AN

EXPERIMENTAL ENQUIRY

INTO THE STRENGTH AND OTHER PROPERTIES OF CAST IRON

FROM VARIOUS PARTS OF THE UNITED KINGDOM.

By Mr. WILLIAM FAIRBAIRN.

Read 7th of March, 1837.

The multifarious uses to which cast iron is applied, and the facility with which it can be moulded into almost every shape, render the investigation of its properties a subject of interest in a national as well as an individual point of view. Many experiments to ascertain its strength, elasticity, and other properties have therefore been made by authors, not only of our own, but other countries; as by Banks, Rondelet, Muschet, Bramah, Dunlop, Brown, Rennie, Tredgold, &c. besides the numerous experiments made at my works by my friend Mr. Hodgkinson.

None of those writers, however, with the ex-

ception of Tredgold, have, so far as I know, made any inquiries into the fluidity of the different sorts of cast irons; nor has much attention been paid to their comparative powers of application.

The following pages contain—1st., a laborious enquiry into the transverse strength of cast irons from various parts of the kingdom; and, 2ndly, an extended investigation into the less cultivated field of their relative values, as regards their adaptation to the arts.

In pursuing these experiments it was originally my intention to have investigated the question of mixtures, or the proportions necessary for the production of different sorts of castings. This subject is, however, of such importance, and requires so much time and labour, that I am induced to forego its consideration for the present, and confine myself exclusively to the objects above stated. In adverting to this matter, however, it may be proper to remark that the same admixture or compound of pig iron is not suited for every description of casting; a water wheel axle, or steam engine beam, for instance, requires a different mixture to the finer and sof-

ter preparations for light machinery. Cylinders, air pumps, and pistons of steam engines have also (in practice) their peculiar compounds; and it is important in all these operations to have confirmed data (the results of actual experiment) for directing the labours of the architect, engineer, and mechanic.

Tredgold in his essay on the strength of cast iron seems to have been aware of the deficiencies under which the labours of the iron founder have been conducted; he describes the properties of the iron* but gives no proportions for the mixtures; nor have we at the present time any guide beyond what is indicated by the appearance of the fracture. The amalgamation of the different metals, however important in practice, is generally left to chance; or at best to the

* Soft iron yields easily to the file, when the external crust is removed, and is slightly malleable in a cold state.

White cast iron is less subject to be destroyed by rusting than the grey kind, and it is less soluble in acids; therefore it may be usefully employed when hardness is necessary, and when its brittleness is not a defect; but it should not be chosen for purposes where strength is necessary.

White cast iron, in a recent fracture, has a white and radiated appearance, indicating a crystalline structure; it is very brittle and hard. Gray cast iron has a granulated fracture of a gray colour with some metallic lustre; it is much softer and tougher than the white cast iron.—Tredgold's Essay, p 7.

imperfect knowledge of the person who attends the furnace: on some future occasion I may, however, make this a distinct subject of enquiry.

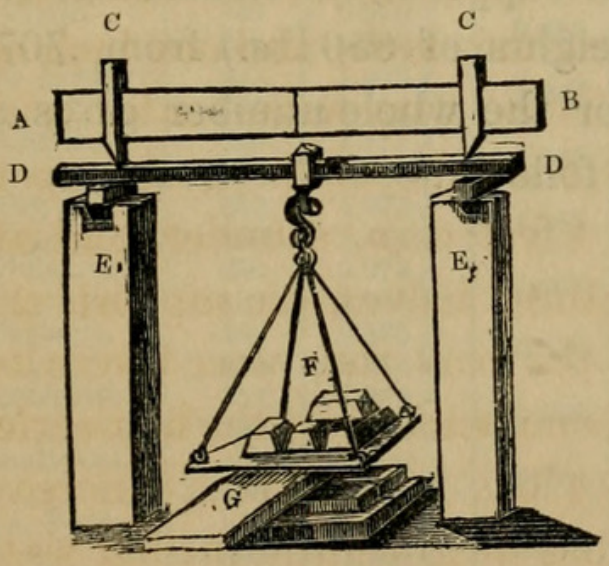
During the prosecution of the following experiments, I have been favoured with the assistance of Mr. Hodgkinson, to whom I am indebted for the calculations and many valuable suggestions; also to one of my own pupils, Mr. J. Patchett, who rendered valuable assistance.

Before exhibiting the experiments, I would here observe that they were made on quadrangular bars, one inch, and one inch and a half, square. These bars were loaded with weights suspended from the middle, and supported, first, on props 4 feet 6 in. asunder, and afterwards, their fractured halves, on supports 2 feet 3 in. asunder; the bars thus placed were loaded with weights, commencing, in the first series (4 feet 6 in.) with 14 lbs., and generally increasing in the ratio of that weight until the bar was broken.* This method was adopted in all the experiments, and conducted with such care as to ensure correct results.

*In the 2ft. 3in. bars, 28lbs. was not considered too great an increase.

The deflection was ascertained every time the weights were increased; and, in order to discover the defects of elasticity, the set was taken at equal intervals between the weights during the progress of the experiments. Considerable attention was also paid to observed discrepancies appertaining to the point at which the elasticity became defective.

The following sketch of the apparatus shows in what manner the experiments were conducted :—



A B represents a straight edge or parallel guage, having two dovetailed slides C C, to regulate the height above the bar D D, resting upon the supports E E, and F the scale on which the weights were laid. The

method adopted in removing the weights, for the purpose of ascertaining the defects of elasticity, was by pressing down the end of a wooden lever, G, applied to the bottom of the scale, and thus raising it to a height sufficient to disengage the hook every time the set was taken; this was done by a slow steady motion, and the weights were laid gently upon the scale to prevent jerks or sudden derangement of the parts under strain.

In 52 experiments on inch bars 4 ft. 6 in. between the supports, the deflections varied (with equal weights of 350 lbs.) from .707 to 1.582, which for the whole number gives a mean of 1.051 as follows:—

Table of deflections as exhibited with equal weights on bars cast to be 1*in. square* and* 4*ft.* 6*in. between the supports.*

No. of Experiments.	Names.	Weight in lbs.	Deflection in inches.	Mean.	
1	Apedale.	350	1.115	1,106	
2	,,	350	1.098		
3	Varteg.	350	1.050	1,045	
4	,,	350	1.040		
5	Monkland.	350	1.352	1,358	
6	,,	350	1.365		
7	Carroll.	350	0.810	0,825	
8	,,	350	0.840		
9	Windmill End.	350	0.834	0,862	
10	,,	350	0.890		
11	Low Moor.	350	1.180	1,195	
12	,,	350	1.210		
13	Butterley.	350	1.130	1,142	
14	,,	350	1.155		
15	Beaufort.	350	0.745	0,726	
16	,,	350	0.707		
17	Maesteg.	350	1.115	1,144	
18	,,	350	1.176		
19	Level.	350	1.023	1,005	
20	,,	350	0.987		
21	Old Park.	350	1.025	1,021	
22	,,	350	1.016		
23	Calder.	350	1.240	1,218	
24	,,	350	1.197		
25	Clyde.	350	0.979	0,985	
26	,,	350	0.993		
27	Eagle Foundry.	350	1.083	1,047	
28	,,	350	1.012		
29	Adelphi.	350	1.177	1,125	
30	,,	350	1.073		
31	Pontypool.	350	1.073	1,088	
32	,,	350	1.104		
33	Oldberry.	350	0.973	1,008	
34	,,	350	1.043		
35	Pentwyn.	350	0.885	0,878	
36	,,	350	0.872		
37	Gartsherrie.	350	1.042	1,062	
38	,,	350	1.083		
39	Dundayven.	350	0.926	0,961	
40	,,	350	0.995		
41	Lays Works.	350	1.582	1,524	
42	,,	350	1.466		
43	Bute.	350	0.942	0,960	
44	,,	350	0.979		
45	Brimbo.	350	1.016	1,046	
46	,,	350	1.076		
47	Ponkey.	350	0.834	0,840	
48	,,	350	0.846		
49	Frood.	350	1.092	1,127	
50	,,	350	1.162		
51	Lane End.	350	1.005	1,022	
52	,,	350	1.039		

REMARK.—We have therefore a mean deflection of 1,051, rather more than 1 inch from the whole number of experiments.

* The bars usually measured somewhat more than 1 inch square, as will be seen from the experiments; the deflections therefore would have been a little greater than those shown above, if the bars had been exactly one inch square.

