§11. Research and Development of Oxide Superconducting Cables with a Large Current Capacity

Iwakuma, M., Kajikawa, K., Funaki, K., Matsushita, T. (Kyushu University), Mito, T.

We made a preliminary investigation of the applicability of high-T_c superconducting parallel conductors to pancake coils. For the sake of a uniform current distribution and low ac loss, the constituent strands in parallel conductors need to be transposed so as to be inductively equivalent with each other. We adopted an interdisk transposition where the strands are not transposed inside a single-pancake coil but only at the joint between the pancake coils.

We first searched for the optimum configuration of interdisk transposition in the case of 3-strand by the theoretical calculation with a circuit model. As a result, it turned out that at least 6 disks are required for a uniform current distribution, that is the strands need to be transposed at least 5 times in the case of 3-strand. An example of the optimum arrangement of the strands in the case of 6 disks with 5 layers is shown in Fig.1. We also studied the transposition in the case of many more layers and/or many more disks. We found out that the fundamental configuration of interdisk transposition as shown in Fig.1 is useful even for much larger circular-disk type windings. In any case, for a uniform current distribution, we only have to prepare the same units composed of 6 disks with the interdisk transposition as shown in Fig.1 and simply connect them in series.

In order to verify the theoretical investigation, we made small test coils with 3-strand parallel conductors composed of NbTi rectangular cross-sectional multifilamentary strands for convenience and measured the current. The experimental setup is shown in Fig.2. Rogowski coils were mounted on every strand to measure the branch current. The total transport current was measured by a non-inductive shunt resistance. The measurement was carried out at LHe temperature by applying ac transport current with an amplitude of 20 A and a frequency of 60 to 1000 Hz. The observed frequency dependence of the branch current ratio in a sample coil is shown in Fig.3. We can see that the current distribution is almost independent of the frequency, and therefore the contact resistance at the joint between the pancake coils is negligible. This fact seems to hold for a practical coil with a larger scale even at much lower frequency because the inductance is larger. The theoretical prediction is also shown in Fig.3 in comparison to the experimental results. We can see that current flowed uniformly, as theoretically predicted, within an error of 10%. We also verified the case of many more layers and/or many more disks.

Consequently it was shown that interdisk transposition is useful to obtain uniformity in current distribution in superconducting parallel conductors wound into pancake coils.

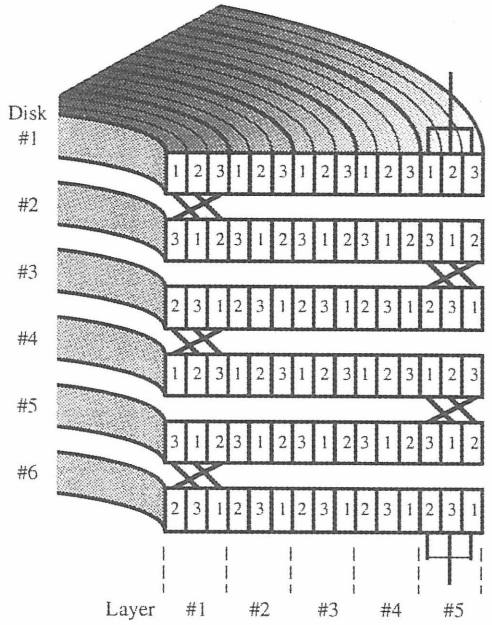

Fig.1 Fundamental configuration of interdisk-transposition in the case of a 3-strand parallel conductor.

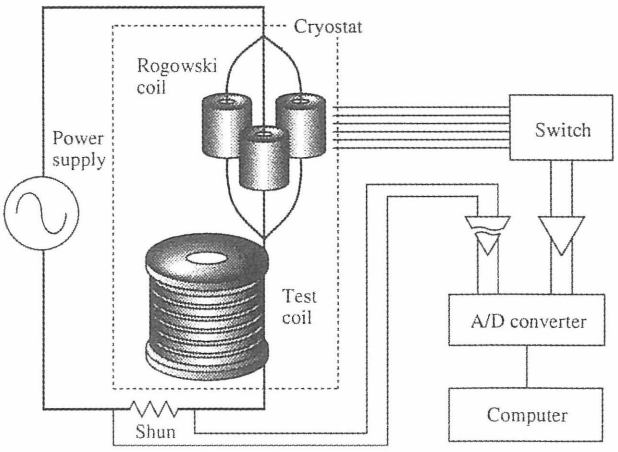

Fig.2 Experimental set-up.

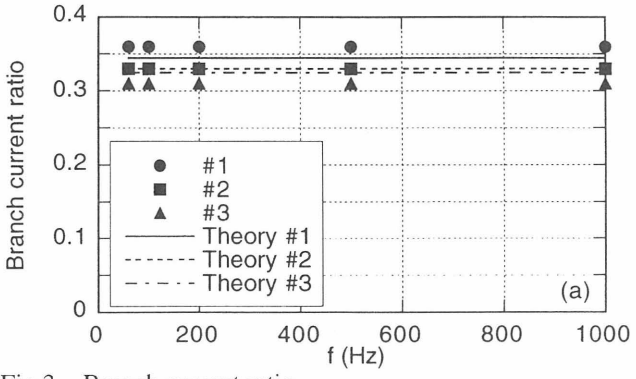

Fig.3 Branch current ratio.