



Lifetime tests for stationary contacts of tap-changers in transformers

Progress report:

Introduction, status of the test equipment and
preview of the intended experimental procedures

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Lifetime tests for stationary tap-changer contacts

Introduction

State of the art:

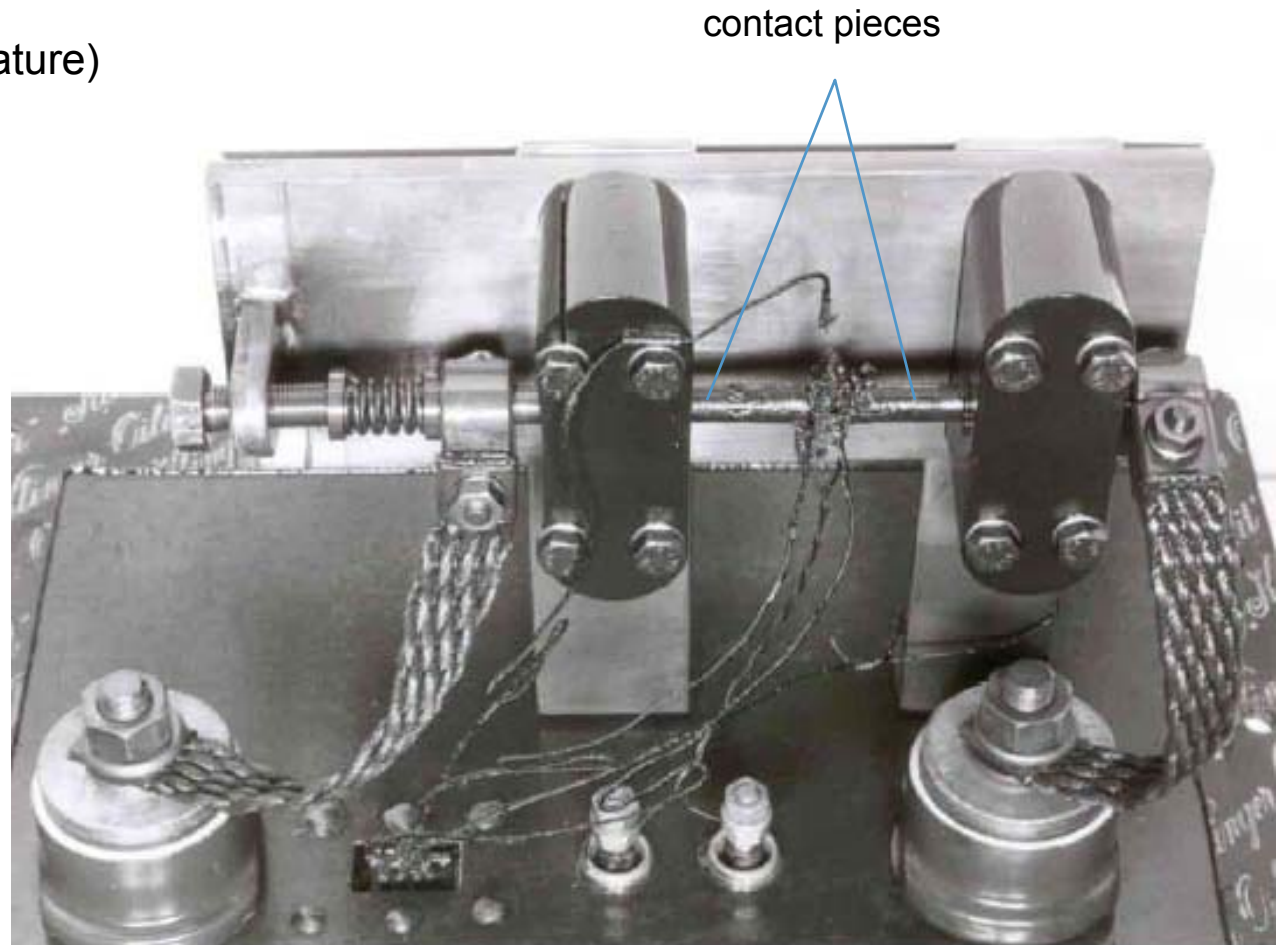
- **IEC 60214-1:2003 requirements**
- **field experience**
- **investigations by Philip J. Hopkinson**
- **other investigations, e.g.**
 - former investigations with MR model arrangement (1966)
 - Dissertation Klaus Lemelson (1973), TU Braunschweig