It appears from authors, who have recently written on the strength of materials, that all crystalline or tenacious bodies, subjected to a transverse strain, have one of their sides elongated, whilst the other is compressed; they are also agreed as to a point, called the neutral point, round which revolve the opposing forces of tension and compression. In our experiments it is evident, as the deflection increases, the atoms or crystals on the lower side of the bar must be separated, and those of the upper side brought nearer together.* Mr. Hodgkinson in his paper on the strength of iron beams, (Manchester Memoirs, vol. 5, second series, page 409,) states the following proposition.—'Suppose a beam horizontal, with one end firmly fixed in a wall, and a weight hung at the other, it will bend; but it is evident that could not take place, except by the lengthening of the top parts, by the compression of the bottom, or by both. Now both of these actually take place; and hence there is some intermediate point or line between the top and bottom of the beam, where the particles are neither extended or compressed. This line may properly be called the

* This has only lately been admitted, bodies have hitherto been considered incompressible.

neutral line." He then goes on to illustrate the theory by a diagram to show that the sum of the forces exerted by the extended fibres is equal to the sum of the forces exerted by the compressed ones, and thus concludes :—" Now it is evident that the extensions or compressions of any particles within these surfaces will be as their distances from the line A B (meaning the neutral line;) and the forces exerted by those particles must be in the same proportion, so long as the elasticity remains perfect; for then the forces are found to be as the extensions or compressions. Afterwards the forces of the particles would be as some different functions of their distances from the neutral line."

In further illustration of this subject, suppose we place a bar of cast iron upon the supports E E in the figure, and subject it to pressure, by weights suspended from the middle; it is obvious, in this case, that the resisting forces of extension and compression immediately come into operation; the particles forming the convex side of the bar, become more widely separated, whilst those on the concave are more closely condensed. It is evident, therefore, that a change of position must take place in

the granulated state of the bar, in order to resist the forces thus operating to produce rupture, either by compression above, or forcible extention below.

From this view of the case, a question arose as to the actual state of the atoms under different degrees of pressure; it appeared to me that the tensible and compressed forces would at every change produce a new adjustment of the parts, and either afford evidence of their adaptation to the load, or demonstrate a progressive yielding to a force sufficient ultimately to destroy the resistance.

On consulting the works of different authors, I found them nearly agreed in supposing that materials could be loaded to one-third or more of the breaking weight, without injuring their elasticity. In pursuing these experiments I was however led to a different conclusion, by observed discrepancies in the bars, accompanied by much earlier indications of impaired elasticity. I mentioned this circumstance to Mr. Hodgkinson, and found similar results had been obtained by him, in experiments made for the British Association previous to those now in progress.

So striking a coincidence, induced a new and extended series of experiments, to determine whether the elasticity is not generally injured with much less than one-third of the breaking weight, and the annexed tables show this to be the case: some slight injury with very small weights is certainly produced; but it admits of doubt whether or not it affects the ultimate strength of the bar,—at first sight it appeared that a weight sufficient to produce a permanent set would, if continued, be sufficient to break the bar, and that time alone was necessary to effect the rupture.

Mr. Hodgkinson took a different view of the case, and conceived that bodies by virtue of their elasticity, combined with slight ductility, might adjust themselves so as permanently to bear a load, nearly sufficient to break them at once. He had formed this view from having found that in experiments on wrought iron wires, torn asunder many times in succession, they bore nearly as much the last time as the first.—See Manchester Memoirs, Vol. 5.

A phenomenon so curious and interesting led to the enquiry. How much will cast iron per-

manently bear without endangering its security? This was an exceedingly important question, which in order to solve, we came to the conclusion of putting to the test of experiment.

For this purpose ten bars were procured, each cast to be one inch square, and having loaded them with different weights,—some nearly approaching the breaking point,—and supported their ends on props 4 ft. 6in. asunder,—they were left in this position to determine how long they would support the loads without breaking. Five weeks have now elapsed since they were charged, and, from what we can at present observe, there is every appearance of a long and tedious experiment.* I should here mention that the deflections are taken weekly, in order to determine the alterations in the state of the bars.

* Since the above was written, one of the bars has given way and broken near the centre, after having sustained a load of 448 lbs. for 37 days. The deflection was observed to have increased from 1.904 to 2.014 between the time of loading and that of the last measurement, three days before the rupture took place. It must be observed that this bar was thinner than any of the others now tried, and had borne for this period a weight larger than had broken bars of the same size in previous experiments upon this iron, when the weights were laid on without loss of time. All the other bars continue to sustain their loads, though they have born them for many months; the deflections however are slightly on the increase. The particulars of these will be given in the Seventh Report of the British Association for the Advancement of Science.

The following being a practical enquiry, it is not necessary to step out of the way in search of general principles: the effort will therefore be confined simply to investigating the peculiar merits of the different irons of British manufacture; exhibiting their most remarkable features, and rendering their applicability matter of certainty as respects strength, fluidity, power of being worked, &c. The enquiry will, therefore, in a great measure be devoted to those objects; shewing the strength and deflection of each iron under a transverse strain in the first instance, and subsequently interspersed with observations arising from microscopic examination, and the turning and filing process to which they were severally subjected.

In the annexed tables I have given an abridged form of the experiments, and selected such weights, deflections, and numbers, as will give a succinct and clear illustration of the methods adopted in the experiments.—To each class of experiments, and to each iron, is attached a tabular form of results, with the values reduced to those of bars exactly one inch square; the reductions being made by supposing, as is generally admitted, that the strength of rectangular

beams is as the breadth multiplied by the square of the depth; the length being given: and that the ultimate deflection is inversely as the depth. The power of resisting impact in each iron is reckoned by the product of the breaking weight multiplied by the ultimate deflection: depending upon the supposition that the elasticity remains unimpaired; and that the blow, in all cases, where the results are to be compared together, is given with the same striking body or hammer upon beams all of which are equal in weight. These suppositions, however, are not strictly true, but as the beams are all very nearly of equal weight, the product above mentioned will give a comparative measure near enough for practical purposes; as may be inferred from the paper on impact upon beams—Fifth Report of the British Association for the Advancement of Science.—The modulus of elasticity is given in pounds for a base of a square inch; this weight may be taken as the measure of the stiffness of the iron. It was usually calculated from the deflection caused by 112lbs. on the 4ft. 6in. bars.

No. I.

ENGLISH IRONS.

Apedale, No. II, Pig Iron, Hot Blast, Newcastle, Staffordshire.

EXPERIMENT 1st. Depth of Bar.....1.010 Breadth do.....1.015 Distance between supports.....4ft. 6in			EXPERIMENT 2nd. Depth of Bar.....1.025 Breadth do.....1.002 Distance between supports.....4ft. 6in. Weight of Bar 5ft. long, 15lbs. 3oz.			EXPERIMENT 3rd. Depth of Bar.....1.015 Breadth do.....1.015 Distance between supports.....2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection, Load removed.	Weight in lbs.	Deflection in inches.	Deflection, Load removed.	Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.275	.008	112	.280	.010	112	.034	
182	.485	.019	182	.490	.028	224	.072	.003
238	.674	.040	238	.672	.051	336	.112	.005
294	.882	.068	294	.874	.084	448	.155	.007
350	1.115	.110	350	1.098	.110	560	.204	.013
378	1.242	.138	406	1.340	.159	672	.255	.020
406	1.372	.165	462	1.613	.227	784	.305	.029
434	broke		476	1.700	broke	896	.370	.040
						952	broke	
This bar was unsound at the bottom side, and broke 7½ inches from the centre.			Broke one inch from the centre.			∴ Ultimate deflection = .399. Broke at the centre.		

Results reduced to those of Bars 1.00 inch square.					
	Specific Gravity	Modulus of elasticity in lbs.	Breaking Weight, (*b*)	Ultimate deflection, (*d*.)	Product $b \times d$ or power of resisting impact.
Exp. 2nd, bar 4ft. 6in.....	7.017	14852000	457	1.730	790.6
Exp. 3rd, bar 2ft. 3in.....			910.4	.405	368.7

This Iron presents a clear and rather open fracture ; when viewed with a magnifier, the crystals appear porous in the centre, but smaller and more compact as they approach the outer edge.

Appearance light grey, slightly tinged with blue.—It is a free working iron, rather stiff in its texture, but yields moderately to the chisel and file. I should conceive it useful in combination with metals of greater fluidity.

No. II.
ENGLISH IRON.
Adelphi, No. 2, Pig Iron, Cold Blast, Derbyshire.

Experiment 1st.
Depth of Bar......1.530
Breadth do..........1.470
Distance between supports......4ft. 6in.
Weight of bar 5ft. long, 34lbs. 3oz.

Weight in lbs.	Deflection in inches.	Deflection, load removed
56	.028	+
112	.058	.003
224	.120	.006
836	.188	.014
443	.265	.023
560	.344	.035
672	.427	.047
784	.526	.067
896	.610	.084
1008	.719	.110
1120	.830	.140
1232	.951	.177
1344	1.080	.226
1400	1.161	broke

Broke at the centre.

