PARALLELING FUSES

1. VOLTAGE RATING AND BREAKING CAPACITY

1.1 Position of the paralleled fuses in the circuit

1.2. The energy stored in the inductance drastically increases

1.3. Power factor variation

2. CURRENT RATING

2.1. Two fuses in parallel

- Distance between paralleled fuses
- Matching resistances

2.2. Three or more fuses in parallel

2.2.1. It is necessary to derate the current carrying capability of the fuse assembly

2.2.2. It is necessary to check the resistance value of each branch created by the fuses in parallel.

2.2.3. The mounting of the fuse assembly requires some special care.

2.2.4. Information about the lay out of the circuit is necessary because there are fields causing current unbalance between fuses.

3. MECHANICAL PROBLEMS

4. DATA OF N FUSES IN PARALLEL

4.1. I^2t
4.2. Arc voltage
4.3. Peak let through current

5. CONCLUSIONS

1. VOLTAGE RATING

The voltage rating of a double body fuse can be smaller than the voltage rating of the single body fuse. But it can be the same. This depends on how far from the limits is the single body fuse.
This is not new: many years ago FERRAZ SHAWMUT produced double body fuses with a voltage rating lower than the rating of the single body fuse.
The problem is a bad sharing of the arc energy between the bodies in parallel.

1.1. The energy stored in the inductance drastically increases

When two fuses in parallel interrupt a short circuit current $\mathbf{I_A}$ the energy E_2 stored in the inductance is about 2.5 times the energy E_1 with one fuse alone interrupting the same short circuit current $\mathbf{I_A}$.

$$\mathbf{E_2 = 2.52 * E_1}$$

Therefore even when the energy is perfectly shared between the two fuses in parallel, each fuse will see more energy then the energy it had to withstand when tested alone.
The breaking capacity of two fuses in parallel can be less than the breaking capacity of one fuse.
It is sometimes necessary to decrease the voltage rating.

Generally, when two fuses in parallel fails to interrupt a short circuit current, it is necessary to decrease the voltage as it is the only way to decrease the interrupting energy for any short circuit current value.

1.2. Power factor variation

Power test stations are all different and the fault circuit inside equipment protected by a fuse is different as well. The consequence is that the inductance value is not the same and the energy absorbed by the fuse during its arcing is different as well. Very often we get a power factor close to 0.15.

2. CURRENT RATING

2.1. Two fuses in parallel

When 2 fuses are in parallel the current rating can be simply two times the current rating of one fuse when the following conditions are fulfilled:

- **Distance between the two fuses**

It must be at least 10 to allow heat evacuation but less than 30 mm to avoid unbalanced resistance due to connections not symmetrical

- **Matching resistances**

It is also essential to try to keep the resistance of the fuses within about 5% .

2.2. Three or more fuses are in parallel

2.2.1. It is necessary to derate the current carrying capability of the fuse assembly

- For 3 and 4 bodies in parallel the current carrying capability becomes 90 % the rating of 1 body multiplied by the number of fuses in parallel.
- For more than 4 bodies it is necessary to check with the FERRAZ SHAWMUT technical support.

2.2.2. It is necessary to check the resistance value of each branch created by the fuses in parallel.

2.2.3. The mounting of the fuse assembly requires some special care.

2.2.4. Information about the lay out of the circuit is necessary because there are fields causing current unbalance between fuses.

3. MECHANICAL PROBLEMS

The last problem to watch carefully is the mechanical damage due to the variations in the length of the fuse. Variations of the length of the fuses are mainly due to the variations of the length of the body.

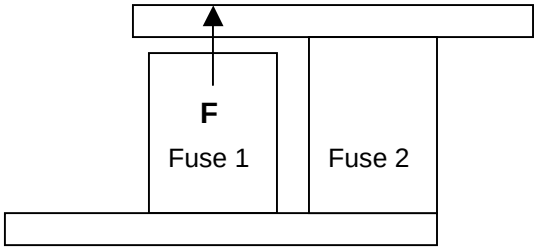

Figure 2

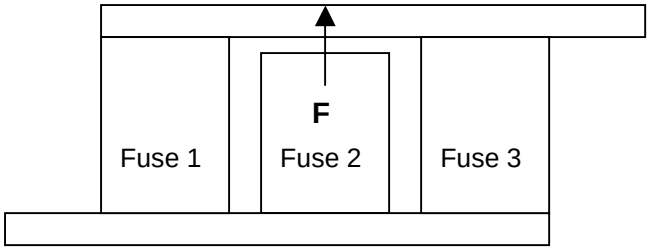

Figure 3

Figures 2 and 3 show that when trying to make the contact with all fuses between two rigid bars the end contact of fuse 1 is pulled by a force **F** . This force is easily high enough to partially break some fuse elements.

Therefore as soon as 2 fuses or more are paralleled the connection on one side of the fuses must be flexible.

4. MAIN DATA OF N FUSES IN PARALLEL

4.1. I^2t of N fuses in parallel: N^2 times the I^2t of 1 fuse

4.2. Peak let through current of N fuses in parallel: about $N^{\frac{2}{3}}$ times the peak current of 1 fuse

4.3. Arc voltage: the arc voltage of N fuses in parallel is the same as for 1 single fuse

5. CONCLUSIONS

Before paralleling 2 or more fuses in parallel it is necessary to check with the fuse manufacturer what are the rated voltage and rated current of the assembly.
It is necessary to check the difference between the fuse resistances in parallel does not exceed 5%.
The fuses must be connected to one flexible conductor.