34.5	200	1200	26½	95	95	3412C31
46	250	1200	35	120	120	4612C33
69	350	1200	48½	175	175	6912C37
115▲	550	1600	79	280	230	11516C43
138▲	650	1600	92	335	275	13816C46
161	750	1600	114	385	315	16116C50
196/230	900	1600	135	465	385	19616C59

▲ The 1600 ampere bushing is interchangeable with and can be used as a spare for the ASA standard 1200 ampere bushing. These bushings are interchangeable between transformers and circuit breakers, and standard ASA bushings of other manufacture.

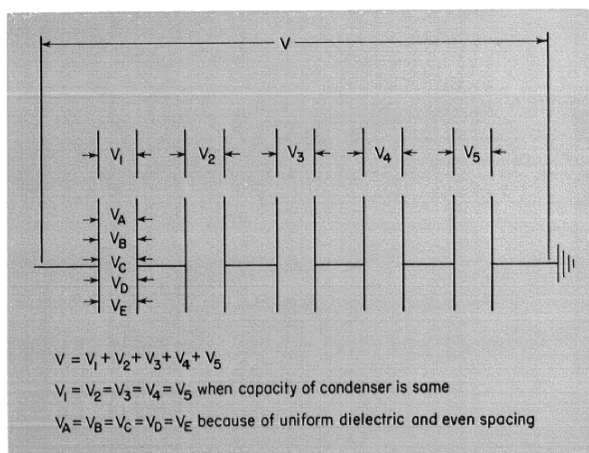
the condenser principle

A series of condensers divide the voltage in inverse ratio to their capacity. Equal capacity condensers in series divide the voltage equally.

The equal capacities prevent concentration of voltage stress radially from the stud to ground flange through the insulation or longitudinally over the surface of the condenser or porcelain weather casing. The voltage gradient is well below that which will produce insulation breakdown of the condenser or produce internal corona.

The condenser, not porcelain weather casing or filling material, provides the main insulation.

This means long life of the dielectric material, negligible radio interference and minimum size.



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indoor 15 kv

The indoor bushing construction consists of a conducting lead, condenser and flange. No weatherproof fittings are furnished on the air end of the bushings as they are for mounting in locations free from excessive moisture or injurious atmospheric conditions.

1 condenser: The condenser construction and treating processes are the same as for outdoor bushings 15 to 46 kv. The bushing is effectively sealed against moisture penetration and is finished with a hard smooth surface for easy cleaning.

2 brass ground sleeve

3 flange: Flanges are pressed on, eliminating cement. The flange tube serves as the outer or grounded plate of the condenser. Studs are of such size and flanges of such design and material as to insure temperature rises well within AIEE temperature limitations.

4 aluminum foil: Foil is carefully inserted to supply equal capacitance for each condenser section, and foil thickness is kept to a minimum to prevent formation of voids.