Lifetime tests for stationary tap-changer contacts

Investigations with MR model arrangement (in 1966)

Test parameter

- $T = 100\text{ }^{\circ}\text{C}$ (oil temperature)
- $F = 60\text{ N}$
(contact force)
- $I = 250\text{ A}$
- model arrangement
- $d = 8\text{ mm}$
(diameter of the rods used as contact pieces)
- $t = 4000\text{ hours}$
- contact materials
e.g. Cu, Ag, brass, Elmedur, Argodur.
- contact material Sn was **not** investigated.

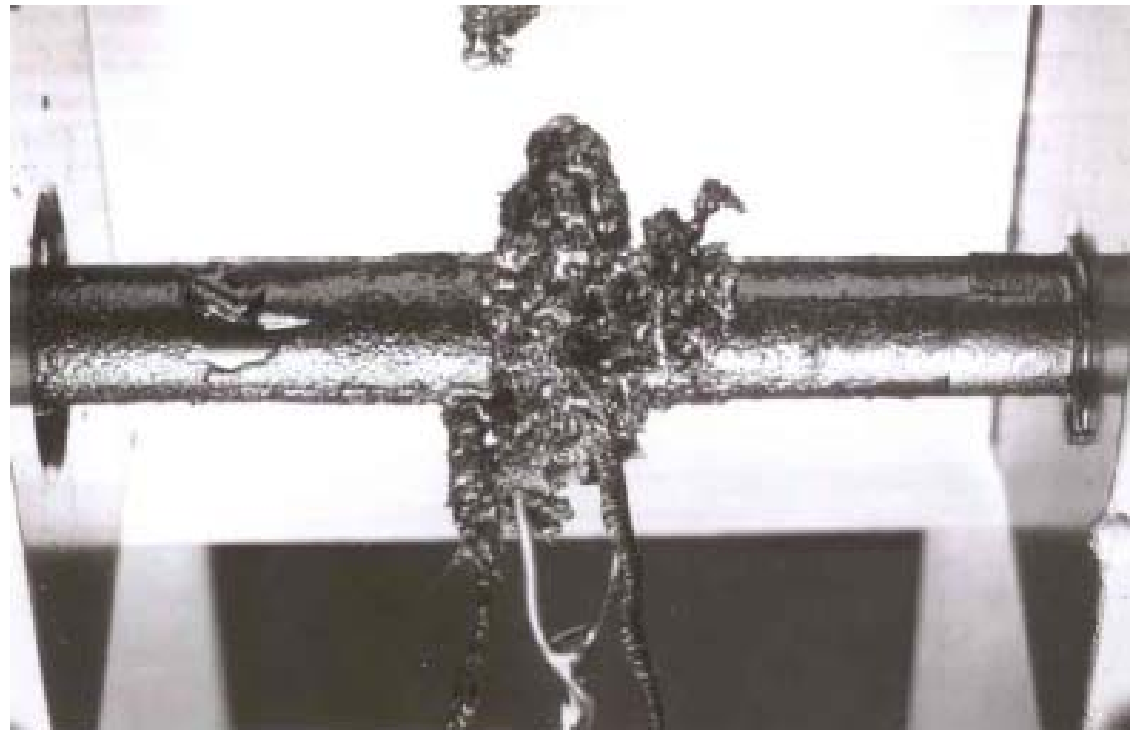


Lifetime tests for stationary tap-changer contacts

Investigations with MR model arrangement (in 1966)

Results

- Tests showed good results for all investigated contact materials and all investigated combinations of contact materials except Cu against brass.
- Results for contacts, where one contact piece is made of Cu and the other of brass:
 - Significant increase of contact voltage drop begins approx. 3300 hours (140 days) after the start of the test.
 - At the end of the test, after 4000 hours, the contact voltage drop has exceeded 700 mV.
 - The picture shows such a contact at the end of the test.