Expdriment 2nd.
Depth of bar...... 1.006
Breadth do....... .990
Distance between supports 4ft. 6in,
Weight of bar 5ft. long. 15lbs. 7oz.

Weight in lbs.	Deflection in inches.	Deflection, Load removed,
56	.140	+
112	.307	.012
168	.490	.033
224	.690	.062
280	.906	.100
336	1.130	.149
392	1.405	.218
420	1.560	
434	broke	

∴ Ultimate deflection =1.632.
Broke ⅛ of an inch from the centre.—The elasticity seemed to be injured with 30lbs or less.

Experiment 3rd.
Depth of bar........1,055
Breadth do........ .995
Distance between supports.....4ft. 6in.
Weight of bar 5ft. long, 15lb. 9oz.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
30	.065	+
56	.130	.003
112	.282	.016
168	.450	.035
224	.627	.058
280	.825	.087
336	1.030	.128
392	1.265	.185
448	1.525	.262
476	1.670	
497	broke	

∴ Ultimate deflection = 1.779.
Broke ¼ of an inch from the centre.

Experiment 4th.
Depth of bar.... 1.015
Breadth do...... 1.004
Distance between supports .... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.034	+
224	.073	.004
336	.115	.007
448	.161	.011
560	.212	.019
672	.270	.028
784	.332	.041
896	.405	.060
952	broke	

∴ Ultimate deflection = .439.—Broke ⅛ of an inch from the centre. 672lbs remained on 42 hours, when the deflection increased from .270 to .277; the defect of elasticity from .028 to .034.

Experiment 5th.
Depth of bar 1.038
Breadth do......1.002
Distance between supports....2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.034	+
224	.072	.003
336	.111	.005
448	.156	.009
560	.206	.014
672	.260	.023
784	.320	.035
896	.392	.054
952	.432	
980	broke	

∴ Ultimate deflection = .451.
Broke at the centre.

In Experiment 4th the bar, as mentioned above, sustained $\frac{3}{4}$ of the load for forty-two hours; at the close of the experiment (when the load was removed) an increase of deflection and defect of elasticity had taken place, but probably not more than might have been expected from the particles adjusting themselves to the load.

Results reduced to those of bars 1.00 inch square.

	Specific Gravity.	Modulus of elasticity in lbs.	Breaking weight (*b*.)	Ultimate deflection (*d*.)	Product $b \times d$ or power of resisting impact.
Experiment 1st, bar 4ft. 6in between supports			406.9	1.776	722.7
Experiment 2nd, bar 4ft. 6in. between supports	7.080	14249000	433.2	1.642	711.3
Experiment 3rd, bar 4ft. 6in. between supports	7.080	13382000	448.8	1.877	842.4
Mean	7.080	13815500	441.0	1.759	776.8
Experiment 4th, bar 2ft. 3in. between supports			920.4	.446	410.5
Experiment 5th, bar 2ft. 3in. between supports			907.6	.468	424.7
Mean			914.0	.457	417.6

No. III.

ENGLISH IRONS.

Butterley, —, Pig Iron, ———, Derbyshire.

Experiment 1st. Depth of Bar..... 1.000 Breadth do..... .989 Distance between supports ..... 4ft. 6in. Weight of Bar 5ft. long, 14lb. 13oz.		
Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.067	.000
56	.130	.002
126	.331	.015
+	+	+
182	.504	.040
+	+	+
238	.695	.065
294	.903	.100
350	1.130	.147
406	1.385	.203
462	1.685	.295
490	1.855	.340
497	broke	broke
∴ Ultimate deflection =1,895. Broke one inch from the centre.		

Experiment 2nd. Depth of Bar..... .991 Breadth do ..... .988 Distance between Supports..... 4ft. 6in. Weight of Bar 5ft. long, 14¾lbs		
Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.070	.000
56	.140	.002
126	.339	.016
182	.515	.037
238	.710	.063
+	+	+
294	.921	.099
350	1.155	.147
406	1.420	.203
434	1.580	.253
462	broke	broke
∴ Ultimate deflection =1.752. Broke ⅝ of an inch from the centre. 434lbs. were hung from the bar for 14 hours, when the deflection was found to be 1.630, and the defect of elasticity .292.		

Experiment 3rd. Depth of Bar.,....1.015 Breadth do ..... .993 Distance between supports ..... 2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.033	———
224	.070	+
336	.108	.003
448	.151	.006
560	.195	.009
672	.246	.015
784	.300	.026
896	.362	.038
1008	.442	.064
1092	broke	broke
∴ Ultimate deflection =.493. Broke ⅛ of an inch from the centre.		

Experiment 4th. Depth of Bar.... 1.014 Breadth do..... .988 Distance between supports .... 2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.034	———
224	.073	+
336	.115	.004
448	.160	.007
560	.210	.011
672	.263	.018
784	.320	.026
896	.390	.043
1008	broke	broke
∴ Ultimate deflection =470. Broke in the centre		

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs.	Breaking Weight, (*b*.)	Ultimate deflection (*d*.)	Product *b* x *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports		15372000	502.5	1.895	952.3
Experiment 2nd., bar 4ft. 6in. between supports	7.038	15387000	476.2	1.736	826.7
Mean			489.3	1.815	889.5
Experiment 3rd., bar 2ft. 3in. between supports			1068	.500	534.0
Experiment 4th., bar 2ft. 3in. between supports			992.3	.477	473.3
Mean			1030.1	.488	503.6

The general appearance of the fracture is a dark grey, with smaller crystals than in either the Adelphi or Apedale. Its fluidity is much akin to the Low Moor iron; it works freely under the file, and is well suited for almost every description of casting.—The power of resisting impact in these specimens is even greater than in the Low Moor.

We have no description of the manufacture of the Butterley iron, but I strongly suspect it is No. 2, made from the hot blast.

No. IV.

ENGLISH IRON.

Eagle Foundry, No. 2, Pig Iron, Hot Blast, Staffordshire.

Experiment 1st.
Depth of Bar..... 1.025
Breadth do.... ....1.025
Distance between supports ..... 4ft. 6in.
Weight of Bar 5ft. long, 15lb. 11oz.

Weight in lbs.	Deflection in inches.	Deflection load removed.
56	.141	.003
112	.288	.012
168	.453	.029
224	.633	.050
280	.826	.078
336	1.040	.115
392	1.268	.162
420	1.398	
448	broke	

∴ Ultimate deflection =1.520.
Broke ¼ of inch from the centre.

Experiment 2nd.
Depth of Bar.....1.024
Breadth do 1.045
Distance between Supports.... ..4ft. 6in.
Weight of Bar 5ft. long, 16lbs

Weight in lbs.	Deflection in inches.	Deflection load removed.
14	.032	+
56	.132	.003
112	.270	.015
168	.429	.031
224	.600	.053
280	.780	.079
336	.972	.111
392	1.182	.156
420	1.296	
448	broke	

∴ Ultimate deflection =1.404.
Broke one inch from the centre.

Experiment 3rd.
Depth of Bar.,....1.015
Breadth do 1.024
Distance between supports ..... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.034	+
224	.072	.004
336	.113	.006
448	.155	.010
560	.201	.014
672	.249	.020
784	.304	.030
896	.369	.041
924	broke	

∴ Ultimate deflection =.384.
Broke ¾ of an inch from the centre,

Experiment 4th.
Depth of Bar.... 1.041
Breadth do 1.025
Distance between supports .... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.030	+
224	.063	.002
336	.097	.004
448	.135	.007
560	.174	.010
672	.216	.013
784	.264	.020
896	.317	.030
1008	.379	.045

Broke ½ an inch from the centre when the weight 1008 was replaced.

Results reduced to those of bars 1.00 inch square.					
	Specific Gravity.	Modulus of elasticity in lbs.	Breaking weight (*b.*)	Ultimate deflection (*d.*)	Product $b \times d$ or power of resisting impact.
Experiment 1st, bar 4ft. 6in between supports.....	6.997	13869000	416	1.558	648.1
Experiment 2nd, bar 4ft. 6in. between supports.....	7.080	14553000	400.6	1.467	587.7
Mean.....	7.038	14211000	408.3	1.512	617.9
Experiment 3rd, bar 2ft. 3in. between supports.....			875.9	.389	340.7
Experiment 4th, bar 2ft. 3in. between supports.....			907.5	.395	358.4
Mean.....			891.7	.392	349.5

The Eagle Foundry Iron has an uniform and rather porous fracture, with a deeper blue colour than either the Butterley or the Apedale.—It is similar in appearance to the Coed-Talon, Hot Blast; and from the ease with which it cuts, I should conceive it well adapted to the finer descriptions of castings. The crystals appear more regular than in any of the former irons examined.

