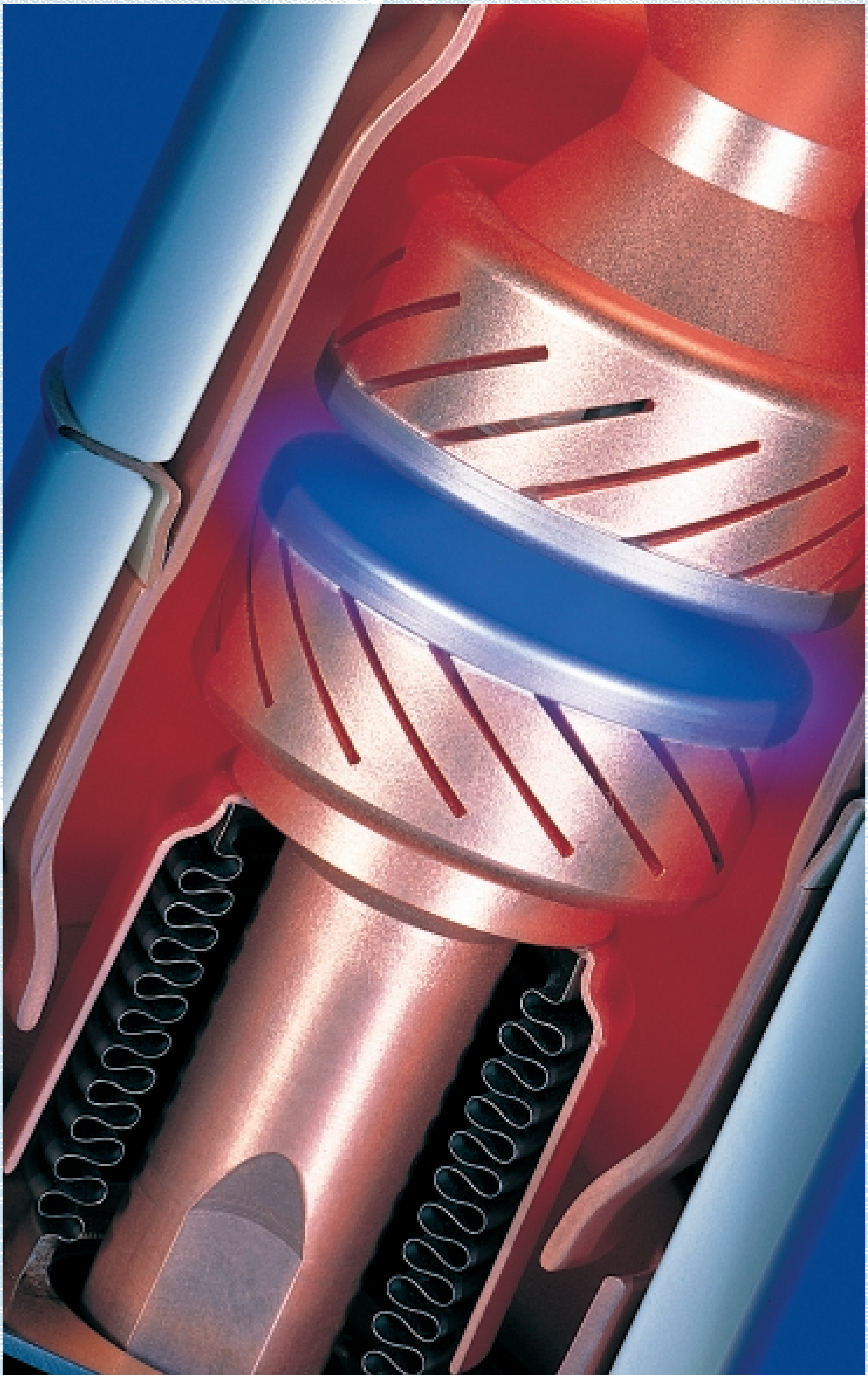
SIEMENS

Vacuum Interrupters
for Medium Voltage



Reliable, Maintenance-Free and Environmentally Friendly

Today, vacuum as an arc extinguishing medium provides the most cost-effective solution for medium-voltage circuit-breakers.

Siemens vacuum interrupters convince in respect of reliability, long service life and fully environmentally friendly materials used for and during production process.
Decades of experience, continuos research and development as well as latest production technology and updated quality concepts makes Siemens superior in vacuum technology.

