

On Superposed Magnetic Inductions in Iron.

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(Read July 7 and 21, 1902.)

(Abstract.)

A communication was made to this Society on February 3, 1902, on "Magnetic Shielding in Hollow Iron Cylinders." At an early stage of this investigation, and when dealing with more magnetising forces than that due to the transverse field acting upon the shield, the subject of cross magnetisation necessarily came to the front. This paper deals, *First*, with the *superposition of two magnetising forces at right angles* to each other, and the co-ordination of the two components of the resultant magnetic induction, under the various conditions of field superposition; and *Second*, with the *magnetic æolotropy of demagnetised iron*. The same hollow iron cylinders were used as in the shielding experiments.

I. Of the two magnetising forces at right angles to each other, let H_1 be the force first acting, H_2 the force superposed. Each force acting alone produces the normal B-H induction curve. Let B_1 and B_2 be the two components of the resultant induction in the directions of H_1 and H_2 respectively.

When H_2 is superposed upon a pre-existing induction due to H_1 , the B_1 component of the resultant induction always lies above the B_2 component. Repeated reversals of H_2 accentuate this result; B_1 is further increased; and concurrently with this, B_2 is further lowered. For low fields, the B_1 component is considerably above the normal induction curve, but as the fields are increased a point is reached where the curves cross, the B_1 component then falling below the normal curve. Also the superposition of H_2 lowers the B_2 component below the normal induction curve, *with this exception*, that at low values of H_1 the superposition of the second force H_2 increases the B_2 component above the normal induction curve. This is, however, a relatively small effect.

When the superposed force H_2 carries the B_2 component round a complete magnetic cycle, the B_1 component due to H_1 kept at a constant value responds and likewise passes through a complete magnetic cycle or series of cycles.

A connection appears to exist between the change which takes place in the B_1 component and the permeability impressed upon the iron by the magnetising force which is superposed. This is especially well marked when H_1 is constant and the superposed force cyclic, the maximum and minimum values of B_1 corresponding with the maximum and minimum values of dB_2/dH_2 respectively. The whole phenomena, however, are exceedingly complicated—permeability, retentivity, coercive force, and vibration effects all contributing to the final result under the various conditions of field superpositions.

II. During the early stages of induction, the experiments described show that iron is more permeable to a reapplication of a magnetising force in the same direction (positive or negative) as that used in the immediately preceding process of demagnetising by decreasing reversals, than it is to a force (positive or negative) at right angles to that used in the immediately preceding demagnetising process. The difference for the two qualities of iron used was found to be of the order of 30 per cent., but it vanishes as the magnetising force is increased.

An explanation of this magnetic æolotropy of demagnetised iron based upon the molecular theory of induction is given.

(Issued separately October 7, 1902.)