No. V.

ENGLISH IRONS.

Level, No. 1, Pig Iron, Hot Blast, Staffordshire.

Experiment 1st. Depth of Bar.....1.013. Breadth do.......1.005. Distance between supports......4ft. 6in. Weight of bar 5ft. long, 15lbs. 1oz.

Weight in lbs.	Deflection in inches.	Deflection load removed.
56	.139	+
112	.279	.015
168	.440	.031
224	.610	.050
280	.790	.078
336	.982	.105
392	1.192	.142
448	1.415	.193
476	broke	

∴ Ultimate deflection =1.525. Broke at the centre.

Experiment 2nd. Depth of bar......1.009. Breadth do.......1.015. Distance between supports ....4ft. 6in. Weight of bar 5ft. long, 15lbs. 12oz.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
56	.135	+
112	.268	.009
168	.418	.020
224	.586	.039
280	.762	.062
336	.948	.090
392	1.151	.124
448	1.370	.178
476	broke	

∴ Ultimate deflection =1.474. Broke at the centre.

Experiment 3rd. Depth of bar.......1.500. Breadth do........1.470. Distance between supports.....4ft. 6in. Weight of bar 5ft. long, 34lb. 0oz.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.060	.005
224	.120	.010
336	.183	.017
448	.250	.026
560	.322	.036
672	.397	.049
784	.478	.057
896	.553	.071
1008	.641	.085
1120	.735	.112
1232	.840	.137
1344	.937	.159
1400	broke	

∴ Ultimate deflection =990, and 1429lbs breaking weight if the bar had been 1.50 square.

Experiment 4th. Depth of bar ....1.025. Breadth do......1.000. Distance between supports ....2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.032	—
224	.067	—
336	.104	+
448	.144	.007
560	.189	.010
672	.236	.013
784	.285	.020
896	.341	.034
952	broke	

∴ Ultimate deflection =.368. Broke at the centre.

Experiment 5th. Depth of bar ....1.040. Breadth do......1.024. Distance between supports ....2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.031	—
224	.064	—
336	.100	+
448	.137	.007
560	.177	.010
672	.222	.014
784	broke	

∴ Ultimate deflection =.267. Broke ⅛ an inch from the centre.

Results reduced to those of Bars 1.00 inch square.					
	Specific Gravity	Modulus of elasticity in lbs.	Breaking Weight, (b.)	Ultimate deflection, (d.)	Productr $b \times d$ o power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	7.101	15127000	461.6	1.545	713.2
Experiment 2nd., bar 4ft. 6in. between supports	7.059	15778000	460.6	1.487	685.0
Mean	7.080	15452500	461.1	1.516	699.1
Experiment 3rd., bar 4ft. 6in. between supports			423.3	1.207	510.9
Experiment 4th., bar 2ft. 3in. between supports			906.1	.377	341.6
Experiment 5th., bar 2ft. 3in. between supports			707.8	.278	196.7
Mean			806.9	.327	269.1

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No. VI.

ENGLISH IRON.

Level, No. 2, Pig Iron, Hot Blast, Staffordshire.

Experiment 1st. Depth of Bar.....1.040 Breadth do.....1.024 Distance between supports.....4ft. 6in. Weight of Bar 5ft. long, 16lbs. 4oz.			*Experiment 2nd.* Depth of Bar.....1.030 Breadth do.....1.010 Distance between supports.....4ft. 6in. Weight of Bar 5ft. long, 15lb. 10oz.			*Experiment 3rd.* Depth of Bar.....1.030 Breadth do.....1.000 Distance between Supports.....4ft. 6in. Weight of Bar 5ft. long, 15lbs. 10oz.			*Experiment 4th.* Depth of Bar.....1.058 Breadth do.....1.024 Distance between supports....2ft. 3in.			*Experiment 5th.* Depth of Bar....1.022 Breadth do.....1.029 Distance between supports....2ft. 3in.			*Experiment 6th.* Depth of bar.... Breadth do..... Distance between supports....		
Weight in lbs.	Deflection in inches.	Deflection, load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.
56	.120	.002	56	.136	.002	56	.130	.003	112	.026	—	112	.030		112	.032	
112	.242	.009	112	.226	.010	112	.270	.015	224	.055	+	224	.066		224	.068	
168	.382	.019	168	.412	.021	168	.417	.027	336	.086	+	336	.105		336	.104	
224	.527	.031	224	.573	.041	224	.578	.043	448	.119	.005	448	.143		448	.144	
280	.685	.052	280	.742	.065	280	.750	.066	560	.154	.008	560	.185		560	.187	
336	.858	.080	336	.930	.090	336	.927	.093	672	.190	.010	672	.233		672	.231	
392	1.033	.106	392	1.128	.129	392	1.124	.127	784	.230	.014	784	.277		784	.274	
448	1.230	.149	420	1.233		420	broke		896	.271	.020	896	.332		896	.324	
476	1.333		448	broke					1008	.318	.029	1008	.391		952	broke	
490	broke											1036	broke				
∴ Ultimate deflection =1.384. Broke $\frac{5}{8}$ of an inch fromthe centre.			∴ Ultimate deflection =1.337. Broke $\frac{3}{4}$ of an inch from the centre.			∴ Ultimate deflection =1.222. Broke at the centre.			Broke with the 1008 laid on again, $\frac{5}{8}$ of an inch from the centre,						This bar had borne within 28lbs. of the breakiug weight.		

Experiment 5th and 6th were made by Mr. Hodgkinson. In the former the bar was cut in the middle to half its depth from the top with a saw, and the cut filled up with soft steel. In the latter or Experiment 6th, the bar was cut in the middle two-thirds through from the top downwards, and the aperture filled up with steel as before.

The dimensions of the last bar were not taken, but as all the bars were cast from the same model, and comparing the breaking weight in Experiment 5th and 6th with that in Experiment 4th, or with twice the breaking weights of the bars of double length in Experiment 1, 2 and 3, we shall see that the bar cut through half of its depth, and the cut filled up as above, bore more than the rest, and that the bar cut through two-thirds of its depth and filled in the same manner, bore nearly, if not quite, as much as the whole ones.

Results reduced to those of bars 1.00 inch square.

	Specific Gravity.	Modulus of elasticity in lbs.	Breaking Weight, (*b.*)	Ultimate deflection (*d.*)	Product *b* x *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	6.997	15817000	442.4	1.439	636.6
Experiment 2nd., bar 4ft. 6in. between supports	7.059	14962000	418.1	1.377	575.8
Experiment 3rd., bar 4ft. 6in. between supports	7.038	14944000	395.9	1.259	498.4
Mean	7.031	15241000	418.8	1.358	570.2
Experiment 4th., bar 2ft. 3in. between supports			879.4	.336	295.5

There is something anomalous in the Level Iron, and that more particularly as respects the manufacture; it has generally been supposed to contain an admixture of cinder; but comparing the results of these experiments with others, the strength does not appear to be much reduced.—The cooling or shrinking of this iron is rather remarkable, the contraction is not only greater than in most others, but when cast in moulds, the castings appear collapsed on all sides with deep indentations, as if the crystals had been forced inwards during the process of cooling.

From irregularities indicated in these experiments, I was induced to extend them to a greater length than at first intended; this was done principally for the purpose of investigating the shrinkage and other properties peculiar to this iron.

The Level gave better results than was at first anticipated; it sustains with considerable tenacity a heavy load, but indicates weakness in its power of resisting impact, and is irregular in its strength, as shown in the experiments on the short specimens. The fracture presents a dull grey colour, closely granulated, but less ductile in appearance than either the Apedale or Adelphi.—It is certainly inferior to the Butterley and Eagle Foundry specimens—cuts short and crumbles under the file.

No. VII.

ENGLISH IRONS.

Low Moor, No. 2, Pig Iron, Cold Blast, Yorkshire.

Experiment 1st.
Depth of Bar.....1.004
Breadth do.....1.004
Distance between supports.....4ft. 6in.
Weight of bar 5ft. long, 14lbs· 14oz.

Weight in lbs.	Deflection in inches.	Deflection, Load removed,
56	.143	.005
112	.298	.007
182	.518	.043
238	.713	.070
294	.938	.107
350	1.180	.156
406	1.461	.230
462	1.803	.335
469	broke	

∴ Ultimate deflection =1.844.
Broke ½ of an inch from the centre,

Experiment 2nd.
Depth of bar.....995
Breadth do.....1.015
Distance between supports 4ft. 6in,
Weight of bar 5ft. long, 14lbs. 12oz.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
56	.147	.007
112	.305	.019
182	.531	.050
238	.735	.079
294	.955	.115
350	1.210	.170
406	1.500	.244
448	1.764	
462	broke	

∴ Ultimate deflection = 1.863.
Broke ⅝ an inch from the centre.