The high reliability of our vacuum interrupters are based on all common designs:

- The arc chamber that acts as a vapour shield: During the switching process, a metal vapour arc occurs between the contacts and is extinguished at current zero. The small amount of metal vapour that is not redistributed over the contact pieces condenses on the arc chamber wall. The arc chamber protects the inside of the ceramic housing against the effect of the metal vapour, which would reduce the insulation.
- One contact is fixed to the ceramic housing. The other is a moving contact connected to the housing via bellows.
- The metal bellows forms the vacuum-tight connection between the moving contact and the interrupter housing, thus allowing the moving contact to perform its stroke. The stroke is a function of the rated voltage of the vacuum interrupter.
- The insulators are made of metallized aluminum oxide ceramics.
- All connections, whether metal-to-metal or metal-to-ceramics, are brazed in vacuum ovens and therefore provide a vacuum seal for life.

Long service life means

- up to 30,000 interruptions with rated current;
- high short-circuit breaking operations (average of 50 times);
- mechanical operations of up to 2 million (e.g. contactor interrupters).

The vacuum interrupters are manufactured in an environmentally friendly production process, using only materials for the interrupters which can easily be disposed after usage.

Selected materials, minimal wear and contact erosion ensure that the vacuum interrupter is maintenance-free for its entire life and makes for maximum availability.

Switching Duties

Short-circuit currents

Siemens vacuum circuit-breakers switch short-circuit currents of up to 80 kA. The arcing times are less than 15 ms, even at the highest currents. These short arcing times and the minimal arc voltage keep energy conversion in the break to a minimum. Consequently, the breakers are suitable not only for the usual O-0.3s-CO auto-reclosure cycle, but also for multiple auto-reclosures. An O-0.3s-CO-15s-CO-15s-CO-15s-CO duty cycle was carried out successfully (up to 31.5 kA).

Small inductive currents

Magnetizing currents of unloaded transformers are interrupted without undue voltage surges building up, because the chopping current of Siemens vacuum interrupters is below 5 A. In numerous tests it was shown that the overvoltage factor k was less than 3.1 at 12 kV and less than 2.2 at 24 kV.

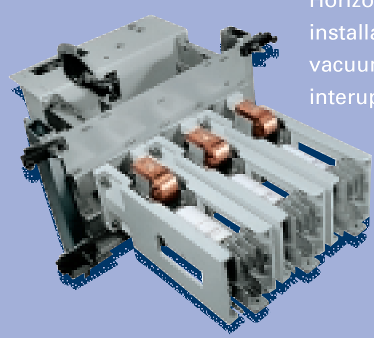
Loads with high switching rate

The use of vacuum interrupters is an especially economic proposition in cases where loads have to be switched frequently (e.g. motors, arc furnaces, reactive power compensating coils and capacitors). This is because they are capable of switching rated normal current up to 30,000 times.

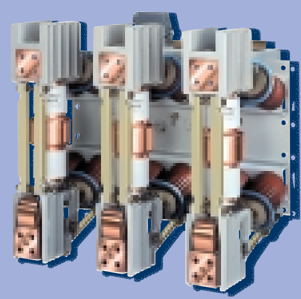
Capacitive currents

Unloaded cables, overhead lines and capacitor banks are switched off without voltage surges because Siemens vacuum interrupters are capable of interrupting capacitive circuits without restrike. Even where the contact gap is small, dielectric recovery is remarkable. In numerous tests, currents of up to 1000 A at 36 kV were reliably interrupted without restrike. The capacitive currents switched in test laboratories are limited by the capacitors installed, and operating experience has shown that even greater capacitive currents can be reliably switched. Even paralleling of capacitors poses no problems.

