§3. A Study on Current Equalization by Interphase Reactors

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A large current conductor is necessary for the superconductive coil of a nuclear fusion device, a superconducting bus line, etc. Compacted stranded conductors, CICC's, spiral cabled conductors and such are usually employed for the large current carrying conductors, in which many small size strands or tapes are connected in parallel.

However, the above parallel connection arrangement of many strands might bring about the unequal current flow among strands owing to discrepancies of a resistance and/or an inductance of each strand and thus there is a possibility of causing the increase in the ac losses and the superconducting stability might be aggravated.

We reported the strands current equalization by the action of transformer coupling, and this method was effective for large current conductors as well as magnets wound with parallel conductors and also parallel connected magnets. The idea of employing interphase reactors was developed as a more advanced approach. This time, it is examined the interphase reactor is valid for currents equalization of two parallel wires, each one having different inductance.

Fig. 1 explains how the unequal currents of two strands are equalized by means of one interphase reactor. Provided that the current of each conductor is different, a magnetic flux appears in the iron core of the interphase reactor and therefore the voltage will be induced in the winding due to the flux in order that this flux may be cancelled. This induced voltage bring about the circulating current in the electrical loop composed of two parallel conductors, one end short circuited and the other connected with the interphase reactor and thus the different current is equalized.

Two parallel conductors are represented by two small size superconducting coils (L1 L2) wound with Bi2223 silver sheath tape wires, each kept at the temperature of 77 K with liquid nitrogen, for the convenience of experimental demonstration. Each superconducting coil has the inductance of L1=1.35mH and L2 = 6.15mH. Two conductors carries the almost equal current with the help of interphase reactor as depicted in Fig. 2, that is, the current of coil L1 0.599 A and the other one 0.598 A, where the total supply current is 1.2 A. However, those currents are 0.99 A and 0.22 A in the case of having no interphase reactor, flowing according to the difference of inductance. The above test result was also confirmed by the circuit analysis.

It is worthy of noting that the number of strands equalized is basically not limited and this current equalization needs the tournament formation as shown in Fig. 4 as a case of four strands. In this case, three interphase reactors have to be provided, but it is possible to be managed with only one iron core.

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Reference

1) Nagasawa T., Yamaguchi M., Fukui S., et al., 65th Autumn Cryogenic and Superconductivity Conference (2001)188

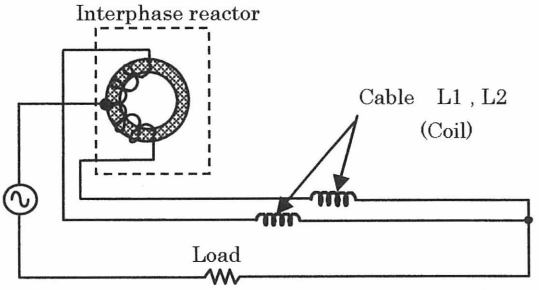

Fig. 1. Current equalization with interphase reactor

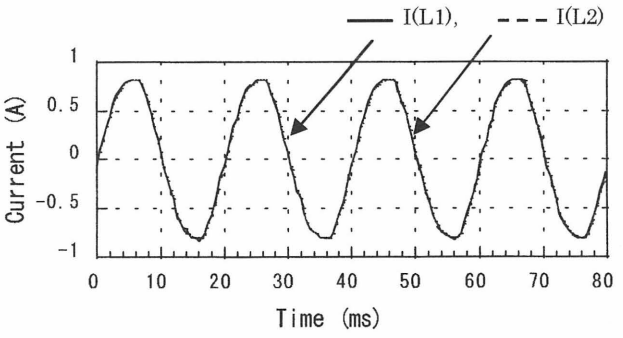

Fig. 2. Current equalization test of two strands

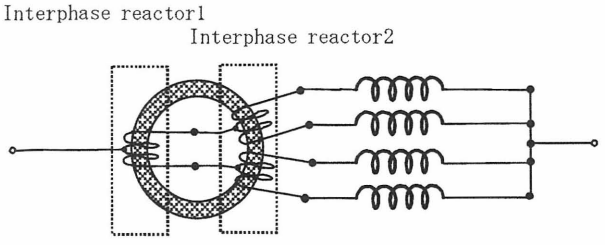

Fig. 3. Current equalization of four strands