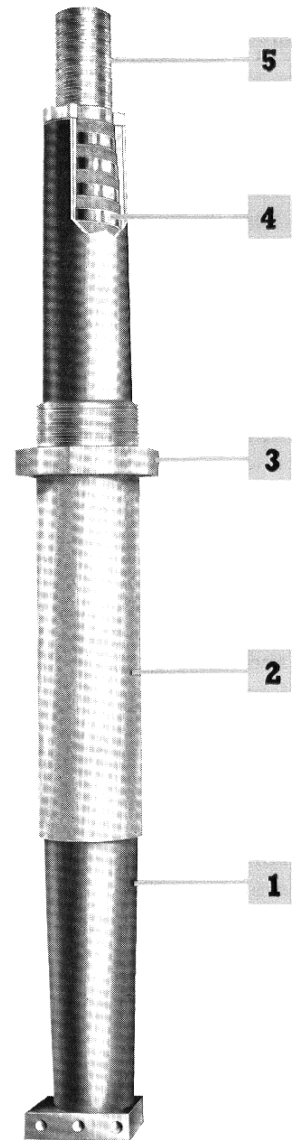
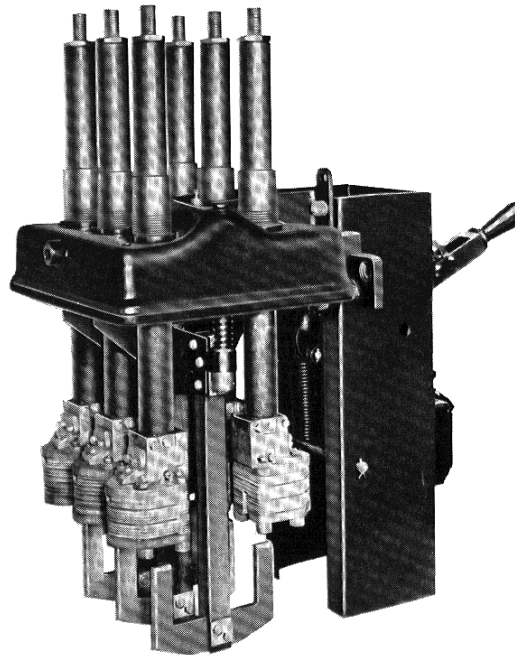
5 copper stud

test values

bushing withstand Δ

kv class	dry 1 min. 60 cycle	impulse 1½ 40
5	21	60
7.5	27	75
15 (small)	35	95
15 (large)	50	110
34.5	80	200

Δ Values apply to bushings only, not necessarily to the apparatus in which the bushings are assembled.



**15 kv
condenser bushing**



outdoor type S 15 to 46 kv

For outdoor applications of 15 to 46 kv, the bushing consists of a treated paper condenser wound on a copper tube or stud, metal mounting flange, and one-piece flexibly mounted porcelain weather casing hermetically sealed at each end by the solder seal process.

On bushings suitable for draw leads provision is made in the cap for attaching these leads. The seal of the bushing is not disturbed when connecting the draw-through leads. Outside terminals are in line with ASA standards when they apply.

High-current oil circuit breaker bushings are wound on solid copper studs with the upper and lower ends threaded. When specified, clamp or tube terminals or contact nuts are provided for connecting to line leads.

1 condenser

After winding and curing, the condenser is turned down on a lathe to the desired dimensions. Coats of a special varnish seal the condenser with a baking after each coat which give the surface a higher resistance to "treeing" or "tracking". The finish is smooth and hard, prevents holding of dust, carbon or other foreign substances, and is easy to clean.

2 mounting flange

For bushings rated 1200 amperes and higher, flanges are of non-magnetic material. The flange is pressed onto the condenser.

3 power factor test tap

Accurate power factor testing of the complete bushing, in place, is simplified by an ungrounded test-tap. The power factor tap is grounded to the bushing flange while the bushing is in service. For testing, the ground is removed. The power factor of the insulation can then be measured by using an ungrounded test set and eliminating the effects of the oil, interrupters, transformer windings and line, thus giving an accurate measurement of the bushing power factor.

4 porcelain seals

A flexible copper cap and a copper ring at the bottom are soldered directly to this metallic casing glaze.

This assembly of cap, casing and ring is screwed onto the lead until the lower ring rests in a groove in the flange plate. The groove is filled with solder and the cap soldered to the lead.

5 aluminum foil

Foil is carefully inserted to supply equal capacitance for each condenser section, and foil thickness is kept to a minimum to prevent formation of voids.

6 porcelain weather casing

The weather end is protected by a one piece wet process porcelain casing, flexibly mounted and hermetically sealed to the flange and lead by the solder seal process. The solder seal between flange, porcelain, cap and stud or tube is a metallic seal throughout and has an indefinite life. A metallic glaze on the upper end and lower end of the porcelain is applied by an exclusive Westinghouse process, and on firing, becomes an integral part of the porcelain. The cap and flange are then soldered to this glaze, giving a completely hermetically sealed unit.

