SOME EXPERIMENTS IN MAGNETIC MOMENT.

BY W. P. BECK.

AT the suggestion of Professor James S. Stevens, and under his direction I have undertaken during the past year a study of the effects of certain mechanical changes upon the magnetic moment of a bar magnet. These changes were comprised under four heads: bending, twisting, concussion, change in temperature. The experiments were carried on in the constant temperature room on the first floor of the Shannon physical laboratory; the conditions for taking observations were favorable, and the liability to errors due to external disturbances was small.

EFFECTS OF BENDING.

A bar of tool steel $1' \times 1'' \times \frac{3}{16}''$ was magnetized by being placed in a helix through which was passing a strong current. It was then placed on two brass blocks as shown in Fig. 1. The edges

Fig. 1.

of the blocks served as knife-edges and were kept at a constant distance of 29.5 cm. apart. The magnetometer was placed on the block *B* and the "end on" position of the magnet bar *I*. Lead weights were placed upon the wooden scale-pan *P*, and resulting

changes in deflections of the magnetometer needle were read by a telescope and scale. By means of a micrometer microscope it was seen that the bar returned to its original position when the weights were removed, and therefore the limit of elasticity was not reached in any case.

TABLE I.

No.	Scale Reading.	Microscope Reading.	Weights on Pan.	Temp. C.
1	46.45	0-2.1	500 g.	17.7°
2	46.54	5-4.2	4,500	17.7
3	46.30	11-9.1	9,650	17.7
4	46.22	14-8.5	12,025	17.7
5	46.24	12-1.2	9,650	17.8
6	46.01	5-8.1	4,500	18.0
7	46.09	0-1.9	500	18.0

For zero deflection, scale reading = 9.84.

Tables II. and III. give representative readings. These were carefully taken but the results are not very satisfactory. In Table IV. a greater bending was effected by use of the lever *EF*. A force due to a weight of 16,000 grams was thus alternately applied and released, with the results indicated in Table IV.

TABLE II.

No.	Total Weight on Bar	Scale Reading.	Temp. C.
1	0 g.	46.51	19.3°
2	590	46.32	19.4
3	2,590	46.14	19.4
4	5,455	46.11	19.4
5	8,500	46.13	19.4
6	10,700	46.08	19.4
7	12,200	45.92	19.4
8	12,200	45.82	19.4
9	15,100	45.52	
10	17,000	44.78	19.0

For zero deflection, scale reading = 9.84.

Distance of S. pole from needle = 76.30 cm.

Curve No. 2 represents the relation between the magnetic moment and the weights applied. The time of taking the observations is noted in the tables, since considerable variations of *H* occur during 24 hours, and this work assumes *H* to be constant. The changes in *H* should be noted here as a source of error, but the general result remains, that bending a magnet tends to decrease its moment.

Fig. 2.

TABLE III.

No.	Force, in Grams.	Scale Reading.	Temp. C.
1	0	42.09	18.8°
2	0	42.02	"
3	16,000	41.91	"
4	0	41.81	"
5	16,000	41.77	"
6	0	41.68	"
7	16,000	41.73	"
8	0	41.66	"
9	16,000	41.66	"
10	0	41.58	18.8
11	16,000	41.53	"
12	0	41.45	"
13	16,000	41.51	"
14	0	41.34	18.8
15	16,000	41.40	"
16	0	41.30	18.8
17	0	41.22	"
18	0	41.18	"
19	0	41.22	"
20	16,000	41.28	"
21	16,000	41.34	"

EFFECTS OF TWISTING.

In order to twist the magnet each end was rigidly fixed in slots in brass blocks, and the center attached to a bar which served as a lever. To the other end of the lever was fastened a cord which in turn was attached to one arm of a balance. By applying weights to the other arm, the desired torsion could be given to the magnet.

TABLE IV.

No.	Force.	Deflection.	Temp. C.
1	0	28.77	17.0°
2	500 g.	28.68	"
3	1,000	28.59	"
4	1,500	28.53	"
5	1,500	28.63	"
6	2,000	28.46	"
7	2,500	28.23	"
8	3,000	27.91	17.0
9	3,370	27.66	"
10	3,870	27.19	17.2
11	3,370	27.18	"
12	3,000	27.05	17.3
13	2,500	27.04	"
14	2,000	26.90	"
15	1,500	26.76	17.4
16	1,000	26.68	19.2
17	500	26.52	19.1
18	0	26.48	"
19	0	26.25	"
20	500	26.08	"
21	1,000	26.06	"
22	1,500	25.93	19.9
23	2,000	26.00	"
24	3,000	25.93	"
25	3,870	25.78	"
26	4,800	25.30	"
27	5,670	24.68	19.9

Table IV. expresses the results obtained, and they are shown graphically in plot No. 3.

The results show that there is a loss in magnetic moment produced by twisting; and that the loss is not regained by the magnet when the torsion is removed. As a check the

Fig. 3.

magnet was twisted in the opposite direction, when similar results were obtained.

EFFECTS OF CONCUSSION.

The object of this part of the experiment was to discover if any law governed the loss of magnetization when a magnet was severely jarred. The deflection of the magnetometer needle was noted when the magnet was in its normal condition ; the magnet was then removed, held vertically five cm. from a stone pier and allowed to drop, striking squarely on its N. pole. It was caught on the rebound and placed in its former position with reference to the magnetometer, and the deflection again read. This was repeated for several heights with results which follow :

TABLE V.

No.	Pole Struck.	Height of Fall.	Scale Reading.	Deflection.	Decrease of Deflection.
1		0 cm.	35.09	20.26	
2	N.	5	34.76	19.93	.33
3	S.	5	34.19	19.36	.57
4	N.	10	33.84	19.01	.35
5	N.	10	33.75	18.92	.09
6	N.	20	33.46	18.63	.29
7	N.	30	31.92	17.09	1.54
8	N.	30	31.81	16.98	.11
9	N.	30	31.67	16.84	.14
10	N.	40	31.78	16.95	-.11
11	N.	50	31.88	17.05	-.10
12	N.	100	28.70	13.87	3.18

No regularity is observed in the falling off of the deflections ; but it may be noted that blows of a certain intensity have a greater proportional effect than others, and that if the magnet be struck a series of blows of about the same intensity, the first will produce by far the greatest effect. This would suggest that if one is experimenting with a magnet which he wishes to remain at a constant intensity, but which must undergo some jar in the experiment, it would be well to subject the magnet at the outset to a jar similar to those it is likely to receive.

Conclusion.—In general it may be said that the sources of error which were likely to exist in these measurements were the following: Uncertainty as to values of H at different times; instability of the magnetometer needle; the presence of other bodies in the field which might affect the needle. The first of these has already been discussed. The second was eliminated to a considerable extent, but not entirely. Regarding the third, great pains was taken to make the apparatus free from iron.

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