Spring operating mechanism for high voltage circuit breakers

Model FSA 1
ABB – a global leader

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The product offering covers a wide spectrum of technologies across the entire voltage range including indoor and outdoor circuit breakers, air and gas insulated switchgear, disconnectors, capacitor banks and reactive power compensators, power and distribution transformers as well as instrument transformers.

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☑ Unparalleled domain competence
☑ Vast global experience
☑ Total solution provider
☑ Large installed base
☑ Environment-friendly technologies
Introduction

Availability is of paramount importance for efficient electricity supply. Reliability of lines, relays and high voltage apparatus are important factors which increase availability. With improved designs of SF6 high voltage circuit breakers, increased attention is paid to reliability. International statistics, like Cigre's report, have shown that 80% of the failures in a circuit breaker are of mechanical origin. Most of these failures have been traced to the operating mechanisms. The dynamic mechanical and electrical performance of a circuit breaker is complicated. Within milliseconds, the operating mechanism has to change the circuit breaker from a perfect conductor to a perfect insulator. A failure in the operating mechanism may result in a failure of the total breaking operation. The FSA 1 operating mechanism is characterised by an especially robust, simple, and thereby functionally reliable design. It is suitable for three pole as well as single pole application.

Main features and advantages
- The immediate availability of stored energy without any losses ensures constant contact travel behaviour
- A minimum number of mechanical components increases the reliability
- No seals or valves
- Accessible and clear arrangement of components in the operating mechanism cubicle
- Easy access to all components without obstruction, after lowering the outer housing
- The closing spring can be tensioned manually
- Maximum availability and reliability
- Minimal maintenance costs

Design

The principal components and the design can be seen in Figure 1. The well-sized position and spring tension indicators are readily visible through the observation window in the door, and allow positive identification of the breaker position, and of the state of tension of the closing spring. The electrical monitoring and control units are easily accessible after opening the door. The electrical leads are all taken to the terminal blocks. The sheet metal housing including the door, can be removed for ready access to all the internal components. The closing and opening springs are arranged on the two sides. All movements are frictionless damped by means of a dashpot.

Mode of operation

The spring operating mechanism, the design of which is shown schematically in Figure 2, consists essentially of two tension spring systems. Closing spring(5) is tensioned by means of the motor(13), over the worm gear drive(21). This provides the energy for a closing operation, which will tension the opening spring(6) during the closing operation.

Charging of closing spring

The main shaft(1) is rotated through 180 degrees via the worm gear drive(21), by means of the motor(13) or the hand crank(14), in this way tensioning the closing spring(5).

Closing operation

On a closing signal, the locking latch(7) is released from the main shaft and closing spring(5) discharges itself. In this way the transfer cams rotate via the transfer lever(9). Switching shaft(2) is actuated and the breaker closes, simultaneously tensioning and locking the opening spring(6). The motor(13) tensions the closing spring(5) are every closing operation. It is stopped via the motor limit switch(16).

Opening operation

On an opening signal, locking latch(8) is released from switching shaft(2) and the opening spring(6) discharges, thereby opening the breaker. Auxiliary contacts(15) are mechanically linked to the switching units and follow the breaker operation exactly.

Mounting of the operating mechanism

The operating mechanism cubicle (Figure 1), containing the spring operating mechanism FSA 1 as well as the control and monitoring units is easily attached to the circuit breaker. After mounting, the mechanism cubicle to the pole support the operating rod is coupled to the breaker poles. In case of single pole operation the control and monitoring elements are positioned in each mechanism cubicle. Special provisions for supporting the operating mechanism during assembly are not required.

Maintenance

With minimal maintenance, the spring operating mechanism FSA 1 offers distinct advantages, which contribute to a reduction in operational costs.

Lubrication of the transmission shafts and worm-gears as well as the gear wheels is required for the first time only after 2500 CO switching operations, while an overhaul of the complete operating mechanism should be carried out after 5000 CO operations.
Fig. 1
Design and internal view of the spring operating mechanism FSA 1.

References to Figures 1 and 2

1 Main shaft
2 Switching shaft
3 Hydraulic damper
4 Discharge lever
5 Closing spring
6 Opening spring
7 C locking latch
8 O locking latch
9 C transfer lever
10 C release coil
11 O trip coil
12 Breaker operations counter
13 Motor
14 Hand crank (for manual operation)
15 Auxiliary contacts
16 Motor limit switch
17 C manual operation
18 O manual operation
19 Spring tension indicator for the CO spring
20 Position indicator
21 Worm gear drive
Fig. 2
Schematic layout of the spring operating mechanism FSA1. Reference as given on Page 4.
### Optional features

**Auxiliary contacts.** The operating mechanism can be supplied with 6 N/O plus 7 N/C additional auxiliary contacts.

**Protective cover** for the terminals (only for the incoming AC cables). Made of transparent plexiglass.

**Lockable cover** for control panel. A hinged lockable cover protects the entire operator’s panel.

**Lighting arrangement for cubicle illumination.**

**Fuses.** UK 10,3-HESi or HRC fuse link. Quantity, type and position in circuit diagram to be stated when ordering.

**Central control cubicle.** This is needed if three pole operation is required for single phase operated breakers.

### Technical data

#### Motor

Universal series motor for voltage 110-125 V or 220-250 V a.c. or d.c.

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Rated voltage</th>
<th>Starting (A)</th>
<th>Normal (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>220</td>
<td>20</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>110</td>
<td>40</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Spring charging time 15 sec. max.

