The operation in every case is completed by placing a piece of sterile 1 per cent. atropine ointment in the conjunctival sac, and applying a pad and bandage.

The after-treatment of these cases is conducted on general lines, namely: frequent hot bathing and the use of atropine ointment, together with complete rest in bed.

We wish to express our sincere thanks to Colonel W. T. Lister, C.M.G., A.M.S., for his kind advice and encouragement, and for his assistance with the illustrations; and also to Lt.-Colonel Sidgwick, R.A.M.C., for allowing us to put on record the experience we have gained at his Hospital.

THE RING MAGNET.*

BY

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UNTIL Professor Mellinger, of Basle, invented the ring magnet (*Innenpolmagnet*), the giant magnets in use by ophthalmic surgeons were all modifications of the Haab pattern. These consist of a central core of soft iron, surrounded by a bobbin of insulated copper wire. The core is prolonged into a cone which terminates in a point.

All these instruments have great polar magnetic power, but, as the lines-of-force radiate in all directions, the power is concentrated at the immediate pole, and rapidly falls off as the distance increases—in fact, diminishes as the square of the distance.

The divergence of the lines-of-force can be graphically shown by attaching a bunch of keys or iron filings to the pole of the magnet.

This feature diminishes the value of a magnet of the orthodox type for removing fragments of steel from the interior of the eye, and explains why a hand magnet is unable to extract these bodies unless it is brought into almost immediate contact with them.

A field of sufficient saturation can be obtained by the use of a giant magnet, such as a Haab, Volkmann, Schlosser, or Rollet.

Professor Mellinger has met the difficulty in a more scientific manner.

It is well known that when an electric current flows round a

* A paper read before the MIDLAND OPHTHALMOLOGICAL SOCIETY on October 3rd, 1916. The new magnet in the operating theatre of the Birmingham and Midland Eye Hospital was shown to the Society, and the direction of the lines-of-force in the Haab and ring magnet was demonstrated by iron filings.

solenoid, a homogeneous magnetic field is generated, whose greatest saturation lies at the centre of the solenoid axis.

The lines-of-force lie parallel and do not diverge, as in the case of the ordinary magnet. In consequence, the tractive force is great along the central axis at right angles to the plane of the ring.

FIG. 1.

Outside this axis the force rapidly falls off, a fact which we shall emphasize when describing the method of employing the instrument.

The ring, or internal pole, magnet was originally made in Switzerland, but it is now manufactured in London by Messrs. Weiss, of Oxford Street.

The first in England was installed at Newcastle-on-Tyne, and after

informing myself that this had proved a success, I advised the Committee of the Coventry Hospital to procure one. I have used this instrument for the past four years, and have satisfied myself that it is thoroughly trustworthy.

We have just received a ring magnet at the Birmingham Eye Hospital, and, although we have used it only for a few weeks, we are satisfied that it is immensely superior to our Haab, which after doing duty for many years, was beginning to show signs of defective insulation.

The ring magnet consists of an oval ring just large enough to admit the patient's head. This is wound with about a mile of insulated copper wire, whose diameter varies according to the voltage of the current at command. This solenoid is covered with an insulating mass, and is fitted within a heavy iron case, which increases the density of the magnetic field. See Fig. 1.

FIG. 2.

The original model was mounted, like the Haab, upon a standard, and the patient was obliged to sit with his head in the ring. The disadvantages of this posture are obvious, and I have experienced them with my magnet at Coventry. I have heard of an accident due to this position.

The new model (Fig. 1) is a great improvement. The ring is balanced, and can be used either for a sitting subject, or placed round the head of a patient recumbent upon the operating table. This feature has proved to be so valuable that I have sent the Coventry Magnet to be remounted upon a balanced frame.

A switch and a rheostat form part of the new apparatus.

The magnet can be wound for any desired voltage between 100 and 250. If the town current be of the alternating type, a rotary converter must be fitted. There are fluid rectifiers on the market, but I am told by a practical electrical engineer that they are unsatisfactory. The Volkmann magnet used at the Hotel Dieu, at Paris, is supplied with a continuous current from a mercury vapour lamp rectifier.

A case of soft iron rods and a massive horn are supplied with the instrument.

I have had a small spatula made by Messrs. Weiss which can be inserted into the eye, and is a useful addition to the apparatus. This is shown in Fig. 2.

Experience with the spatula has shown that one tip should be bent over almost at a right angle.

I find that the magnet is balanced with the horn *in situ*. This is infrequently used, and is rather in the way when the instrument is employed upon a recumbent patient. Under these circumstances, without the horn, the magnet does not balance. I have suggested to Messrs. Weiss that they should fit the stand with adjustable balance weights, an improvement which they have adopted. The locking-screws are unsatisfactory, and have to be hove up very hard. This will be remedied in future by introducing a split locking-washer.

FIG. 3.

The tractive power of the magnet is enormous, and great care must be taken that the fragment is not dragged through the lens. The force, however, can be so perfectly graduated by the use of the rheostat and by the choice of rods, that there is no excuse for causing damage to the eye.

Watches must not be brought near the apparatus at any time. The residual magnetism is quite sufficient to magnetise the hair-spring. When in use, the magnet will saturate a watch and

actually stop it. I have twice had to have my watch demagnetised since I have had a ring magnet.