Experiment 3rd.
Depth of bar.....1,004
Breadth do.....1.004
Distance between supports .....2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.032	—
224	.073	+
336	.115	.005
448	.163	.008
560	.213	.013
672	.265	.020
784	.327	.031
896	.400	.048
952	broke	

∴ Ultimate deflection = .434.
Broke ¼ of an inch from the centre.

Experiment 4th.
Depth of bar....1.005
Breadth do.....1.005
Distance between supports....2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.036	—
224	.078	+
336	.120	.005
448	.166	.008
560	.220	.011
672	.278	.021
784	.341	.032
896	.412	.050
952	.457	
1008	.506	broke

Broke with 1008lbs. ½ an inch from the centre.

Results reduced to those of Bars 1.00 inch square.					
	Specific Gravity	Modulus of elasticity in lbs.	Breaking Weight, (b.)	Ultimate deflection, (d.)	Product $b \times d$ or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	7.026 / 7.059	14561000	463.4	1.81	858.0
Experiment 2nd., bar 4ft. 6in. between supports	7.080	14458000	459.8	1.854	852.1
Mean	7.055	14509500	461.6	1.852	855.2
Experiment 4th., bar 2ft. 3in. between supports			940.7	.436	409.9
Experiment 5th., bar 2ft. 3in. between supports			993.0	.509	505.5
Mean			966.8	.472	457.6

The Low Moor indicates less brilliancy in the crystals than the Apedale;—colour a deep grey, accompanied with fluidity and richness in the appearance of the fracture.—Its freedom of working is of the first order; it cuts easily with the chisel, and is peculiarly adhesive when reduced by the file.—This iron runs the thinner moulds without risk, and retains its fluidity much longer than most other metals.

No. VIII.

ENGLISH IRONS.

Milton, No. 1, Pig Iron, Hot Blast, Yorkshire.

Experiment 1st. Depth of Bar.....1.064 Breadth do.....1.064 Distance between supports.....4ft. 6in. Weight of bar 5ft. long, 16lbs. 9oz.			*Experiment 2nd.* Depth of bar.....1.058 Breadth do.....1.020 Distance between supports ....4ft. 6in. Weight of bar 5ft. long, 16lbs. 8oz.			*Experiment 3rd.* Depth of bar .....1.090 Breadth do.....1.047 Distance between supports .....2ft. 3in.			*Experiment 4th.* Depth of bar....1.067 Breadth do.....1.040 Distance between supports....2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection, Load removed,	Weight in lbs.	Deflection in inches.	Deflection, Load removed.	Weight in lbs.	Deflection in inches.	Deflection, Load removed.	Weight in lbs.	Deflection in inches.	Deflection, Load removed.
42	1.03	+	42	.103	+	112	.033	—	112	.033	—
112	.294	.010	112	.298	.006	224	.066	+	224	.070	+
182	.499	.038	182	.518	.033	336	.103	.004	336	.110	.004
238	.685	.065	238	.710	.056	448	.143	.007	448	.153	.006
294	.892	.094	294	.922	.090	560	.186	.009	560	.200	.009
350	1.126	.139	350	1.160	.135	672	.236	.015	672	.250	.016
406	1.382	broke	406	1.430	.209	784	.286	.024	784	.306	.025
			420	broke		896	.350	.038	896	.372	.041
						952	broke		924	broke	
Broke $\frac{3}{8}$ of an inch from the centre.			∴ Ultimate deflection = 1.492. Broke $1\frac{1}{4}$ inch from the centre.			∴ Ultimate deflection = .379. Broke at the centre.			∴ Ultimate deflection = .388. Broke $\frac{1}{4}$ inch from the centre.		

Results reduced to those of bars 1.00 inch square.

	Specific Gravity.	Modulus of elasticity in lbs.	Breaking Weight, (*b.*)	Ultimate deflection (*d.*)	Product *b* x *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	7.016 6.977	11701000	337.1	1.471	495.8
Experiment 2nd., bar 4ft. 6in. between supports	6.936	12248000	367.9	1.579	580.9
Mean	6.976	11974500	352.5	1.525	538.3
Experiment 3rd., bar 2ft. 3in. between supports			765.3	.413	316.0
Experiment 4th., bar 2ft. 3in. between supports			780.4	.414	323.0
Mean			772.8	.413	319.5

No. IX.

ENGLISH IRON.

Milton, No. 3, Pig Iron, Hot Blast, Yorkshire.

Experiment 1st. Depth of Bar.....1.010 Breadth do.....1.014 Distance between supports.....4ft. 6in Weight of Bar 5ft. long, 15¾lbs.			*Experiment 2nd.* Depth of Bar.....1.036 Breadth do.....1.005 Distance between supports.....4ft. 6in. Weight of Bar 5ft. long, 16lbs.			*Experiment 3rd.* Depth of Bar.....1.037 Breadth do.....1.018 Distance between Supports.....2ft. 3in			*Experiment 4th.* Depth of Bar.....1.050 Breadth do.....1.015 Distance between supports....2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection, load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.
42	.093	+	42	.092	+	112	.028	—	112	.027	—
56	.126	+	56	.128	+	224	.060	—	224	.057	—
126	.300	.008	126	.288	.014	336	.093	+	336	.090	+
182	.453	.027	182	.431	.029	448	.129	+	448	.125	+
238	.617	.045	238	.582	.045	560	.165	.004	560	.160	.005
294	.796	.070	294	.749	.066	672	.209	.007	672	.200	.007
350	.983	.100	350	.927	.095	784	.252	.013	784	.240	.013
406	1.193	.143	406	1.120	.131	896	.300	.020	896	.285	.021
434	1.304	.174	448	1.285		952	.326		952	.310	
448	broke		455	broke		1008	broke		980	broke	
∴ Ultimate deflection =1.358. Broke ⅜ of an inch from the centre.			∴ Ultimate deflection =1.318. Broke 1¼ inch from the centre.			∴ Ultimate deflection =.351. Broke ⅜ of an inch from the centre.			∴ Ultimate deflection =.322. Broke ¼ of an inch from the centre.		

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs.	Breaking weight (*b*.)	Ultimate deflection (*d*.)	Product *b* X *d* or power of resisting impact.
Experiment 1st, bar 4ft. 6in. between supports	7.058 7.017	15986000	433.1	1.372	594.2
Experiment 2nd, bar 4ft. 6in. between supports	7.080	15719000	421.8	1.365	575.7
Mean	7.051	15852500	427.4	1.368	584.9
Experiment 3rd, bar 2ft. 3in. between sdpport			920.8	.364	335.1
Experiment 4th, bar 2ft. 3in. between supports			875.7	.338	296.0
Mean			898.2	.351	315.5

Milton, No. 3, displays a circle of open crystals in the centre, surrounded by a compact frame of smaller granules.—It cuts and files with difficulty, and presents a fracture of a dull grey colour.—In the 4ft. 6in. bars, it is rather inferior in strength to the Level, and also in its flexure and power of resisting impact.

No. X.

ENGLISH IRONS.

Elsicar, No. 2, Pig Iron, Cold Blast.

Experiment 1st.
Depth of Bar.....1.015
Breadth do.....1.015
Distance between supports.....4ft. 6in.
Weight of Bar 5ft. long, 15lbs. 8oz.

Weight in lbs.	Deflection in inches.	Deflection, Load removed,
56	.151	.008
126	.365	.025
182	.577	.058
238	.81	.094
294	1.075	.149
350	1.387	.224
406	1.74	.327
434	1.94	.395
469	broke	

∴ Ultimate deflection = 2.147.
Broke one inch from the centre.

Experiment 2nd.
Depth of bar.....1.036
Breadth do.....1.000
Distance between supports 4ft. 6in,
Weight of bar 5ft. long, 15½lbs.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
56	.153	.007
126	.375	.027
182	.563	.062
238	.784	.090
294	1.054	.153
350	1.338	.21
406	1.68	.31
462	2.09	.44
476	broke	

∴ Ultimate deflection = 2.19.
Broke ¾ of an inch from the centre.

Experiment 3rd.
Depth of bar.....1.030
Breadth do.....1.006
Distance between supports.....2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.030	—
224	.073	+
336	.115	.005
448	.165	.009
560	.222	.014
672	.290	.025
784	.351	.036
896	.434	.065
924	broke	

∴ Ultimate deflection = .452.
Broke ½ an inch from the centre.

