The static shaft current protection RYRIC is used for indication of the shaft current in rotating machines. RYRIC effectively protects against current damage in bearings which is caused when the induced voltage between the shafts breaks through the bearing insulation. Shaft voltage occurs due to magnetic asymmetry in the machine (caused by segment joints, ventilation ducts, variation in the permeability of the plate, support seams in stator or rotor, etc.).

The magnitude of the shaft voltage varies with the voltage and load of the machine and the frequency is dependent on the division of the stator and the number of pole pairs of the rotor. The bearing in one shaft end is insulated in order to prevent current breaking through when the shaft voltage exceeds the breakdown value of the oil film. In the event of damage to the bearing insulation, the shaft currents can reach such a magnitude that the bearings are seriously damaged within a very short time. The current can exceed 100 A, but even small currents of the order of a few amperes can, in time, cause considerable damage to the bearings.

The shaft current protection RYRIC effectively supervises the bearing insulation by sensing and indicating even a low current which, in the event of damage, flows through the shaft. RYRIC effectively protects against current damage in bearings and, in the case of Kaplan turbines, also in the governor, as the shaft current closes its loop outside the machine and then normally passes through these parts.
The shaft current protection RYRIC comprises a relay set in which the measuring units are of solid state design and thereby the low operating power is obtained. RYRIC is supplied from a ring-shaped shaft current transformer that surrounds the shaft, which acts as the primary conductor. The protection has a continuous variable operating value of 0.5-1.5 A, 50-60 Hz. The lowest shaft current at which the protection can be set to operate is depending on the dimensions of the shaft current transformer and the size of the magnetic disturbance fields around the transformer. Operation ever takes place at intermittent shaft current. Operation is obtained both instantaneously (Signal) and after a variable time-lag of 1-10 seconds (Tripping). By means of the RYRIC shaft current protection a considerably better protection against bearing damage is obtained for machines compared, for example, to supervision with the aid of a shaft voltage voltmeter (-relay).

Block diagram

The current through the shaft generates a flux which induces a voltage in the secondary winding of the shaft current transformer. Due to the low magnetization, the voltage is not directly proportional to the current but the transformer is so dimensioned that, within the setting range of the protection for all shaft diameters, an operating value corresponding to a shaft current of 0.5-1.5 A (r.m.s. value) can be obtained. The setting of the required operating value is carried out on the over-current relay RRTEC 1.

Operation is obtained if the shaft current exceeds the value set on the protection for a period which is longer than the pick-up time of the protection. If the shaft current is intermittent, e.g., at repeated breakdowns in the insulation of one bearing, the RYRIC is supplied with impulses. If these impulses exceed the set value of the protection and have a shorter duration than the pick-up time, but are repeated at shorter intervals than the drop-out time, operation is obtained after a certain time. When the output relay RRM 17 operates, normally a signal system is switched in, often with a delayed circuit, and also the time-lag relay RRKN for delayed tripping and indication. If additional contacts and flag indication are required, the protection can be complemented with an auxiliary relay RRME 18 which is then supplied with d.c. or a.c. via a contact on RRKN.

Connection diagram
The relays and the components, which are parts of the RYRIC, are of the plug-in type and are inserted in an ASEA case for plug-in relays, RHGA 3, which comprises a robust base of black insulation material with a dust-proof, black-enameled aluminum cover with door and window.

Seats 3-4 are intended for RRTUB 2, supply device

Seat 5 is intended for RRM 17, output relay

Seat 6 is intended for RRKN, static time-lag relay

Seat 7 is intended for RRTEC 1, solid-state over-current relay

Seat 8 is intended for RRME 18, auxiliary relay, not part of RYRIC, must be ordered separately.

RYRIC is intended for mounting on a panel and has the connection terminals placed at the rear. By using a special adjustable frame, the protection can be flush-mounted in the panel. When mounting on a wall, the connection can be carried out via front terminals. See Catalogue RK 93 E.

The dimensions of the RYRIC are shown in enclosure 5283 174-A.

Over-current relay RRTEC 1 is a solid-state level detector with amplifier and constitutes the measuring part of RYRIC. The operating value of the relay, 0.5-2 mA, 50-60 Hz, is continuously variable by means of a knob with a straight slot flush with the front. The input side has an RC-circuit which reduces the sensitivity of the relay considerably with regard to stray signals with frequencies > 500 Hz. The output side is also provided with an RC-circuit. The purpose of this is to integrate the output pulses at intermittent shaft current. Furthermore, the relay comprises zener diodes that stabilize the supply voltage and diodes that protect the input against overvoltages at large shaft currents. RRTEC 1 is described in Information RK 70-303 E.