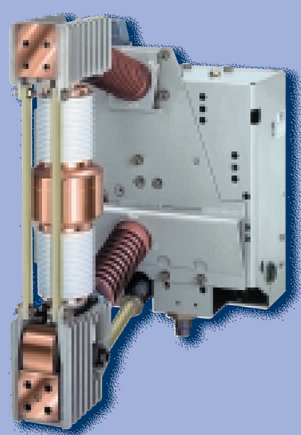
NXACT vacuum circuit-breaker module



Horizontal installation of vacuum interupters



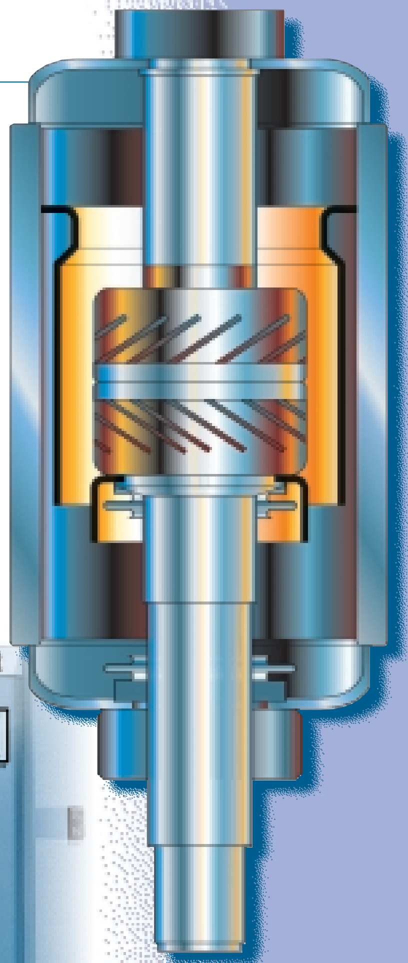
High power vacuum circuit-breaker



Traction vacuum circuit-breaker

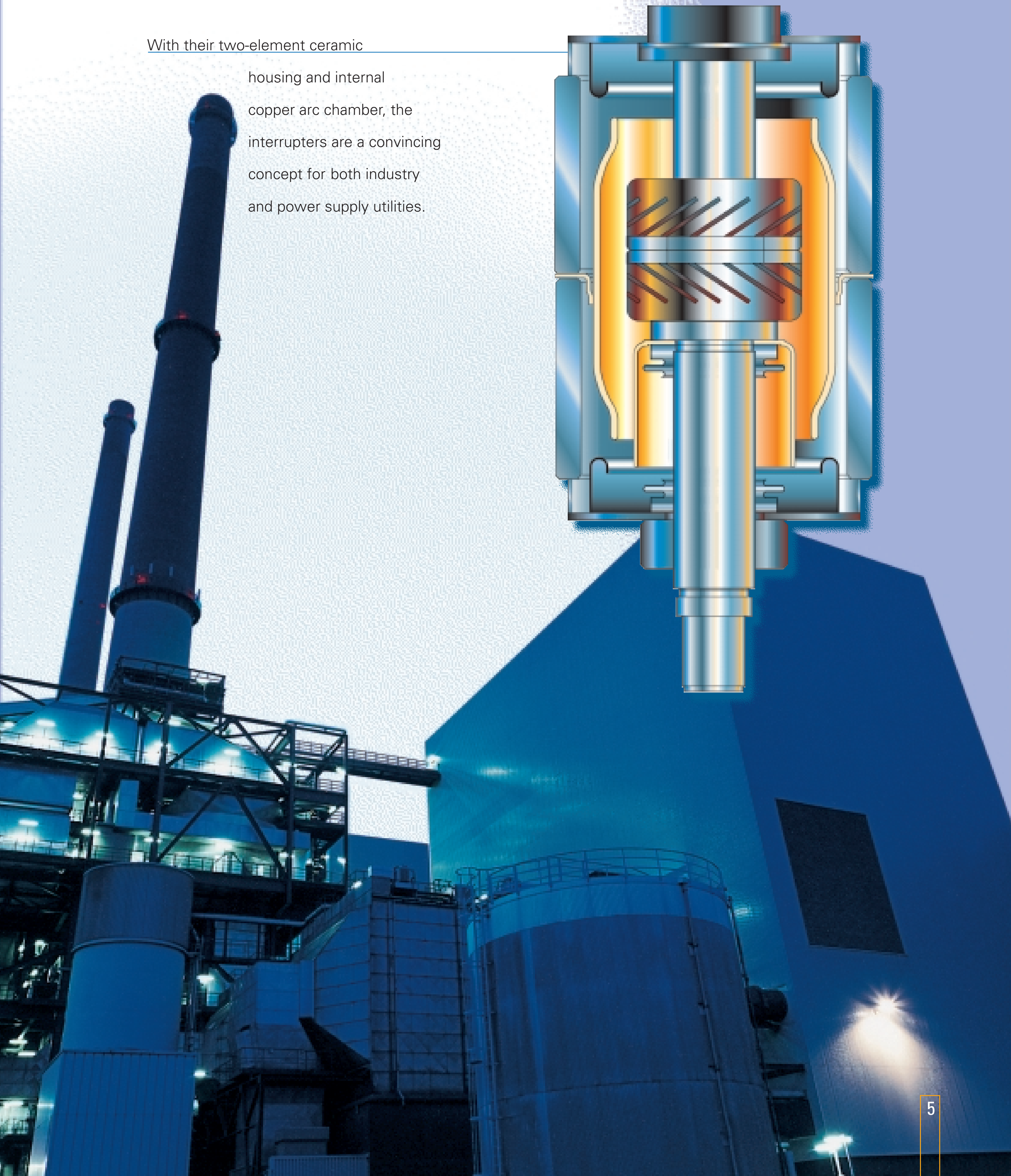
Compact and Economical Concept for the Low Range of Rating