Experiment 4th.
Depth of bar....1.024
Breadth do.....1.008
Distance between supports....2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.040	—
224	.088	+
336	.140	.006
448	.200	.011
560	.264	.020
672	.341	.034
784	.428	.060
812	broke	

∴ Ultimate deflection = .449.
Broke at the centre.

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs.	Breaking Weight, (*b*.)	Ultimate deflection (*d*.)	Product *b* x *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	6.932 6.936	12821000	448.5	2.179	977.2
Experiment 2nd., bar 4ft. 6in. between supports	6.916	12352000	443.5	2.269	1006.3
Mean	6.928	12586500	446.0	2.224	991.7
Experiment 3rd., bar 2ft. 3in. between supports			865.7	.466	403.4
Experiment 4th., bar 2ft. 3in. between supports			768.2	.460	353.3
Mean			816.9	.463	378.3

This Iron has a vitrified and glutinous appearance over the entire section of the fracture; there is great uniformity in the size of the crystals, being nearly the same in the centre as those next the outer skin of the bar. It has a grey colour, intermixed with blue. Its working properties are of the first order, the action of filing being accompanied by a soft adhesive sound.*

* The comparative values of the Elsicar Cold Blast and the Milton Hot Blast Iron, will be found in my Report as given in the 7th volume of the Transactions of the British Association for the Advancement of Science.

No. XI.

ENGLISH IRON.

Oldberry, No. 2, Pig Iron, Cold Blast.

Experiment 1st. Depth of Bar....1.063 Breadth do.....1.006 Distance between supports ....4ft. 6in. Weight of bar 5ft. long, 16lbs. 5oz.			*Experiment 2nd* Depth of bar....1.038 Breadth do.....1.009 Distance between supports ....4ft. 6in Weight of bar 5ft. long 15¾lbs.			*Experiment 3rd.* Depth of Bar....1.071 Breadth do.....1.027 Distance between supports.....2ft. 3in.			*Experiment 4th.* Depth of Bar....1·049 Beadth do.....1.017 Distance between supports ....2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.
30	.063	+	30	.065	—	112	.029	—	112	.029	—
56	.125	.005	56	.124	+	224	.057	—	224	.060	+
112	.257	.014	112	.271	.010	336	.090	+	336	.095	+
168	.409	.032	168	.434	.030	448	.123	.005	448	.133	.005
224	.570	.055	224	.607	.053	560	.161	.007	560	.174	.009
280	.742	.083	280	.795	.084	672	.205	.014	672	.219	.014
336	.934	.119	336	1.002	.125	784	.250	.020	784	.267	.022
392	1.140	.167	392	1.230	.184	896	.300	.032	896	.326	.036
448	1.373	.240	448	1.495	.267	1008	.364	.050	008	.395	.056
504	1.661	.344	476	1.644		1064	.400				
			504	broke		1092	broke				
Broke ¼ of an inch from the centre, when the same weight was placed on again, after the deflection and elasticity had been taken.			Ultimate deflection =1.788. Broke 1¾ iuch from the centre.			∴ Ultimate deflection =.416. Broke ⅝ of an inch from the centre,			The weight (1008) when replaced broke it ⅝ of an inch from the centre.		

Results reduced to those of bars 1.00 inch square.					
	Specific Gravity.	Modulus of elasticity in lbs.	Breaking weight (*b*.)	Ultimate deflection (*d*.)	Product $b \times d$ or power of resisting impact.
Experiment 1st, bar 4ft. 6in between supports	7.037				
	7.059	14198000	443.4	1.766	783.0
Experiment 2nd, bar 4ft. 6in. between supports.	7.080	14417000	463.6	1.856	860.4
Mean	7.059	14307500	453.5	1.811	821.7
Experiment 3rd, bar 2ft. 3in. between supports			927.0	.446	413.4
Experiment 4th, bar 2ft. 3in. between supports			900.6	.414	372.8
Mean			913.8	.430	393.1

Oldberry, No. 2, surrounds the middle of the fracture wtth a band of small compact crystals, in colour a dark grey; rather porous in the centre, but in other respects sound and perfect.—It is similar in its power of being worked to the Masteg, South Welsh Iron.—It cuts freely with the chisel, and is easily reduced by the file.

No. XII.
ENGLISH IRONS.
Old Park, , No. 2, Pig Iron, Cold Blast.

Experiment 1st. Depth of Bar ......1.54 Breadth do........ 1.47 Distance between supports......4ft. 6in Weight of Bar 5ft. long, 34½lbs.			*Experiment 2nd.* Depth of Bar...... 1.033 Breadth do....... 1.005 Distance between supports..... 4ft. 6in. Weight of Bar 5ft. long, 15lbs. 10oz.			*Experiment 3rd.* Depth of Bar......1.036 Breadth do.. ....1.012 Distance between supports......4ft. 6in Weight of bar 5ft. long, 16¾lbs			*Experiment 4th.* Depth of Bar.....1.025 Breadth do......1.000 Distance between supports .... 2ft. 3in.			*Experiment 5th.* Depth of Bar.....1.005 Breadth do ....1.005 Distance between Supports... ..2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs,	Deflection in inches.	Deflection load removed.
28	.014	—	28	.065	—	28	.068	—	112	.032	—	112	.033	—
56	.027	—	56	.135	—	56	.140	—	224	.066	—	224	.069	—
112	.054	+	112	.265	.011	112	.276	.019	336	.103	.005	336	.105	+
224	.113	.005	168	.427	.028	168	.427	.030	448	.143	.007	448	.146	.006
336	.179	.011	244	.595	.050	224	.600	.055	560	.185	.010	560	.188	.009
448	.249	.019	280	.782	.080	280	.778	.080	672	.235	.019	672	.230	.012
560	.322	.029	336	.984	.119	336	.976	.111	784	.286	.025	784	.281	.020
672	.399	.038	392	1.205	.163	392	1.185	.155	896	.345	.035	896	.344	.031
784	.478	.052	420	1.320		448	1.421	.213	1008	.407	.251	1008	.410	.050
896	.569	.068	448	broke		504	1.700	.295	1064	broke		1064	.450	
1008	.655	.081										1120	broke	
1120	.748	.103												
1232	.860	.131												
1344	.975	.167												
1400	1.038													
1456	broke													
∴ Ultimate deflection =1.097. Broke [illegible] of an inch from the centre.			∴ Ultimate deflection =1.435. Broke at the centre.			Broke 1¼ of an inch from the centre after the weight (504) had been dut on again.			∴ Ultimate deflection. =.435. Broke ¾ an inch from the centre.			∴ Ultimate deflection =.487. Broke ¼ of an inch from the centre.		

Results reduced to those of Bars 1.00 inch square.	Specific Gravity	Modulus of elasticity in lbs.	Breaking Weight, (*b*)	Ultimate deflection, (*d*.)	Product *b* X *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports			417.7	1.689	705.6
Mean					
Experiment 2nd., bar 4ft. 6in. between supports	7.072 7.017	15018000	417.8	1.482	619.2
Experiment 3rd., bar 4ft. 6in. between supports	7.059	14196000	464.0	1.761	817.2
Mean	7.049	14607000	440.9	1.621	718.2
Experiment 4th., bar 2ft. 3in. between supports			1013.0	.457	462.90
Experiment 5th., bar 2ft. 3in. between supports			1103.0	.490	540.47
Mean			1058.0	.473	501.68

Comparing this Iron with the preceding, it appears closer-grained, accompanied with more lustre.—Characteristics, a grey colour, with a remarkable degree of softness when cut with the tool; it also files with great ease, and may be classed with some of our softest metals.

No. XIII.

ENGLISH IRON.

Horace St. Pauls, Windmill End, No. 2, Pig Iron, Cold Blast, Staffordshire.

Experiment 1st. Depth of Bar....1.043 Breadth do.....1.024 Distance between supports....4ft. 6in Weight of bar 5ft. long, 16¼lbs			*Experiment 2nd.* Depth of bar....1.038 Breadth do.....1.010 Distance between supports....4ft. 6in Weight of bar 5ft. long 15¾lbs			*Experiment 3rd.* Depth of Bar....1.058 Breadth do.....1.021 Distance between supports.....2ft. 3in.			*Experiment 4th.* Depth of bar....1.045 Breadth do.....1.020 Distance between supports....2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.
56	.110	—	56	.115	+	112	.025	—	112	.028	—
112	.227	+	112	.240	.009	224	.060	—	224	.060	+
168	.352	.013	126	.274	.011	336	.090	+	336	.094	+
224	.490	.029	182	.412	.023	448	.125	.005	448	.130	.005
280	.630	.045	238	.560	.042	560	.160	.007	560	.167	.008
336	.788	.066	294	.719	.064	672	.196	.010	672	.206	.011
392	.955	.094	350	.107	.091	784	.240	.017	784	.255	.020
448	1.140	.125	406	1.279	.123	896	.285	.024	896	.295	.027
504	1.350	.187	462	1.394	.170	1008	.336	.036	1008	.352	.042
			490	broke	.204	1120	.398	.059	1036	broke	
560	1.589	.260	504			1176	.431				
						1204	broke				
Broke at the centre.			Ultimate deflection =1.45 Broke ⅝ of an inch from the centre.			∴ Ultimate deflection =.447. Broke ⅜ of an inch from the centre.			∴ Ultimate deflection =.364. Broke ¼ of an inch from the centre.		