Lifetime tests for stationary tap-changer contacts

Dissertation Lemelson (1973, TU Braunschweig, Prof. Erk)

- results of the experimental investigations with a model arrangement (similar but not equal to the one mentioned before) confirm MR results
- presentation of a iterative procedure for a calculation of the contact behaviour (see Fig. 1)
- important input parameter for these calculations (e.g. diameter of the contacting spots) are unknown and can only be defined on the basis of the results of experimental investigations

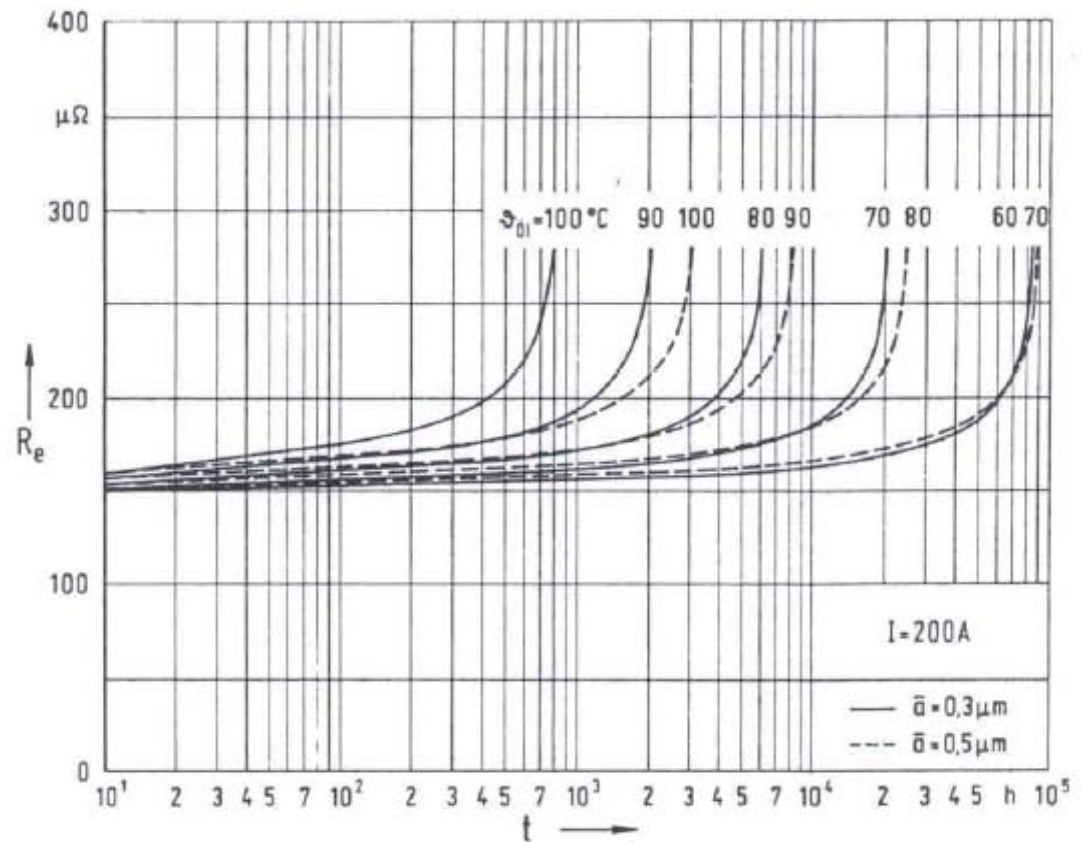


Fig. 1: Calculations of the constriction resistances R_e of a contact Cu against brass, different assumptions for the diameter of the contacting spots \bar{a} , other parameters as shown