#### Auxiliary contacts

<table>
<thead>
<tr>
<th>Rated Voltage (V)</th>
<th>Rated Current (A)</th>
<th>Breaking Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>220</td>
<td>20</td>
<td>2</td>
</tr>
</tbody>
</table>

The operating mechanism normally includes 6 N/O and 7 N/C spare auxiliary contacts.

#### Operating coils

<table>
<thead>
<tr>
<th>Operating coil</th>
<th>Rated voltage (V, d.c.)</th>
<th>Power consumption (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closing coil</td>
<td>110-125, 220-250</td>
<td>500</td>
</tr>
<tr>
<td>Opening coil</td>
<td>110-125, 220-250</td>
<td>500</td>
</tr>
</tbody>
</table>

Voltage operating range for the motors and the operating coils meet the requirements in IEC 62271-100.

#### Heating elements

<table>
<thead>
<tr>
<th>Rated voltage (V, AC)</th>
<th>Power consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>210-240</td>
<td>70</td>
</tr>
<tr>
<td>110-127</td>
<td>70</td>
</tr>
</tbody>
</table>

#### Power frequency test, 50 Hz as per IEC 60694

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Rated voltage (V, AC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor</td>
<td>1.5 kV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Auxiliary circuit</th>
<th>2.0 kV</th>
</tr>
</thead>
</table>

#### Degree of protection

as per IEC 529 IP 55

**Terminal blocks**

Through 6 mm² block

**Cable-entry plate**

Size 135 x 200 mm

### Testing

The spring mechanism has passed type testing according to IEC 62271-100. Mechanical life test is performed up to 10,000 operations. Before delivery each operating mechanism has to pass rigorous routine testing. For each breaker a routine test report is issued showing the actual test result.
Electrical Functions

Fig. 3
Basic diagram of the electrical components in the spring operating mechanism FSA 1

<table>
<thead>
<tr>
<th>Component</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2 Density switch</td>
<td>M Motor</td>
</tr>
<tr>
<td>F3 Direct on line motor starter</td>
<td>E3 Heater</td>
</tr>
<tr>
<td>F4 Miniature circuit breaker</td>
<td>S0 Auxiliary contacts</td>
</tr>
<tr>
<td>K1 Antipumping relay</td>
<td>S3 Limit switch</td>
</tr>
<tr>
<td>K2 Interlocking relay, Close and Trip</td>
<td>S12 Selector switch</td>
</tr>
<tr>
<td>Y1 Closing coil</td>
<td>Y2 Shunt trip coil 1</td>
</tr>
<tr>
<td>Y3 Shunt trip coil 2</td>
<td></td>
</tr>
</tbody>
</table>

Circuit diagram shows operating mechanism when circuit breaker is in ‘off’ position, not pressurised, closing springs uncharged, no power supply connected and selector switch in position LOCAL.

The functions of the electrical components of the operating mechanism are shown in the basic circuit diagram (Figure 3)

Closing circuit
The closing coil Y1 can be activated manually via the operating switch(17) (Figure 1) in the operating mechanism, or electrically by means of local or remote control.

Interlocking at close
Auxiliary contacts S0 ensure that the closing signal is only transmitted when the breaker is fully open. The gas density monitor contact F2 controls auxiliary contactor K2 and blocks the switching command when the SF6 pressure is too low. Antipumping relay K1 cancels the persistent closing signal after successful completion of the closing operation.

Tripping circuits
The breaker is equipped with two tripping coils Y2 and Y3, each independent of the other. These can be manually activated via the manual switch (18) (Figure 1) in the operating mechanism, or electrically by means of local or remote control.

Interlocking at trip
Auxiliary contacts S0 ensure that the tripping coils Y2 and Y3 can be energised when the breaker is closed. In the event of too low SF6 density, the tripping circuits are interrupted via the gas density monitor contact in F2.

Monitoring and signalling
In order to monitor the operating condition of the SF6 gas and the operating mechanism, electrical signals are employed for remote indication of:
- SF6 gas density too low
- SF6 gas alarm pressure
- Protection switch “Motor supply” tripped
- Protection switch “Heating supply” tripped
- Phase discrepancy via auxiliary contacts S0 (only for single pole operated breakers).

Heating circuit
The operating mechanism cubicle is fitted with a continuous heating system in order to avoid water condensation. For low temperature operation an extra thermostatically controlled heater is supplied (only for applications lower than -30°C).
<table>
<thead>
<tr>
<th>Region</th>
<th>Location</th>
<th>Address Details</th>
<th>Contact Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>NBCC Tower</td>
<td>4th Floor No. 15, Bhikaj Cama Place</td>
<td>+91 11 26186000, +91 11 26197592/84035</td>
</tr>
<tr>
<td>East</td>
<td>Vandana House</td>
<td>1st Floor G E Road, Ramkund 492 001</td>
<td>+91 771 5060816-8, +91 771 5023051</td>
</tr>
<tr>
<td>South</td>
<td>Embassy Star, 1st Floor</td>
<td>No. 8, Palace Road Vasanth Nagar 560 052</td>
<td>+91 80 22949779, +91 80 22949808</td>
</tr>
<tr>
<td>Central</td>
<td>ABB House</td>
<td>Dr. S B Path Ballard Estate Mumbai 400 038</td>
<td>+91 22 56318231 – 39, +91 22 56318276/77</td>
</tr>
</tbody>
</table>

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