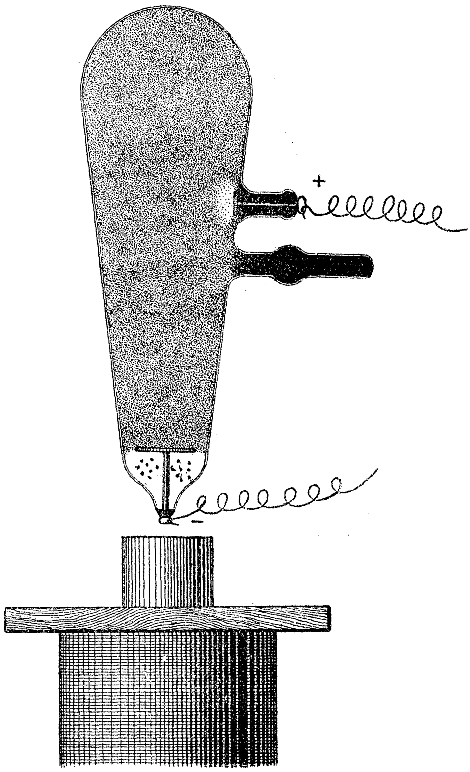

— Fig. 3. —

Further experiments with the tube placed horizontally so that the magnetic lines cut the cathode rays produced the usual deflection of the latter, but did not seem to have any appreciable effect on the internal resistance of the tube.

"The Hysteresis of Iron and Steel in a Rotating Magnetic Field." By Francis G. Baily, M.A. Communicated by Professor Lodge, F.R.S. Received April 9,—Read June 4, 1896.

(Abstract.)

That the hysteresis of iron varies with the conditions of magnetic change has been ascertained in some instances, notably those in which the attractions between the molecular magnets of the Weber-Maxwell-Ewing theory are diminished by super-imposed vibrations in the

molecules. By deduction from this theory it has been surmised that the hysteresis in magnetic metals under the influence of a constant rotary magnetic field will be less than that in an alternating field in which the magnetising force passes through a zero value. As familiar practical examples of the two conditions may be instanced: the armature core of a continuous current dynamo, and the iron circuit of an alternating current transformer or choking coil.

It is supposed that residual magnetism is due to the combination of molecular magnets in stable magnetic arrangements, and that the energy dissipated in any magnetic change corresponds to the work done in breaking up these arrangements. This energy is rendered kinetic by the movement of the magnets to form new combinations, the magnets either oscillating about the new position or moving to it aperiodically, according to the amount of damping to which they are subject. It is further suggested that the damping is of an electrical or electro-magnetic nature rather than of a frictional character, being produced by the effect of rapid oscillations of the magnets on the surrounding particles or medium. Hence any movement of the molecular magnets during which the formation of new combinations is checked or prevented will take place with considerable reduction in the energy loss due to this cause.

Such a condition is realised when the magnetic substance is subjected to a rotary magnetic field of sufficient strength to force the molecules to maintain a direction parallel to that of the field. If hysteresis is due only to the formation of new combinations and not to mechanical restraint, then under these conditions it will vanish altogether.

Experiments were carried out to verify this deduction. A finely laminated cylinder of iron was suspended on its axis between the oles of an electro-magnet which was capable of rotation about the axis of suspension of the cylinder, thus producing a magnetic field rotating in a plane at right angles to this axis. The cylinder, though otherwise free to rotate, was restrained from continuous rotation by a spring, and the angle of rotation and consequent restoring force of the spring was indicated by a beam of light reflected from a mirror on the cylinder. The speed of the electro-magnet and the exciting current could each be varied.

On rotating the magnet, the armature was dragged round until the restoring force of the spring equalled the force due to hysteresis, and the value of the latter could be obtained from the observed deflexions. The result showed that the value of the hysteresis under these conditions was very different from that obtained in an alternating field. At first the value was higher for corresponding inductions, but at an induction of about 16,000 in soft iron and 15,000 in hard steel the hysteresis reached a sharply defined maximum and rapidly dimin-

ished on more complete magnetisation, until at an induction of about 20,000 it became very small with every indication of disappearing altogether. Soft iron and hard steel gave very similar curves, and in both the curve of hysteresis-induction cut the curve obtained from the values in an alternating field at a point just before the maximum. The result fully bears out the deduction from the theory, and proves in addition that hysteresis is not sensibly due to anything of the nature of mechanical restraint of the molecules. The form of the curve also gives clear indications of the three stages of molecular movement, the first stage giving a slowly rising curve, the second a straight rapid rise, and the third a straight and much more rapid descent.

Further experiments were carried out on the effect of speed of rotation. In an alternating field the speed of reversal has been shown to be without sensible effect on the hysteresis, and theory points to this result as a natural deduction. The above apparatus was well adapted for testing the matter, since the hysteresis per reversal could be read at each instant independently of the speed. From an extremely slow speed up to 70 revolutions per second no definite change was found in the value of the hysteresis. At the same time several small modifications were noted, produced by rapid variations in the speed of rotation or magnetising force. The effect lasted through many revolutions, but ultimately the same steady condition was arrived at. At and near the maximum value the hysteresis was very variable. The effects were much more marked in soft iron than in hard steel, as would be anticipated from the theory of their constitution.

The experiments in their verification of an untried deduction form a strong proof of the validity of the molecular theory of magnetism, and throw some light on the nature of the molecular complex and of the interactions which take place therein.

"A Magnetic Detector of Electrical Waves and some of its Applications."

By E. RUTHERFORD, M.A., 1851 Exhibition Science Scholar, New Zealand University, Trinity College, Cambridge. Communicated by Professor J. J. THOMSON, F.R.S. Received June 11,—Read June 18, 1896.

(Abstract.)

The effect of Leyden jar discharges on the magnetisation of steel needles is investigated, and it is shown that the demagnetisation of strongly magnetised steel needles offers a simple and convenient means for detecting and comparing currents of great rapidity of alternation.