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Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs.	Breaking Weight, (*b*.)	Ultimate deflection (*d*.)	Product *b* x *d* or power of resisting impact.
	7.080	16717000	502.7	1.657	833.0
Experiment 1st., bar 4ft. 6in. between supports	7.059	16263000	463.2	1.505	697.1
Experiment 2nd., bar 4ft. 6in. between supports.....	7.075				
Mean.....	7.071	16490000	482.9	1.581	765.0
Experiment 3rd., bar 2ft. 3in. between supports			1053.	.473	498.0
Experiment 4th., bar 2ft. 3in. between supports			930.1	.380	353.4
Mean.....			991.5	.426	425.7

The fracture has a firm compact appearance.—Crystallization very minute at the edges of the bar, and surrounded with a hard skin.—Colour a dark grey; resists cutting with tenacity, but yields more freely to the file.—Windmill End is decidedly a strong iron, but more difficult to be worked than either the Old Park or Low Moor irons.

No. XIV.

ENGLISH IRONS.

Ley's Works, No. 1, Pig Iron, Hot Blast.

Experiment 1st.
Depth of Bar..... .998
Breadth do.....1.006
Distance between supports.....4ft. 6in.
Weight of Bar 5ft. long, 15lbs.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
28	.089	—
56	.177	.009
112	.385	.035
168	.614	.074
224	.884	.117
280	1.187	.170
336	1.519	.251
364	1.710	
392	broke	

∴ Ultimate deflection =1.882.
Broke $\frac{1}{2}$ an inch from the centre.

Experiment 2nd.
Depth of bar..... 1.009
Breadth do..... 1.025
Distance between supports 4ft. 6in,
Weight of bar 5ft. long. 15lbs. 6oz.

Weight in lbs.	Deflection, Load removed.	Deflection in inches.
28	.084	—
56	.170	.006
112	.363	.030
168	.588	.062
224	.820	.101
280	1.098	.145
336	1.408	.215
392	1.760	.312
406	broke	

∴ Ultimate deflection =1.843.
Broke $\frac{1}{2}$ an inch from the centre.

Experiment 3rd.
Depth of bar 1.016
Breadth do.....1.004
Distance between supports .....4ft. 6in.
Weight of bar 5ft. long, 15lhs. 5oz

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
28	.084	—
56	.169	.007
112	.360	.029
168	.590	.060
224	.846	.103
280	1.124	.152
336	1.415	.216
392	1.780	.321
413	broke	

∴ Ultimate deflection =.1.903
Broke $\frac{5}{8}$ of an inch from the centre.

Results reduced to those of bars 1.00 inch square.					
	Specific Gravity.	Modulus of elasticity in lbs.	Breaking weight (*b*.)	Ultimate deflection (*d*.)	Product *b* X *d* or power of resisting impact.
Experiment 1st, bar 4ft. 6in. between supports	6.979 6.997	11452000	391.2	1.878	734.7
Experiment 2nd, bar 4ft. 6in. between supports	6.916	11535000	389.1	1.859	723.3
Experiment 3rd, bar 4ft. 6in. between support	6.936	11631000	398.5	1.933	770.4
	6.957	11539333	392.9	1.890	742.8

Leys Works, Hot Blast, is a weak iron as respects its breaking weights, but evidently stands well in its power of resistance to the force of impact, it exhibits a porous uniform fracture, cuts with freedom, and yields freely to the file.

I should consider this a valuable metal for reducing the harder irons, and adapted for light work where strength is not required.

No. XV.

ENGLISH IRON.

Lane End, No. 2, Pig Iron.

Experiment 1st. Depth of Bar....1.005 Breadth do.....1.007 Distance between supports ....4ft. 6in. Weight of bar 5ft. long, 15lbs. 7oz.			*Experiment 2nd.* Depth of bar.... .995 Breadth do.....1.020 Distance between supports ....4ft. 6in. Weight of bar 5ft. lon,g 15lbs. 6oz.			*Experiment 3rd.* Depth of Bar....1.016 Breadth do.....1.028 Distance between supports.....4ft. 6in. Weight of bar 5ft. long, 15lbs. 9oz		
Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.070	—	28	.070	—	28	.070	—
56	.140	—	56	.142	—	56	.137	—
112	.281	.011	112	.289	.012	112	.243	.007
168	.447	.027	168	.458	.027	168	.430	.021
224	.610	.043	224	.628	.040	224	.592	.038
280	.780	.061	280	.800	.060	280	.760	.051
336	.965	.082	336	.998	.082	336	.945	.075
392	1.160	.110	392	1.198	.110	392	1.138	.100
448	1.370	.143	420	1.308		448	1.340	.131
476	broke		448	broke				
Ultimate deflection =1.471 Broke at the centre.			∴ Ultimate deflection =1.411. Broke ½ an inch from the centre.			Broke at the centre.		

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs.	Breaking weight (*b.*)	Ultimate deflection (*d.*)	Product *b* X *d* or power of resisting impact.
Experiment 1st, bar 4ft. 6in between supports	7.000				
	7.017	15350000	468.0	1.478	691.7
Experiment 2nd, bar 4ft. 6in. between supports.	7.017	15184000	443.6	1.404	622.8
Experiment 3rd, bar 4ft. 4in. between supports	7.080	16829000	422.1	1.361	574.7
Mean	7.028	15787666	444.5	1.414	629.7

Lane End, No. 2, is a stronger iron than Leys, and equally fluid. When cast in large masses it collapses and shrinks rapidly when cooling. It presents a fine crystalline appearance; open grained and easily reduced by the file. In many respects it is similar to the Leys, but inferior in its power of resisting impact.

No. XVI.

ENGLISH IRONS.

Carroll, No. 2, Pig Iron, Cold Blast.

Experiment 1st. Depth of Bar .....1.050 Breadth do.....1.010 Distance between supports.....4ft. 6in. Weight of Bar 5ft. long, 16lbs. 10oz.			*Experiment 2nd.* Depth of Bar.....1.025 Breadth do.....1.015 Distance between supports.....4ft. 6in. Weight of Bar 5ft. long, 16lbs.			*Experiment 3rd.* Depth of Bar.....1.069 Breadth do.....1.020 Distance between supports.....2ft. 3in.			*Experiment 4th.* Depth of Bar.....1.030 Breadth do.....1 044 Distance between supports....2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.225	.008	56	.112	+	112	.026	—	112	.028	—
126	.256	.010	112	.233	.008	224	.054	—	224	.060	—
182	.384	.019	126	.264	.010	336	.083	+	336	.090	+
238	.518	.035	182	.398	.016	448	.112	+	448	.124	.005
294	.659	.052	238	.534	.033	560	.149	.006	560	.159	.007
350	.810	.073	294	.683	.052	672	.183	.007	672	.196	.010
406	.870	.099	350	.840	.073	784	.224	.016	784	.234	.014
462	1.144	.133	406	1.008	.110	896	.262	.020	896	.278	.021
476	broke		434	1.097	.118	952	.284		952	broke	
			448	1.144		1009	broke				
			462	broke							
∴ Ultimate deflection =1.183. Broke at the centre.			∴ Ultimate deflection =1.191. Broke ¾ of an inch from the centre.			∴ Ultimate deflection =.305. Broke ¼ of an inch from the centre.			∴ Ultimate deflection. =.299. Broke ¾ of an inch from the centre.		

Results reduced to those of Bars 1.00 inch square.	Specific Gravity	Modulus of elasticity in lbs.	Breaking Weight, (*b*)	Ultimate deflection, (*d*.)	Product *b* x *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	7.080	16760000	427.5	1.242	531.0
Experiment 2nd., bar 4ft. 6in. between supports	7.059	17312000	433.2	1.221	529.0
Mean	7.069	17036000	430.3	1.231	530.0
Experiment 3rd., bar 2ft. 3in. between supports			864.8	.326	281.9
Experiment 4th., bar 2ft. 3in. between supports			859.6	.308	264.7
Mean			817.2	.317	273.3

The Carroll is analogous to the Varteg (Welsh) iron in its density and crystalline structure. It has less lustre, and presents features of hardness when acted upon by the chisel or turning tool; it however files with more ease than that iron.