Lifetime tests for stationary tap-changer contacts

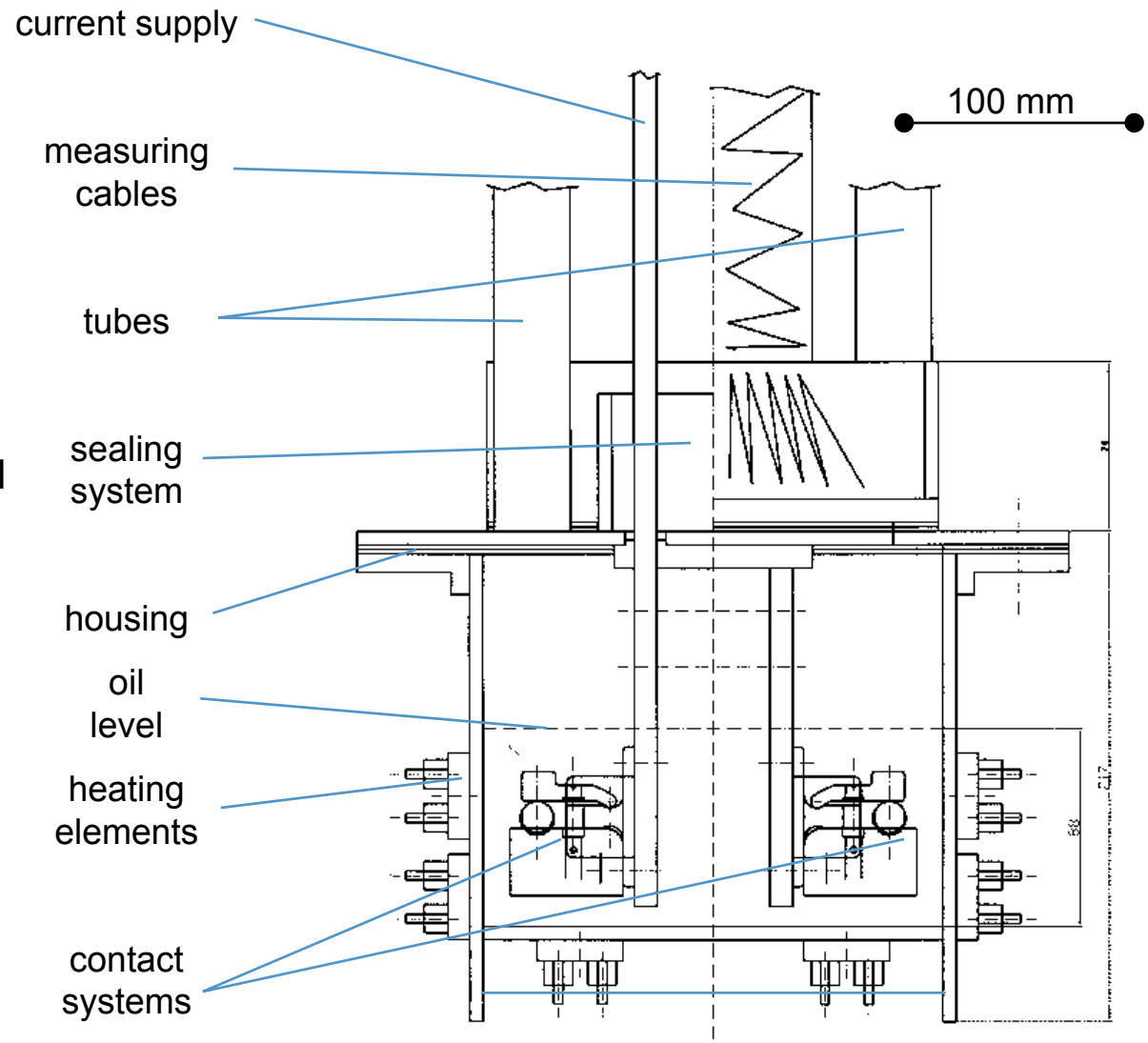
Consequences of the precognition regarding the intended new tests