7 filling material

The space between the condenser and weather casing is filled with insulating medium (allowing space for expansion in the cap). The filling and breather holes are plugged and soldered over completing the metallic seal and permanently protecting the bushing from entrance of moisture.

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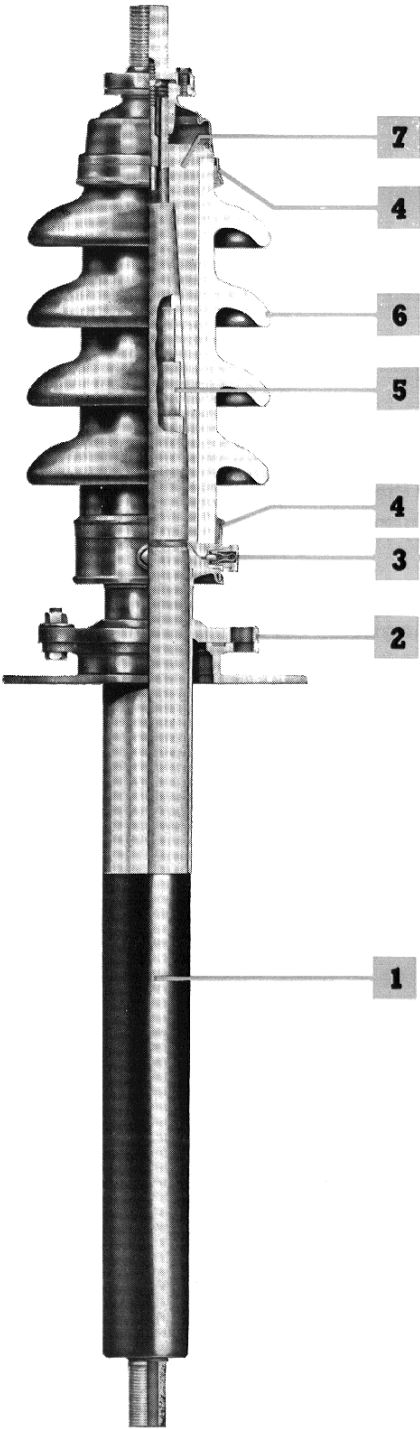
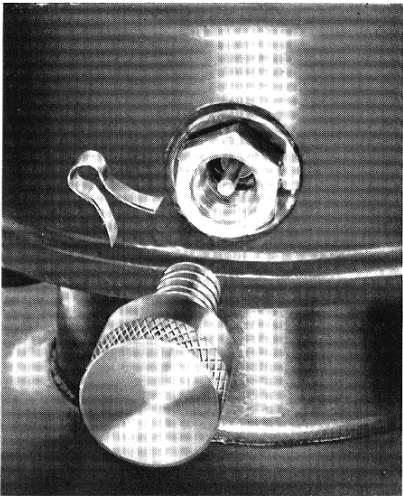


figure A: power factor test tap



test values

bushing creepage and overpotential Δ

kv class	withstand tests		impulse 1½ 40	external creepage, inches minimum
	dry 1 min. 60 cycle	wet 10 sec. 60 cycle		
15	50	45	110	11
23/25	70	70	150	17
34.5	95	95	200	26½
46	120	120	250	35

Δ Values apply to bushings only, not necessarily to the apparatus in which the bushings are assembled.



outdoor type O 69 kv to 345 kv

For service voltages 69 to 345 kv oil-impregnated condenser bushings are supplied. The bushing consists of a central copper tube, oil-impregnated condenser, metal mounting flange, and porcelain and enclosures.

Type O bushings may be stored indoor or outdoor, preferably in a vertical position, without special precautions except against mechanical injury, since the condenser is completely enclosed in a metal and porcelain housing.

