XXXV. Electromagnets.—IV. Cast iron, charcoal iron, and malleable cast iron

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light disappeared each time. It follows from this, as well as from former observations of Hittorf* and W. Siemens† on the luminosity of flames, that up to the temperature of melting iridium, gases possess no perceptible emissive power, if they are not concerned in chemical changes or in electric discharges. The cessation of luminosity at the white heat of the electrodes may perhaps be explained by the hot metallic vapours taking over the conduction, so that only a small fraction of the current goes through the hydrogen or nitrogen, which is not sufficient to bring it to luminosity. The conditions under which metallic vapours emit light may be quite different from those which hold good for ordinary gases. The investigations of Schuster‡ have shown, at least, that mercury vapour in a vacuum tube, from which every trace of other gas has been expelled, presents essentially different and, in fact, simpler phenomena, so that the electric discharge takes place without glow-light, dark space, or stratifications. Whether Schuster's explanation is correct, that the reason is to be found in the simpler constitution of mercury vapour, or whether metallic vapours generally do not show this simpler mode of discharge, seems to be worthy of further investigation. Since I have myself always seen an unstratified coherent mass of light filling the space between the electrodes in an arc of 3 centim. in length, the second possibility appears to me the more probable.

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XXXV. *Electromagnets*.—IV. *Cast Iron, Charcoal Iron, and Malleable Cast Iron*. By R. H. M. BOSANQUET, *St. John's College, Oxford*.

To the Editors of the Philosophical Magazine and Journal.

GENTLEMEN,

THE following measures of permeabilities have been made on a number of rings of cast iron, charcoal iron, and malleable cast iron. The magnetizing forces used varied in all cases from small forces to forces large enough to raise the metal to a condition but little removed from saturation. I do not include at present any comparisons with formulæ, as the facts are perhaps best kept separate in the first instance. These measures complete all the experiments on rings which I have contemplated so far.

It may be convenient to summarize shortly some chief points of the results of all the experiments on rings.

* Wied. *Ann.* vii. p. 587 (1879). † *Ibid.* xviii. p. 311 (1883).

‡ Proc. Roy. Soc. xxxvii. p. 317 (1884).

Permeabilities or Susceptibilities.

	Small inductions.	Maximum permeability.	Permeability for $\mathfrak{B}=10,000$.	For $\mathfrak{B}=14,000^*$.
Cast iron	{ 50 80	170 250	30 80	
Malleable cast iron ...	{ 160 240	700 800	400 500	20 100
Wrought iron	{ 200 450	1800 2500	1200 2000	500 1000
Charcoal iron	{ 450 470	2900 3000	2000	600 860
Cast tool steel (hard) ..	{ 40 50	145 155	100 130	70 86
" " (soft) ...	{ 90 120	420 460	350 450	200

Saturation-points.

 $\mathfrak{B} =$

Cast iron	9,000—14,000.
Malleable cast iron	14,000—16,000.
Wrought iron }	17,000—19,000.
Charcoal iron }	
Cast tool steel, both hard and soft	20,000.

The malleable cast-iron rings were supplied to me by Messrs. Crowley, of Sheffield. The material cuts exactly like charcoal iron; and it seemed probable that its magnetic qualities might be similar to those of charcoal iron. In this case the possibility of casting the material would have been of the highest importance with reference to dynamo machines.

The results for ordinary cast iron show that it is wholly unfit for use in dynamo machines; the low saturation-point being particularly objectionable. The malleable cast iron would undoubtedly be a great improvement on ordinary cast iron; but still inferior to wrought iron.

It may be noted that the variations of temper in the different rings of malleable cast iron did not appear to correspond to any recognizable differences, either mechanical or magnetic.

About the time these experiments were drawing to a close I became aware, by a notice in 'Nature,' that Dr. Hopkinson had communicated to the Royal Society a series of investigations apparently similar to my own. I have not yet been able to learn any thing about the contents of the paper in question; but considering the diversity of the properties of different specimens, as well as of the methods in use, I still hope that my results may not be without usefulness.

* As before, $\mathfrak{B}$ stands for the magnetic induction, or number of lines of force across unit area; μ for permeability or susceptibility.

TABLES OF RESULTS.

Cast-Iron Ring, T. Cylinder Iron (Hard).