- The tests must be accelerated tests to receive results within a reasonable time.
- One main task is to find sets of parameters (e.g. current, temperature and time) where
 - “good” contacts, which show good behaviour in the field, pass the test.
 - “bad” contacts, which show bad behaviour in the field, fail the test.
 - the test parameters (especially the test periods) are within realistic limits.
- Standard MR contact systems can be used as “good” reference systems.
- Contacts with one contact piece made of Cu and one piece made of brass shall be used as “bad” reference systems.
- To enable easy comparisons with the “Hopkinson tests” the test parameters shall be adjustable to “Hopkinson conditions” (130 °C oil temperature!).
- The majority of the tests shall be made in mineral oil.

Lifetime tests for stationary tap-changer contacts

Model arrangement - 1

- contact systems from MR standard production
- contact systems are modified to reach 1 contact point instead of the 2 original ones.
- 12 contacts in one model arrangement
- 2 x 6 contacts electrically in series; consequently 2 different test currents per model arrangement possible
- rated current of the used contact system $I = 150 \text{ A}$

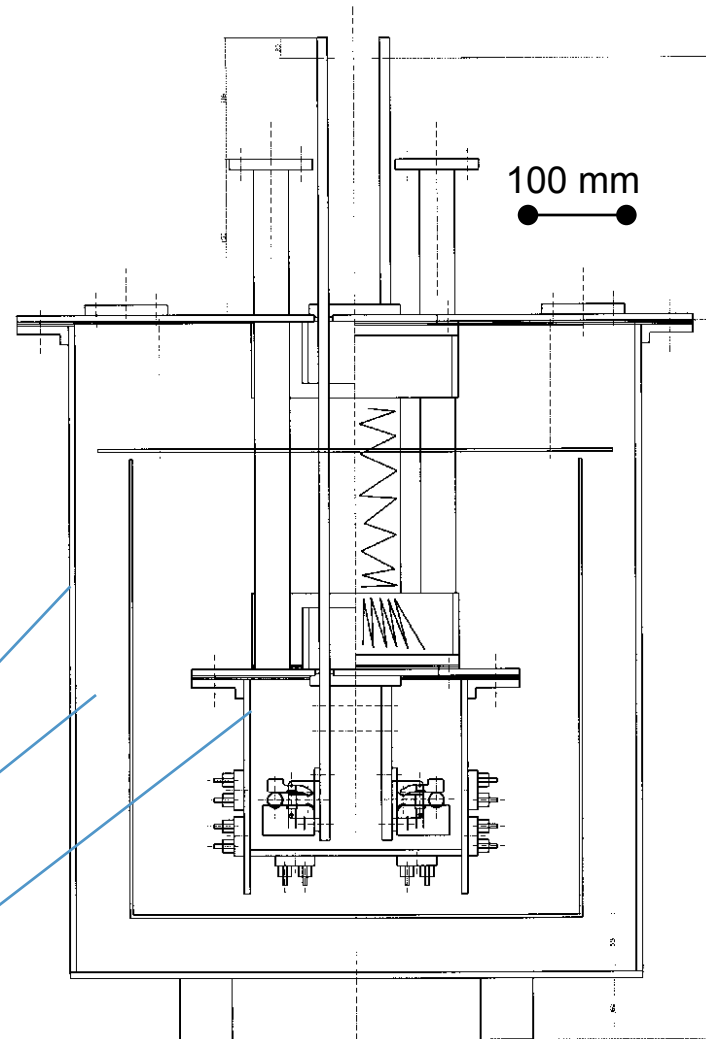


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Model arrangement - 2

- outer housing for safety reasons (high temperatures) and heat insulation
- outer housing is possibly filled with gas (N_2 or SF_6) for fire protection (depending on the results of preliminary tests).
- measured values:
 - contact voltages
 - contact temperatures
 - oil temperature
 - currents

outer housing
space for heat insulating material
inner housing



Lifetime tests for stationary tap-changer contacts

Model arrangement – Actual status

- model arrangement **under construction**
- According to **time schedule**: Start of the **first tests in 2003**



