FUTURE TRENDS IN DEVELOPMENT OF LOW-VOLTAGE VACUUM SWITCHGEAR

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ABSTRACT

A range of new products emerging from recent development in vacuum switching technology is presented. Their technical characteristics as well as particular benefits providing for customers are discussed.

1. INTRODUCTION

Since the early 60's, vacuum switching technology has evolved to become the basic technology used in medium voltage switchgear. However, due to the low cost and technological advances in air break technology, vacuum switching has not significantly penetrated the low-voltage area. Historically vacuum heavy-duty contactors represent in reality, the only market niche where vacuum technology dominates at voltages below 1100V.

However, further development of vacuum technology combined with advanced electronics, sensors and actuators opens application areas that did not previously exist. A few examples of these applications are Rezap, Fusemate and Low voltage vacuum starter. Details are given on each of these products to depict the amalgamation of vacuum technology with other technologies, to solve particular and important problems below 1100V.

2. REZAP

The Rezap sets out to solve the problem of the management of faults on low voltage cable networks.

The U.K. distribution system is typical. It is an extensive 415V, radial network that is fed from 11kV open rings circuits with 11kV/415V transformers that feed the cables via fused distribution panels.

The cables are a mixture of paper/lead and polymeric types and can be up to 50 years old. They carry nominal currents of either 400A or 630A and the level of fault current can vary between 50kA and a few hundred amps. Most faults on the network begin life as intermittent and gradually progress to become permanent.

The pressure that has been applied to the electricity companies has focussed attention on the problem of minimising power outages, especially those due to these intermittent faults.

The Rezap is designed to temporarily replace a fuse in a distribution panel to re-energise a faulted feeder after an overcurrent event. It is essentially a single phase auto-recloser with intelligent electronics providing various protection algorithms which emulate the relevant fuse characteristics, thereby allowing intermittent faults to be cleared completely or conditioned to accelerate the onset of a permanent fault and subsequent repair.

Several accessories have also been developed to aid the engineers when on site such as a Remote Controller permitting the user to walk down the length of the cable while attempting to acoustically locate the fault and also view any damage created. The Rezap Sigma can also locate the transient or intermittent faults and has built in remote communications capability via GSM.

When the fault first appears it ruptures the distribution fuse and the fault engineer then installs the Rezap in place of the fuse. If the fault is permanent the Rezap will trip open after it is closed and lock open, however, if the fault is intermittent, the unit will remain closed and will be left installed.

When the fault reappears the Rezap will open in order to clear the fault and then reclose in order to restore the supply. The position of the fault will have been

automatically located and the result communicated to the Operations Centre, or the local office (Rezap Sigma)

The Rezap is a central tool used by all of the UK electricity companies in order to control and manage cable faults.

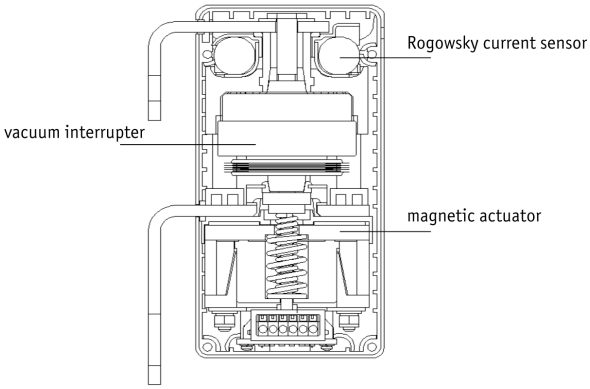

Fig.1. Structure of low voltage vacuum switch used in the Rezap

Rezap parameters

Rated voltage, V	415
Rated current, A	400 (630 optional)
Rated breaking current, kA	16
Max fault making capacity, kA rms	35
Interrupting life, CO operations -at rated current -at rated breaking current	 10 000 50
Weight*, kg	10
Dimensions*, mm	360 x 280 x 140

* these parameters relate to complete Rezap assembly including control electronics

3. FUSEMATE

The Fusemate was designed to minimise the risk of personal injury when replacing an LV Fuse. Although this is normally a straightforward procedure it can occasionally be extremely hazardous, especially if there is a severe fault still present on the circuit. The danger is often amplified by the physical position of the fuse, for example, when replacing fuses in restricted areas such a link-boxes or on a pole-mounted holder. The Fusemate eliminates much of the inherent hazards by permitting the operator to complete the faulted circuit and test the current flow from a safe distance using remote control

It has a vacuum bottle in series with a built in fuse and can be fitted directly unto the fuse stalks of a distribution panel. It has microprocessor control electronics and is housed in a tough, polycarbonate body that has high insulation properties.