Mean diameter ..... = 21.625 centim.
 Bar-thickness ..... = 1.936 "
 Number of coils ..... = 7223.

$\mathfrak{B}$.	μ obs.	$\mathfrak{B}$.	μ obs.
67	55	4146	142
267	75	4601	127
2007	169	4888	117
2424	167	5327	104
2886	163	5693	98
3259	163	6459	75
3253	160	7177	60
3397	154	7639	52
3668	151	8181	44
3955	143	9098	33

Cast-Iron Ring, P (Medium Hard).

Mean diameter ..... = 10.0 centim.
 Bar-thickness ..... = 1.3095 "
 Number of coils ..... = 2504.

$\mathfrak{B}$.	μ obs.	$\mathfrak{B}$.	μ obs.
37	52	3921	200
229	81	4705	201
581	109	5543	193
908	127	6163	171
1514	158	7258	137
1630	159	8607	107
2033	175	9665	87
2614	206	11123	62
2522	199	13038	29
3264	190		

Cast-Iron Ring, Q (Medium Hard).

Mean diameter ..... = 21.925 centim.
 Bar-thickness ..... = 1.450 "
 Number of coils ..... = 7086.

$\mathfrak{B}$.	μ obs.	$\mathfrak{B}$.	μ obs.
78	75	5680	159
624	124	6199	144
802	100	6877	136
2357	210	7415	104
3013	214	8621	92
3114	205	8862	78
3683	192	9793	75
4122	201	10633	64
4253	191	10756	46
4481	188	12161	46
4952	179		

Cast-iron Ring, N (Medium Hard).

Mean diameter ..... = 10.1 centim.
 Bar-thickness ..... = 1.321 "
 Number of coils ..... = 1138.

$\mathfrak{B}$.	μ obs.	$\mathfrak{B}$.	μ obs.
24	61	3032	219
159	75	3605	256
412	94	4089	212
703	121	4894	199
1226	154	5243	188
1240	155	6580	146
1316	159	7772	111
1752	189	8283	93
2471	215	9497	71
2558	211	10786	35
2616	204		

Cast-Iron Ring, O (Soft.)

Mean diameter ... .. = 10·2 centim.
 Bar-thickness ..... = 1·0325 "
 Number of coils ..... = 2098.

$\mathfrak{A}$.	μ obs.	$\mathfrak{A}$.	μ obs.
40	77	3891	226
236	86	4447	214
578	115	5454	216
865	133	6184	197
1346	164	7226	158
1624	176	8442	120
2286	199	9241	101
2814	219	10769	73
3509	230	13983	38
3570	250		

Swedish Charcoal-Iron Ring, R (Soft.)

Mean diameter ..... = 10·5 centim.
 Bar-thickness ..... = 1·304 "
 Number of coils ..... = 517.

$\mathfrak{A}$.	μ obs.	$\mathfrak{A}$.	μ obs.
79	467	10666	2059
1527	1916	11281	1870
4372	2866	11723	1743
5189	2895	12569	1426
6803	2799	13203	1223
8149	2633	14087	858
8418	2588	14894	585
8763	2540	15336	433
8841	2477	18277	107
9455	2344		

Swedish Charcoal-Iron Ring, S (Soft).

Mean diameter ..... = 11·4 centim.
 Bar-thickness ..... = 1·547 "
 Number of coils ..... = 560.

$\mathfrak{A}$.	μ obs.	$\mathfrak{A}$.	μ obs.
87	453	10379	2139
1345	1776	10514	2013
3397	2750	11148	1903
5149	3027	12480	1322
6201	2954	12980	1072
7616	2793	13587	821
8034	2675	14059	606
8182	2620	14463	471
8411	2552	15366	276
9907	2291	17146	90

Malleable Cast-Iron Ring, Z (Hard).

Mean diameter ..... = 10·0 centim.
 Bar-thickness ..... = 1·332 "
 Number of coils ..... = 1224.

$\mathfrak{A}$.	μ obs.	$\mathfrak{A}$.	μ obs.
84	237	7748	706
839	422	7829	679
3529	767	8011	666
3894	753	8600	650
4543	768	9167	567
4726	775	9573	515
5273	828	9938	427
5760	796	10445	378
6003	784	11034	267
6592	756	11926	175
6693	749	13183	95
7200	723	14765	40
7504	717		

Malleable Cast-Iron Ring, W (Hard).