Single ceramic housing interrupters with copper flanges were developed with the creation of a compact circuit-breaker and switchgear assembly design as well as contactors and load breakers uppermost in mind.



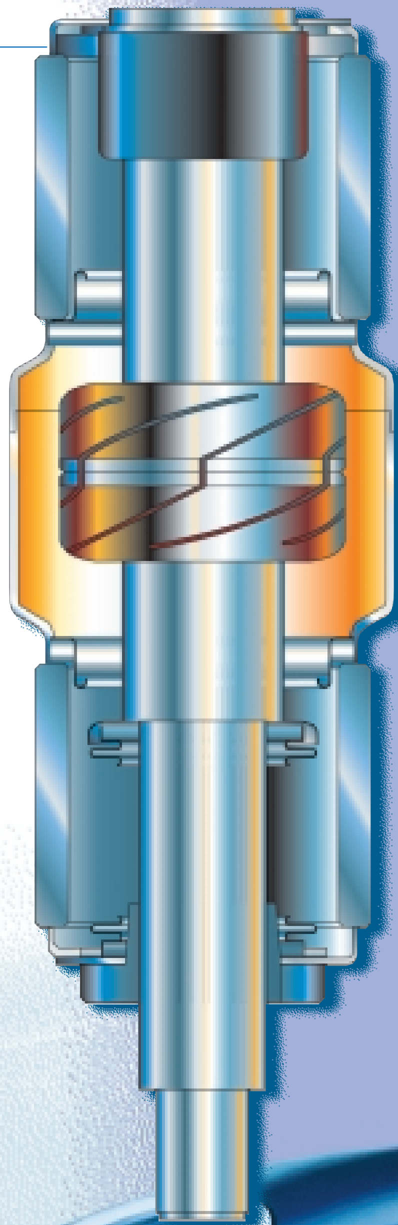
Versatile Standard Concept for all Voltage Levels

With their two-element ceramic housing and internal copper arc chamber, the interrupters are a convincing concept for both industry and power supply utilities.



The High-End Solution for up to 40.5 kV or High Short-Circuit Ratings

The interrupters with a two-element ceramic housing and external copper arc chamber were specially developed for requirements on the 36-kV level and for short-circuit ratings ≥ 50 kA – e.g. generator circuit-breakers, as well as for traction systems with 16 ⅔ Hz.



Arc Quenching

When an arc is quenched, it are the contacts (the prime components of a vacuum interrupter) that must meet the highest demands in terms of:

- High short-circuit breaking capacity;
- High dielectric strength;
- Minimal chopping current;
- Minimal contact erosion;
- Minimal contact resistance.

The requirements have all been met to optimum effect, in both technical and economic terms, as a result of basic research in our laboratories, development of suitable materials (including the contact geometry) and state-of-the-art manufacturing technology.

High dielectric strength

On opening of the contact, the current to be interrupted produces a metal vapour arc discharge and continues flowing through the plasma until the next current zero. The arc is extinguished in the vicinity of the current zero, and the metal vapour loses its conductivity within a few microseconds.

The dielectric strength of the break is thus reestablished very quickly. The steady-state pressure in a vacuum interrupter is less than 10^{-9} bar. Contact clearances of between 6 and 20 mm suffice therefore to produce a high dielectric strength.

Minimal chopping current

Below a certain minimum current, the metal vapour arc is interrupted prior to the natural current zero. In inductive circuits this chopping current must therefore be as low as possible in order to prevent the build-up of impermissibly high voltage surges.
The magnitude of the chopping current depends largely on the contact material used. Optimized chromium copper keeps the chopping current below 5 A.

High breaking current

Two contact geometry variants are used in Siemens vacuum interrupters.

Radial magnetic field contact: With this contact, the arc remains diffuse up to currents of 10 kA (instantaneous value). Higher currents flow through a constricted arc.

Local overheating of the contacts must be avoided. An additional radial magnetic field produces a force which drives the arc around the contact arcing rings. In this way, the contact erosion occurring in the arc root is distributed over the full arcing ring area.