After it has been installed it can be closed remotely and will trip open if the fault is still on the system, giving a measure of the fault current. The device is recommended by the Government health and safety department and approximately 3000 are now in service in the UK.

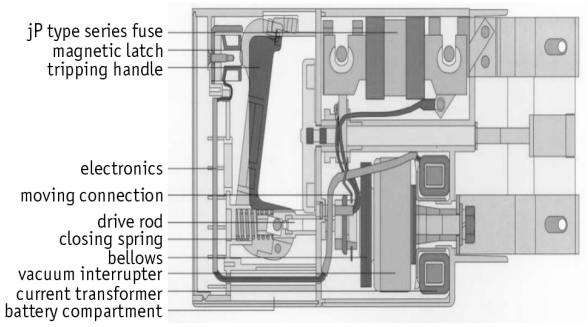

Fig. 2. Fusemate structure

Fusemate parameters

Rated voltage, V	415
Rated current (during 5min), A	400
Rated breaking current (manual operation), A	2,000
Mechanical life, CO operations	10,000
Weight, kg	2
Dimensions, mm	300 x 150 x 85

4. MOTOR STARTER

The traditional motor starter consists of a vacuum contactor, current and voltage transformers and a protection relay installed in a metal or polymeric housing providing the required degree of protection against external objects. The housing is also equipped with the relevant control and indication facilities: pushbuttons, lamps, etc.

Motor starters can provide complex motor protection, control and indication features. The same functionality can be achieved with the aid of the newly developed VS/TEL-1-400 motor starter representing a mono-block including miniaturized vacuum interrupters, magnetic actuator, current and voltage sensors and a microprocessor based control unit. The general layout of VS/TEL-1-400 is presented in the figure below.

The protection functionality includes overcurrent, sensitive earth fault, undervoltage, loss of supply, loss of load, broken wire, thermal and other features necessary to provide complex motor protection. Built in RS232 and RS485 ports allow control of the starter via an external computer or SCADA. Built in man-machine interface also supports basic control and indication functions. The starter also provides fault and load monitoring that permits it to be used as a "point of automation" for industrial networks. The application of the magnetic actuator, instead of the traditional solenoid, makes the starter insensitive to voltage dips that normally occur when starting large motors. The size and weight of the starter are approximately 5 times less than for conventional devices with comparable functionality.

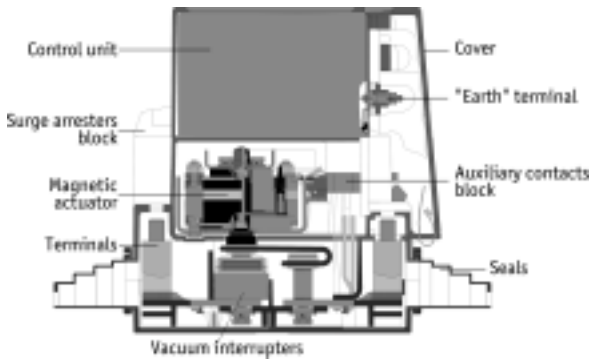

Fig.3. Motor starter structure

Motor starter parameters

Rated voltage, V	1100
Rated current, A	400
Standard duties	AC3, AC4
Degree of protection	IP40
Weight, kg	9.0
Dimensions, mm	190x235x250

5. CONCLUSION

Though vacuum switching devices are barely competitive with conventional air break switches in the majority of standard low voltage applications, the combination of the advanced vacuum technology with sensitive control electronics and actuators create new opportunities in a wider range of applications.

With the advent of these emerging market areas, the potential for vacuum to expand even further seems very positive.