Fig.1:
Outer
housing



Fig.2:
Inner
housing

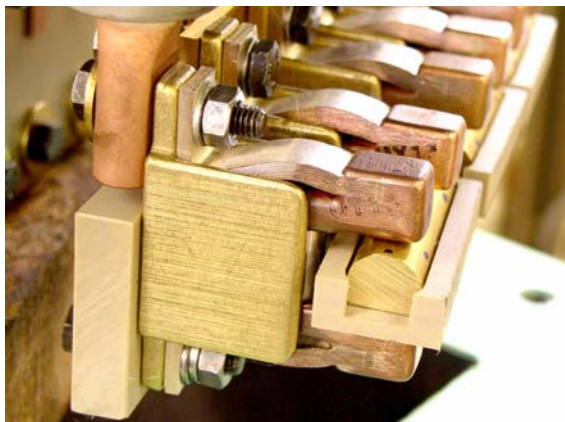


Fig.3: Modified MR contact systems

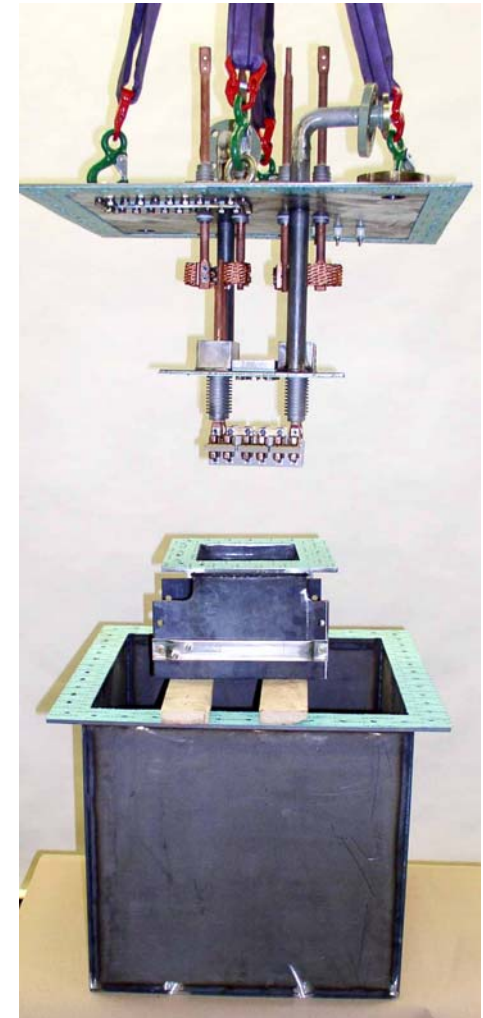
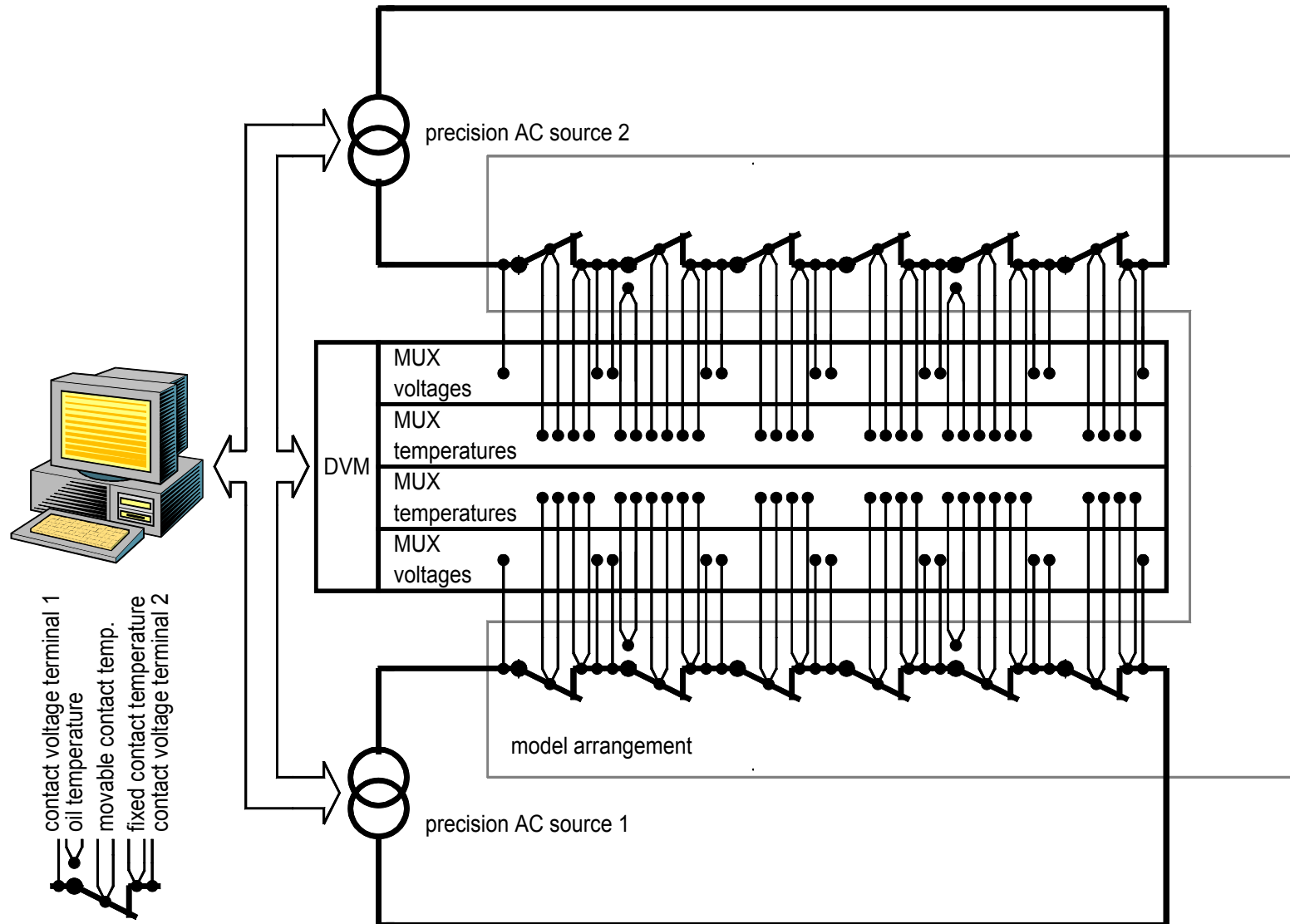


Fig. 4: Assembly

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Test circuit



Lifetime tests for stationary tap-changer contacts

Preview of the intended test procedures

- **1st test:** 6 “good” contacts (Cu against Ag-plated brass) and 6 “bad” contacts (Cu against brass) shall be investigated under “**Hopkinson conditions**” (oil temperature 130 °C, twice the rated current,...).
 - to investigate if “good” contacts show good behaviour (no increase of the contact voltage drop) and “bad” contacts show bad behaviour
- A **2nd test** shall be performed with the same kind of contact materials, but **lower oil temperature and higher currents**. If possible the conditions shall be so, that at start of this test the “super-temperatures” of the contact points are the same as in the 1st test.
 - to investigate differences in comparison with the 1st test.
 - to determine the test conditions for further tests.