1 oil impregnated condenser

The condenser, or heart of the bushing, consists of alternate layers of high grade Kraft paper and metal foil wound on a central copper tube. The condenser is then evacuated and thoroughly impregnated with dried and degassed Wemco C oil under pressure. The oil impregnation increases the dielectric strength of the paper.

2 flange

Designed to provide ASA mounting dimensions where applicable.

3 gasket

All gaskets are below the oil level in the expansion cap precluding the possibility of entrance of moisture into the insulation. All joints in the cap and between cap and stud are soldered or brazed; permanently moisture proof.

4 potential device tap

The basic condenser design of multi-step insulation with voltage distribution across each step being equal, facilitates the use of type PBA-2 bushing devices to provide low cost line potential indication, except for 69 kv class where a power factor test tap is provided per page 4, paragraph 3.

5 porcelain weather casings

Main portion of the bushing shell consists of an upper and lower weatherproof wet-process porcelain casing.

6 2-part magnetic oil gauge

Oil level in the bushing is indicated continuously by a magnetic oil gauge located in the cap. The dial is black with yellow markings for ease of reading.

7 oil chamber

The space between the condenser and the metal and porcelain housing is filled with Wemco C oil. This reservoir of oil insures that the condenser will always be completely impregnated and surrounded by oil. The vent in the cap is plugged and soldered over.

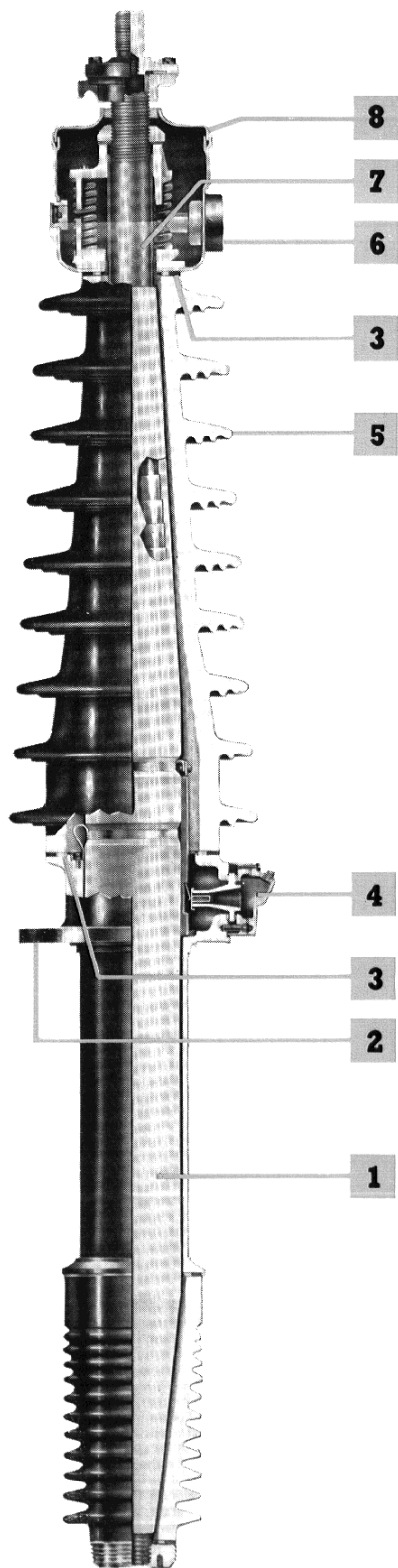
8 bushing cap

The cap has a copper diaphragm which is flexible, to allow for differential expansion. The bushing cap serves as the housing for the springs which place the gaskets under compression. These springs apply a pressure of several tons, depending on the bushing size, on the bushing gaskets, thus assuring a tight seal. Before assembly, the coil springs inside the cap are partially compressed, and on assembly further compressed. The cap also provides oil expansion space.