With axial magnetic field contacts, short-circuit currents of up to 80 kA can be reliably handled.

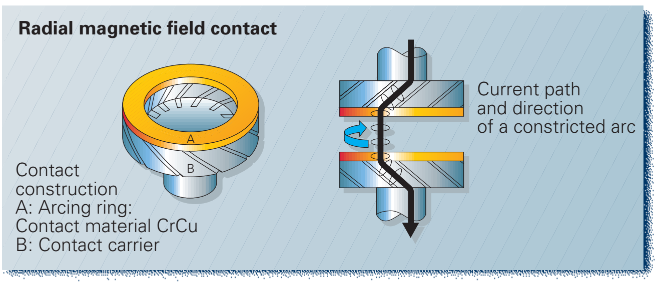
The axial magnetic field allows a diffuse arc even where the current intensity is high. The disc-shaped contact surfaces are uniformly stressed over their full area.
Both the radial and axial magnetic fields are produced by special current paths provided in the contacts under the surface.

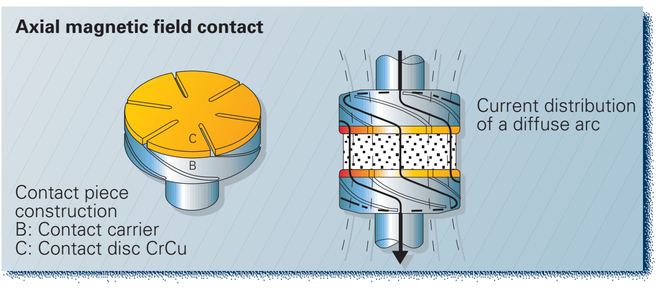
Minimal contact erosion

The metal vapour plasma of the vacuum arc is highly conductive. The arc voltage (only 20 V to 200 V) and the energy conversion in the break are likewise minimal. The high conductivity, in conjunction with the minimal energy conversion and short arcing times are the reasons for the minimal contact erosion and the long electrical service life of the vacuum interrupters.

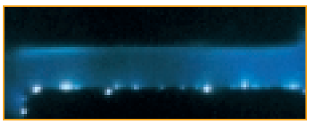
Minimal contact resistance

In a vacuum, the contact surfaces are free of impurities and pollution layers. Highly conductive materials are used. This ensures minimal contact resistance. Between the two outer terminations of an interrupter the figure is between 8 and 15 µ Ω. Heat losses are correspondingly low.

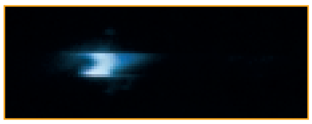




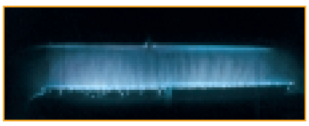
Arc formations with radial and axial magnetic field contacts



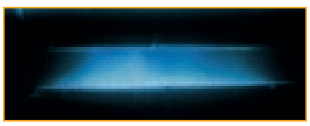
Diffuse arc prior to current zero
(i=2 kA)
(Radial magnetic field contact)



Constricted arc
(i=40 kA)
(Radial magnetic field contact)



Diffuse arc prior to current zero
(i=10 kA)
(Axial magnetic field contact)



Diffuse high current discharge
(i=60 kA)
(Axial magnetic field contact)

Supply Program

Vacuum circuit-breaker interrupters (50 to 60 Hz)

Rated voltage kV	Rated lightning impulse withstand voltage kV	Rated power frequency withstand voltage kV	Rated short-circuit breaking capacity kA	Rated short-circuit making capacity kA	Rated current and interrupter type 630 A	800 A	1250 A	1600 A	2000 A	
7.2	60	20	12.5	31.5	VS 70001					
			16	40			VS 12020			
			20	50			VS 12025			
			25	63				VS 12031		
			31.5	80						
			40	100						
			50	125						
			63	160						
			80	200						
12	75	28	13.1	32.8		VS 12012				
			16	40			VS 12020			
			20	50			VS 12025			
			25	63				VS 12031		
			31.5	80						
			40	100						
			50	125						
			63	160						
			80	200						
15	95	36	20	50						
			25	63						
			31.5	80						
			40	100						
			50	125						
			63	160						
			80	200						
17.5	95	38	20	50						
			25	63						
			31.5	80						
			40	100						
			63	160						
			80	200						
24	125	50	16	40			VS 24016			
			20	50					VS 25005	
			25	63					VS25016*/ VS 25005	
			31.5	80						
			40	100						
36**	170**	70	16	40						
			20	50						
			25	63						
			31.5	80						VS 30029 /
			40	100						