Mean diameter ..... = 10.05 centim.
 Bar-thickness ..... = 1.386 "
 Number of coils ..... = 1189.

$\mathfrak{B}$.	μ obs.	$\mathfrak{B}$.	μ obs.
84	199	8352	653
708	329	8805	603
2211	583	9296	525
3518	726	9925	446
4363	776	10220	392
4520	760	11320	273
5542	796	11792	196
5806	789	12185	146
6348	774	13129	97
7134	761	15035	40
8097	688		

Malleable Cast-Iron Ring, Y (Medium Hard).

Mean diameter ..... = 10.075 centim.
 Bar-thickness ..... = 1.131 "
 Number of coils ..... = 1207.

$\mathfrak{B}$.	μ obs.	$\mathfrak{B}$.	μ obs.
75	163	7585	752
478	281	7741	739
1673	518	7702	753
3413	719	8363	718
4435	774	8947	633
4707	776	9433	577
5057	794	10114	465
5251	784	10406	420
5374	791	11048	291
6546	777	11437	191
6866	793	12409	120
6866	782	12915	100
7294	762	15016	41

Malleable Cast-Iron Ring, U (Medium Hard).

Mean diameter ..... = 10.0 centim.
 Bar-thickness ..... = 1.335 "
 Number of coils ..... { = 503.
                                               = 1981.

$\mathfrak{B}$.	μ obs.	$\mathfrak{B}$.	μ obs.
33	22	4575	737
200	231	5228	781
741	388	7095	812
747	337	8085	574
829	315	9523	560
1175	377	10569	418
1531	430	11110	330
2252	539	11857	212
1942	497	13631	78
2983	611	13965	18
3548	652		

Malleable Cast-Iron Ring, V (Soft).

Mean diameter ..... = 10.01 centim.
 Bar-thickness ..... = 1.341 "
 Number of coils ..... = 1162.

$\mathfrak{B}$.	μ obs.	$\mathfrak{B}$.	μ obs.
70	173	8913	525
495	238	9091	502
1414	387	9268	499
2891	547	9584	481
3254	578	10037	448
4023	612	10393	407
4634	631	10590	385
5719	665	10669	386
5995	649	11773	270
7060	541	12621	195
7888	571	13015	152
8125	558	13568	109
8480	549	15658	46
8716	529		

Malleable Cast-Iron Ring, X (Soft).

Mean diameter ..... = 10.115 centim.
 Bar-thickness ..... = 1.304 "
 Number of coils ..... = 1220.

$\mathfrak{B}$.	μ obs.	$\mathfrak{B}$.	μ obs.
62	178	7144	735
276	146	7628	724
1293	491	7669	755
3784	712	8759	715
3976	701	9142	626
4395	717	9526	618
4622	767	10373	495
5045	746	11080	417
5247	746	11907	276
54.9	753	12412	217
5853	754	12876	173
6196	759	13562	115
6781	762	15762	47

XXXVI. *On the Influence of Heat on the Rate of Chemical Change.* By JOHN J. HOOD, D.Sc. (Lond.)*.

THE accelerating action of heat on the rate at which a chemical change progresses has been made the subject of investigation by several chemists. The amount of work that has been done towards the elucidation of this side of the great problem of chemical action, expressing the rate as a function of the temperature, is as yet too insignificant to allow of any deductions being drawn relative to the probable mechanical processes that take place in a medium containing a chemical system undergoing change. Considered in the light of molecular interdiffusion, it would seem probable that the relation between the rate of change of different chemical systems comprising two or more active bodies (active in a chemical sense) and the temperature should be of the same type; and the experiments that have been made on this subject all seem to show this in common, that the rate of the change increases very rapidly for small increments of temperature.

Warder†, in his experiments on the speed of saponification of ethylic acetate, was led to infer that the increase of speed in this reaction is approximately as the second power of the temperature.

Mills and Mackey‡, studying the evolution of hydrogen from zinc and hydric sulphate at different temperatures, a case of a chemical system of a non-homogeneous character,

* Communicated by the Author.

† American Chemical Journal, vol. iii.

‡ Phil. Mag. [5] xvi.