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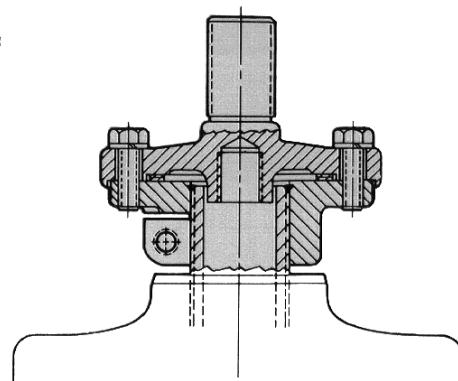
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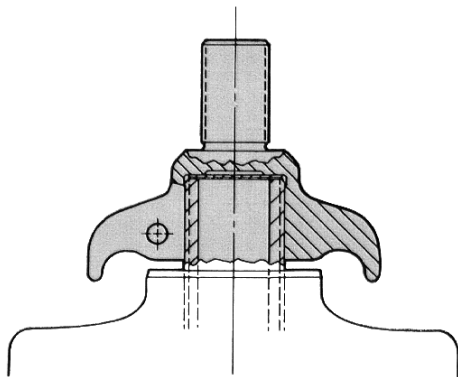
terminal caps

figure B:



top terminal cap for transformer and all type "O" IC bushings 115
kv and above

figure C:



top terminal cap for circuit breakers

test values

bushing creepage and overpotential^Δ

kv class	withstand tests		impulse 1½ 40	external creepage, inches maximum
	dry 1 min. 60 cycle	wet 10 sec. 60 cycle		
69	175	175	350	48
92	225	190	450	66
115	280	230	550	79
138	335	275	650	92
161	385	315	750	114
180	465	385	900	135
196 +	545	445	1050	170
230	680	555	1300	205
287.5 ♦				

^Δ Values apply to bushings only, not necessarily to the apparatus in which the bushings
are assembled.

+ Used in 230 kv breakers.

♦ Used in 345 kv breakers.



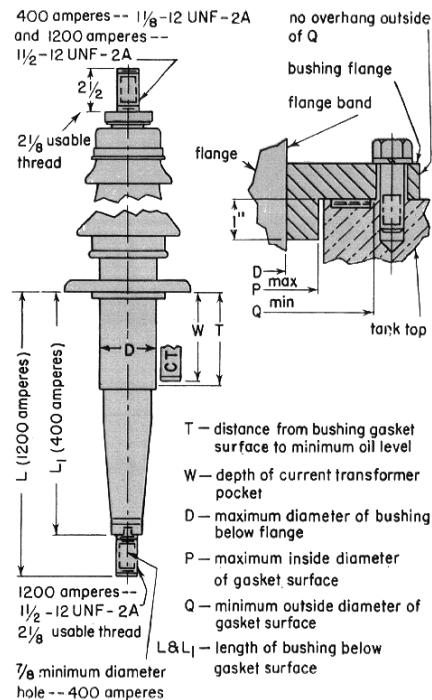
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ASA standards dimensions in inches • approximate