Vacuum contactor interrupters (50 to 60 Hz)

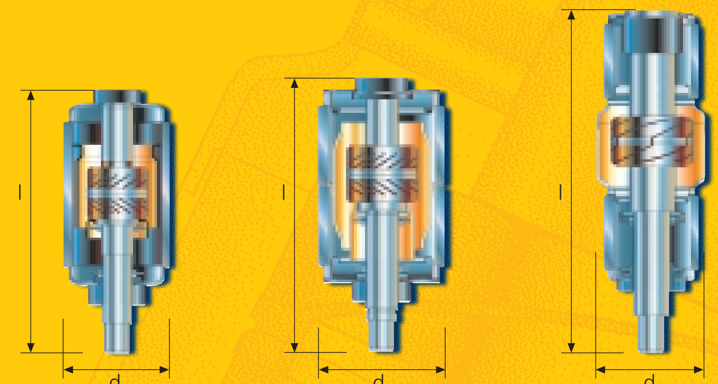
Rated voltage kV	Rated lightning impulse withstand voltage kV	Rated power frequency withstand voltage kV	Rated current A	Max. breaking current kA	Max. making current kA	Number of operating cycles at rated current	Interrupter type	Dimension diameter in mm	length in mm
7.2	60	20	400	3.2	4	$1.0 \cdot 10^6$	VS 7202	75	134
7.2	60	20	400	3.2	4	$0.25 \cdot 10^6$	VS 7203	60	115
12	75	30	400	3.2	4	$0.5 \cdot 10^6$	VS 12003	68	160
24	95	50	800	3.6	4.5	$0.5 \cdot 10^6$	VS 24001	68	190

2500 A	3150 A	4000 A
VS 17005	VS 15100 VS 15050	VS 10047 VS 17080
VS 17005	VS 15100 VS 15050	VS 10047 VS 17080
VS 17005	VS 15100 VS 15050	VS 10047 VS 17080
VS 17005	VS 15100	VS 10047 VS 17080
VS 25007 VS 30040 VS 36025 / VSG 36031* VS 30040		

* With the use of an insulating covering

** Higher values on request

Dimensions (in mm) Illustrations of principle



Type	Design	Diameter d (mm)	Length l (mm)
VS 70001	A	68	124
VS 12012	A	68	124
VS 12020	A	68	144
VS 12025	A	76	187
VS 12031	A	85	219
VS 24016	B	96	284
VS 17005	B	100	219
VS 15100	B	125	255
VS 25016	B	100	219
VS 25005	B	110	284
VS 25007	B	116	315
VS 36025	B	116	326
VS 15050	C	135	368
VS 10047	C	138	379
VSG 36031	C	125	315
VS 17080	C	156	379
VS 30029	C	123	494
VS 30040	C	138	494

Special applications

- Interrupters to ANSI Standard
- Interrupters to Chinese Standard
- Load break switch
- Recloser
- Transformer tap changer
- Traction systems (16 2/3 Hz)
- Installation under gas and oil pressure

Quality Assured
by Sophisticated Testing

Quality assurance

This starts at the very drawing board, since this is where designs and jointing methods are selected, with a view to eliminating sources of faults in manufacture. The various manufacturing process stages are devised in close cooperation between production and development departments, with safety and ease of handling in mind as well as the technical requirements.

Material testing

This is of particular signifcance, due to the special materials used. The technical data of the materials agreed with our suppliers are subject to very tight tolerance ranges, adherence to which is checked on every consignment delivered. Extensive qualitative and quantitative gas analyses ensure that only fully satisfactory materials are processed.

Vacuum tightness

A special internal pressure measuring process has been developed to test for leakage even after the interrupter has been sealed. In a stationary measuring facility, an electrical and a magnetic field are superimposed in such a way that free electrons ionize any residual gas molecules and produce a measuring current that varies as a function of the pressure. All interrupters are stored in argon and then tested by means of this process; they are released for shipment only if a leakage rate of up to 10^{-17} bar x l/s is not exceeded. This amounts to a storage time of 20 years without any loss in quality. Time compression methods can be used to verify such a statement.

To this end, circuit-breaker interrupters were stored for 5000 hrs at 300 °C. It was subsequently verified that no inadmissible rise in pressure had occurred.

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Power to the Point

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