The patient is placed upon the table and his head is raised upon a small pillow. The ring is placed over him, and his head so adjusted that the injured eye lies in the centre of the solenoid (see Fig. 3).

He is now directed to fix an object in the ceiling, and warned that if he move his eye it may be seriously injured. A speculum is introduced, and the current turned on, with full use of the rheostat.

The smallest rod is first taken up and held firmly. The solenoid forcibly draws the rod toward its centre, hence the necessity for a secure grasp. For the same reason the wrist should rest upon the ring or upon the rest furnished with the magnet.

The rod is approached to the eye along the anterior-posterior axis of the globe, and carefully moved towards the cornea. The rheostat is gradually taken out of action, until the full current has been tried, using the small staff. This procedure is repeated with each rod in turn, always passing on to the next largest size. If no effect be produced, the horn is placed in position, and the magnet used as a Haab.

Generally the splinter appears behind the iris with one of the smaller rods. It is now coaxed into the anterior chamber.

The eye must be under the full action of atropine, otherwise the splinter may get impacted in the iris, and iridectomy will become necessary. This calamity can generally be avoided if the pupil be fully dilated before any attempt be made to extract the splinter.

When the foreign body is in the anterior chamber, the current is turned off, and an incision made with the keratome. It is now easy to remove the splinter. The current is turned on, the rheostat placed at "Weak Current," and the small spatula introduced. No hand magnet is necessary; the spatula is sufficient.

In cases where it is judged that it is wiser to extract through the sclera (and I think there are many such), an incision is made, or the wound enlarged; a suture is placed ready in the conjunctiva; and the spatula introduced. If the small spatula fail, the largest may succeed, as it did in the last magnet operation I performed. The tractive force which is exerted by the magnet is very much greater than any which can be obtained by a hand magnet, and in consequence we get more successes than we did with the older methods. The fragment will fly to the spatula from a much longer distance than it will to the Snell, and it is not so necessary to place the instrument almost upon the splinter.

For the same reason foreign bodies embedded in exudate are more likely to be dislodged by the greater force exerted.

If great care be taken to employ only the minimum force which

is necessary to remove these bodies, I believe that we shall, with our new magnet, save many eyes that would have been lost had we the Haab and the Snell alone at our command. But if undue force be used, we shall certainly have more detachments of the retina in cases where the fragment is encapsuled.

I cannot help feeling that these operations, which require great judgment and skill, should not be deputed to the house surgeons until they have proved that they are possessed of the necessary judgment and *technique*.

In the past I have used the Haab for every case of steel splinter in the eye where the ring magnet has failed. *In no single example has the Haab removed the foreign body under these conditions.*

I am sure that with the use of the spatulæ introduced into the eye, we shall be able to remove many pieces of steel which have failed to appear when the magnet has been used according to the classical Haab *technique*.

I would, in the case of a presumedly small spicule of steel, always first try to bring it round the lens, but if this method fail, and I am certain that there is a foreign magnetizable body in the eye, I shall generally make an incision in the sclera and attempt to remove it with the spatula.

We should never forget that there may be two or more splinters in the eye. I have lost one case of this type by overlooking a second fragment. To avoid this error, a second X-ray photograph should be taken when a foreign body has been extracted.

The advantages of the new model of the ring magnet in comparison with those of the Haab pattern are so great, that, in my opinion, the older instruments are completely outclassed.

They may be summarised as follows:—

(1) The operation can be performed upon a patient lying upon the table.

(2) There is no necessity to move him when the splinter has appeared in the anterior chamber. I have lost sight of the fragment in more than one case, and have been obliged to make the patient get up again, and place him before the magnet a second, or even a third, time.

(3) There is no necessity to use a hand magnet. As soon as the splinter is seen in the anterior chamber, the circuit is broken, the anterior chamber opened, and the spicule removed with the spatula.

(4) The power of the ring magnet at its centre is great, and is under absolute control.

(5) It is much easier to operate with the rods upon a motionless patient than to have to move his head this way and that before the Haab.

(6) A patient sitting before the Haab may experience pain, and move at the critical moment; he may even faint from the pain.

The only valid objection to the magnet is that the force is considerable only at the centre of the solenoid. In consequence, the eye must be kept in the centre. I have never found any difficulty in placing the eye in this situation and keeping it there.

I have succeeded in removing pieces of steel from the cornea which were difficult to extract with a needle, and shall make further experiments in this direction.

The two photographs in the text (Figs. 1 and 3) are from the new magnet at Birmingham.

Fig. 3 shows the ring placed too obliquely over the patient's head; it should be almost horizontal, resting gently upon the neck.

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ABSTRACTS.

I.—COLOUR INTERLACING AND PERIMETRY.

- Walker, C. B.**—Colour interlacing and perimetry. *Trans. American Ophth. Society*, Vol. XIV, Part ii, page 684, 1916.

This paper which formed a thesis by **Walker**, of Boston, for membership in the Society, deals with some improved perimetrical methods devised by the author, and the results obtained by them in neurological cases in which there were changes in the optic discs of a nature suggesting increased intracranial pressure.

All surgeons who have paid attention to the difficult subject of perimetry, a subject very inadequately dealt with in the text-books, must have felt how unsatisfactory the results obtained by the ordinary recording perimeters are. For the rough measurement of the peripheral field for white, in the hurry inseparable from the