23 kv to 69 kv condenser bushings

kv	BIL	400 amp L ₁	1200 amp L	circuit breaker W and T	transformer			provision for bolts			Westing- house catalog number
					W	T	D	no. of bolts	bolt hole	bolt circle	
23/25	150	16½	...	...	10	10	3⅝	4	7/8	7¼	2304S16
23/25	150	23	...	...	16½	16½	3⅝	4	7/8	7¼	2304S23
23/25	150	27½	...	...	21	21	3⅝	4	7/8	7¼	2304S27
23/25	150	29½	...	...	16½	21	3⅝	4	7/8	7¼	2312C29
▲23/25	150	...	29½	16½	16½	21	3⅝	4	7/8	7¼	2312S30
23/25	150	...	30½	...	21	21	3⅝	4	7/8	7¼	2312S36
23/25	150	...	36½	...	27	27	3⅝	4	7/8	7¼	...
34.5	200	18½	...	...	10	10	3½	4	7/8	7¼	3404S18
34.5	200	25	...	...	16½	16½	3½	4	7/8	7¼	3404S25
34.5	200	29½	...	...	21	21	3½	4	7/8	7¼	3404S29
▲34.5	200	31½	...	16½	16½	21	3½	4	7/8	7¼	3412C31
34.5	200	...	32½	...	21	21	3½	4	7/8	7¼	3412S32
34.5	200	...	38½	...	27	27	3½	4	7/8	7¼	3412S38
46	250	20½	...	...	10	10	4	4	7/8	8¼	4604S20
46	250	27	...	...	16½	16½	4	4	7/8	8¼	4604S27
46	250	31½	...	...	21	21	4	4	7/8	8¼	4604S31
▲46	250	33½	...	16½	16½	21	4	4	7/8	8¼	4612C33
46	250	...	34½	...	21	21	4	4	7/8	8¼	4612S34
46	250	...	40½	...	27	27	4	4	7/8	8¼	4612S40
69	350	30½	...	...	16½	16½	5¼	6	7/8	9¼	6904S30
69	350	35	...	...	21	21	5¼	6	7/8	9¼	6904S35
69	350	41	...	...	27	27	5¼	6	7/8	9¼	6904S41
▲69	350	37½	...	16½	16½	21	5¼	6	7/8	9¼	6912C37
69	350	...	38	...	21	21	5¼	6	7/8	9¼	6912S38
69	350	...	44	...	27	27	5¼	6	7/8	9¼	6912S44

▲ IC bushings—interchangeable between circuit breakers and transformers



92 kv to 196 kv condenser bushings

kw	BIL	amp	L	W and T	D	tube I.D. H	provision for bolts			top terminal		Westing- house catalog number
							no. of bolts	bolt hole	bolt circle	usable thread	thread class UNF 2-A	
92	450	800	40½	23	8¾	1½	6	1¼	13¼	2	1½-12	9208P40
▲115	550	800/1200	43	23	8¾	1½	6	1¼	13¼	2	1½-12	11512C43
▲115	550	1600	43	23	8¾	1½	6	1¼	13¼	2	1½-12	11516C43
✚115	550	2000	43	23	10¾	...	6	1¼	14¼	2½	2-12	...
▲138	650	800/1200	46¾	23	9¾	1⅝	6	1¼	14¼	2	1½-12	13812C46
▲138	650	1600	46¾	23	9¾	1⅝	6	1¼	14¼	2½	2-12	13816C46
✚138	650	2000	46¾	23	12	...	8	1¼	15¾	2½	2-12	...
▲161	750	800/1600	50¼	23	12	1⅝	8	1¼	15¾	2½	2-12	16116C50
✚161	750	2000	50¼	23	12	...	8	1¼	15¾	2½	2-12	...
180	825	800	56¾	26¾	14¾	2	12	1¼	21	2	1½-12	18008P56
▲196	900	800/1600	59½	26¾	14¾	2	12	1¼	21	2½	2-12	19616C59
✚196	900	2000	59½	26¾	14¾	...	12	1¼	21	2½	2-12	...

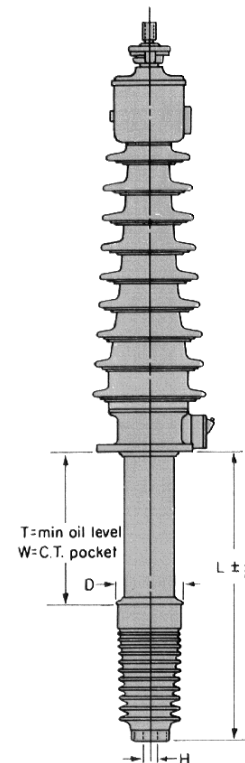
▲ IC bushings—interchangeable between circuit breakers and transformers

✚ proposed standards

further information

prices: price list 33-320

technical data: technical data 33-360



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