Supply device RRTUB 2 comprises transformer, silicon rectifier and smoothing capacitors. The device provides RRTEC 1 with the required supply voltage of 0, +12 V and -12 V, d.c. when connected to 110 V or 220 V, a.c. RRTUB 2 is described in Information RK 70-304 E.

Output relay RRM 17 is a reliable electro-magnetic auxiliary relay which acts as output relay for RRTEC 1. The relay has two make contacts, one for signal and one for connection of the time-lag relay RRKN. RRM 17 is described in Catalogue RK 11 E.

Time-lag relay RRKN is a static time-lag relay with a specially provided scale of 1-10 s for RYRIC. The relay is connected in by RRM 17 and gives delayed tripping and indication. The normal design of RRKN is described in Catalogue RK 91-1 E.

Auxiliary relay RRME 18 is to be ordered separately and can be obtained for various voltages and with various contact combinations. The relay is usually fed from a battery and is used for tripping purposes, when increased contact capacity is required. The relay has a red indicating flag which gives a remaining indication for pick-up. Auxiliary relay RRME 18 is described in Catalogue RK 11 E.
SHAFT CURRENT TRANSFORMER

The shaft current transformer, which is to be ordered separately, is a dividable ring transformer with a spread out secondary winding to which the \textit{RYSIC} is connected according to the connection diagram (page 4). The transformer is normally manufactured in two parts and, in vertical machines, is normally mounted under the rotor, where it requires a space of approximately 100 mm in the axial direction. Furthermore, space must be available for suitable mounting arrangements. The transformer is provided with an extra winding for the testing of the shaft current protection, see below. The core and the windings are moulded in araldite in a flanged U-iron, whereby the transformer will become mechanically stable and protected against strong magnetic fields.

INITIAL ADJUSTMENT AND TESTING

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{connection_diagram.png}
\caption{Connection of the \textit{RYSIC} to the relay testing switch and the shaft current transformer with testing winding.}
\end{figure}

The diagram refers to generators with auxiliary voltage from a generator voltage transformer.

The auxiliary voltage does not have to be supplied via the switch if the voltage is obtained from a separate supply source. The connection via the time-lag relay can also be carried out in a different way.

The testing circuit of the shaft current transformer is connected by means of a test switch to an a.c. voltage, 50 Hz, and a testing equipment comprising an ammeter and a regulating resistor. The time-lag relay contact is connected to "test" at the same time. The regulating resistor is so set that the current in the circuit becomes equal to the bearing current at which \textit{RYSIC} is to operate, i.e., normally approx. 1 A, 50 Hz. The operating value of \textit{RYSIC} is set with \textit{XRTEC 1} so that operation occurs at the set test current.

The setting should be carried out while the machine is running due to the possible stray voltage which can be induced in the shaft current transformer by the magnetic fields from the machine. The stray voltage can be of the same or opposite polarity and for this reason it should also be tested, at the same setting, at what test current \textit{RYSIC} operates when the two conductors of the test circuit are shifted.

MAINTENANCE

\textit{RYSIC} does not require any special maintenance under normal conditions. The cover must be properly fitted and the door closed to prevent the ingress of dust. Burnt contacts should be carefully dressed with a diamond file or an extremely fine file. Emery cloth or similar products being unsuitable for dressing relay contacts, as insulating grains of abrasive may remain on the contact surfaces and cause failures.

\textit{RK 50-300 E Edition 2}
Operating value (RRTEC 1)  Continuously variable 0.5–2 mA, 50–60 Hz
Resetting ratio  > 90 %
Input impedance  80 resistively
Operating power  20 μVA at lowest setting
Maximum current,  
Continuous  125 mA
Maximum current,  
during 1 s  500 mA
Variable operating  
time (RRKN)  1–10 s
Operating time of  
measuring circuit  approx. 80 ms at 2 x set value
(RRTEC + RR KN 17)
Resetting time  approx. 0.3 s
Permissible ambient  
temperature  -5°C to +50°C
Required auxiliary  
voltage  110 V or 220 V, 50–60 Hz
Permissible variation  
in auxiliary voltage  -20 % to +10 %
Power consumption of  
the auxiliary voltage  approx. 2 VA
Test voltage  2000 V, 50 Hz
Net weight  3.5 kg.
Contact data for  
RRM 17 and RRKN  
RRME 18
Max. voltage  
between lines  300 V  450 V
Max. voltage  
between lines  250 V  400 V
Cont. current-carrying  
capacity  5 A  6 A
Making capacity  10 A  20 A
Breaking capacity  
A, at - 10 A  20 A
a.c., max. 220 V,  
cos.φ = 0.1
55 V  1 A  15 A
110 V  0.4 A  3 A
220 V  0.2 A  1 A