Regions of Reversed Magnetization in Strained Wires

In a paper on the propagation of large Barkhausen discontinuities along wires,[1] it has been shown that under certain conditions a phase boundary could be made to move along a wire. The two phases separated by the boundary were distinguished by the direction of magnetization which was axial but of opposite sign. In order to obtain propagation, the main field H, to which the wire was subjected, had to exceed a critical value H_0.

By a small "stopping coil" a local field H_S can be produced opposing H and reducing the field in a short portion of the wire below H_0. Two search coils are placed on opposite sides of the stop coil and the change in induction in these places is measured ballistically. When the propagation is started from one end, the coils show to what extent the wire has changed from phase I to phase II. If the stopping field is below a critical value, complete reversal is indicated in both coils. If, on the other hand, H_S exceeds this critical value, a change is only observed in the first search coil, no change occurring in the second coil on the other side of the stop coil. This shows that the discontinuity has been stopped and by repeating the experiment with search coil I in different places along the wire, the part of the wire which has changed from phase I to phase II can be found.

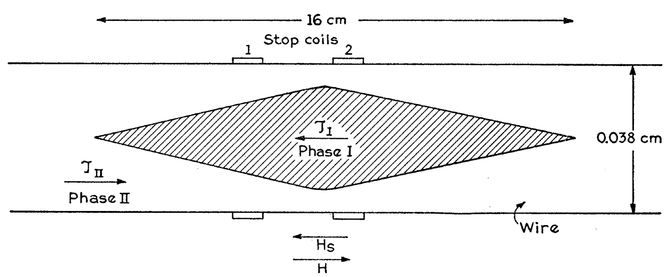

Fig. 1.

The "frozen" discontinuity, like the moving one, is cone-shaped, but its length (of the order of 10 cm) is smaller and depends on H. If now a second stopping field is applied in a place along the boundary region, and the first stopping field is removed, the tail of the boundary is held by the second coil. The front edge, however, no longer held by the first stop coil, acts as a nucleus to start propagation over the rest of the wire. The shape of the phase boundary can be determined ballistically as before and is that of a long and narrow kernel, symmetrical with respect to its center. (See Fig. 1.) The same result can be obtained by starting the propagation from both ends of the wire with one stop coil in its center. An analysis of the resulting magnetic field in the boundary region agrees with the hypothesis that the field at the boundary must be H_0.

Whereas in the former experiments the propagation was initiated either by artificial nuclei or, in the case of a spontaneous start, by accidental nuclei, whose shape in either case was unknown, we now have produced a nucleus whose size may be varied and whose shape is known, and whose behavior under various conditions can be studied. The difference and sum of the two values of external field, H_1 and H_2, e.g., at which a certain point of the boundary will start to move in opposite directions, presumably give a direct measure of $2H_0$ and the field due to the internal phase respectively.

A detailed report of these investigations will be published soon.

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[1] K. J. Sixtus and L. Tonks, Phys. Rev. **37**, 930 (1931).