No. XVII.
ENGLISH IRONS.
Bierly, No. 2, Pig Iron, Bradford, Yorkshire.

Experiment 1st.
Depth of Bar.... 1.016
Breadth do......1.044
Distance between supports .... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.061	
56	.126	+
112	.284	.012
168	.387	.023
224	.538	.039
280	.697	.061
336	.862	.088
392	1.050	.122
420	1.147	
448	broke	

Ultimate deflection =1,237
Broke 1⅝ of an inch from the centre.

Experiment 2nd.
Depth of bar.... 1.034
Breadth do...... 1.034
Distance between supports .... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.061	
56	.125	+
112	.249	.012
168	.389	.021
224	.540	.040
280	.700	.061
336	.862	.089
392	1.049	.121
420	1.152	broke

Broke ⅛ of an inch from the centre,

Experiment 3rd.
Depth of Bar..... 1.021
Breadth do.......1·031
Distance between supports....... 4ft. 6in,

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.060	
56	.119	—
112	.240	.009
168	.376	.019
224	.520	.037
280	.680	.058
336	.834	.081
392	1.013	.117
420	1.108	
448	broke	

∵ Ultimate deflection =1.194.
Broke one inch from the centre.

Experiment 4th.
Depth of Bar...... 1.007
Breadth do........1.035
Distance between supports......2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.032	+
224	.064	+
336	.098	.005
448	.137	.006
560	.177	.008
672	.219	.014
784	.265	.021
896	.323	.036
952	broke	

∴ Ultimate deflection =.346.
Broke ⅜ of an inch from the centre.

Experiment 5th.
Depth of bar...... 1.025
Breadth do....... 1.034
Distance between supports 2ft. 3in,

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.030	+
224	.061	+
336	.095	+
448	.132	.005
560	.171	.008
672	.213	.013
784	.256	.020
896	broke	

∴ Ultimate deflection =1.237.
Broke ½ an inch from the centre.

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs.	Breaking Weight, (*b*.)	Ultimate deflection (*d*.)	Product *b* x *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	7185	16237000	415.7	1.257	522.5
Experiment 2nd., bar 4ft. 6in. between supports		15490000	379.9	1.191	452.5
Experiment 3rd., bar 4ft. 6in. between supports		16741400	416.8	1.219	508.1
Mean		16156133	404.1	1.222	494.3
Experiment 4th., bar 2ft. 3in. between supports			907.0	.3484	316.0
Experiment 5th, bar 2ft. 3in. between supports			824.8	.3034	250.2
Mean			865.9	.3259	283.1

Bierley, No. 2, Yorkshire, is rather closer grained than the Low Moor, but in other respects very similar in appearance and in its power of being worked.

No. XVIII.

ENGLISH IRONS.

W. S. S., No. 2, Pig Iron. Staffordshire.

Experiment 1st.
Depth of Bar.... 1.021
Breadth do 1.015
Distance between supports .... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.067	
56	.134	+
112	.270	.010
168	.429	.020
224	.572	.032
280	.754	.053
336	.942	.078
392	1.139	.108
420	1.248	—
448	broke	

Ultimate deflection =1 347
Broke at the centre.

Experiment 2nd.
Depth of bar.... 1 003
Breadth do 1.012
Distance between supports 4ft. 6in

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.068	
56	.138	+
112	.279	.012
168	.440	.028
224	.607	.046
280	.779	.064
336	.970	.090
392	1.179	.121
420	1.281	—
441	broke	

∴ Ultimate deflection =1.356.
Broke ¾ of an inch from the centre.

Experiment 3rd.
Depth of Bar 1.015
Breadth do .... .995
Distance between supports .... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.072	
56	.146	.005
112	.297	.015
168	.466	.029
224	.644	.048
280	.833	.070
336	1.048	.099
364	1.154	
392	1.264	broke

Broke ½ of an inch from the centre,

Experiment 4th.
Depth of Bar...... 1.011
Breadth do........ 1.033
Distance between supports...... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.033	+
224	.067	+
336	.106	+
448	.149	.006
560	.194	.010
672	.241	.015
784	.295	.025
896	.350	.035
952	broke	

∴ Ultimate deflection =.375.
Broke 1⅝ inch from the centre.

Experiment 5th.
Depth of bar...... 1.011
Breadth do 1.022
Distance between supports 2ft. 3in,

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.035	+
224	.070	+
336	.106	.005
448	.150	.007
560	.192	.010
672	.236	.013
784	.283	.020
896	.338	.028
924	broke	—

∴ Ultimate deflection =.350.
Broke one inch from the centre

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs.	Breaking weight (*b.*)	Ultimate deflection (*d.*)	Product *b* X *d* or power of resisting impact.
Experiment 1st, bar 4ft. 6in between supports	7.041	15116000	423.4	1.375	582.2
Experiment 2nd, bar 4ft. 6in. between supports.		15476000	433.2	1.360	589.1
Experiment 3rd, bar 4ft. 6in. between supports		14268000	382.4	1.283	490.6
Mean		14953333	413.0	1.33 9	553.9
Experiment 4th, bar 2ft. 3in. between supports			901.6	.3791	341.8
Experiment 5th, bar 2ft. 3in. between supports			884.5	.3538	313.0
Mean			893.0	.3664	327.4

This iron has an appearance in its fracture identically the same as the Apedale. It chips with great freedom, but has a hard and gritty feel under the file.—Colour light gray.

No. XIX.

ENGLISH IRONS.

Coltham, B. F., No. 1, Pig Iron, Hot Blast. Staffordsh're

Experiment 1st. Depth of Bar .....1.010 Breadth do....... 1.005 Distance between supports......4ft. 6in			*Experiment 2nd.* Depth of Bar...... 1.005 Breadth do....... 1.013 Distance between supports..... 4ft. 6in.			*Experiment 3rd.* Depth of Bar......1.036 Breadth do..........1.008 Distance between supports......4ft. 6in.			*Experiment 4th.* Depth of Bar.....1.015 Breadth do ......1.009 Distance between supports .... 2ft. 3in.			*Experiment 5th.* Depth of bar .....1.009 Breadth do.......1.015 Distance between supports ....2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection Load removed.
28	.070		28	.067		28	.062		112	.034	+	112	.032	
56	.138	+	56	.137	+	56	.125	+	224	.069	+	224	.067	+
112	.277	.017	112	.278	.013	112	.250	.012	336	.107	.005	336	.105	+
168	.440	.032	168	.448	.030	168	.397	.023	448	.149	.007	448	.149	.006
244	.603	.049	224	.609	.050	224	.547	.040	560	.193	.010	560	.191	.009
280	.777	.072	280	.788	.074	280	.703	.059	672	.236	.015	672	.235	.014
336	.968	.102	336	.981	.106	336	.869	.082	784	broke		784	.285	.022
392	1.172	.140	392	1.190	.145	392	1.049	.110				812	broke	
448	1.408	.193	420	1.305		448	1.245	.150						
469	broke		441	broke		504	1.467	.208						
						546	broke							
∴ Ultimate deflection =1.489	Broke 3/4 of an inch from the centre.		∴ Ultimate deflection =1.383.	Broke 6/8 of an inch from the centre.		∴ Ultimate deflection =1.644.	Broke 3/8 of an inch from centre.		∴ Ultimate deflection. =.278.	Broke 4/8 of an inch from the centre.		∴ Ultimate deflection =.296	Broke at the centre.	

Results reduced to those of Bars 1.00 inch square.	Specific Gravity	Modulus of elasticity in lbs.	Breaking Weight, (*b*)	Ultimate deflection (*d*)	Product *b* X *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	7128	15371900	457.5	1.504	688.0
Experiment 2nd., bar 4ft. 6in. between supports		15423600	431.0	1.390	599.1
Experiment 3rd., bar 4ft. 6in. between supports		15734700	504.7	1.703	859.5
Mean		15510066	464.4	1.532	715.5
Experiment 4th., bar 2ft. 3in. between supports			754.2	.2822	2 12.8
Experiment 5th., bar 2ft. 3in. between supports			785.8	.2986	234.6
Mean			770.0	.2904	223.7

The Coltham iron has its interior granules encased with a frame-work of minute crystals surrounding the edge of the bar.—Colour nearly similar to that of the W. S. S., with rather a whiter appearance.

This iron is worked with perfect freedom, and has a less gritty sensation under the file than the W. S. S.

No. XX.

ENGLISH IRONS.

Corbyn's Hall, No. 2, Pig Iron. Near Dudley, Staffordshire.

Experiment 5th. Depth of bar..... 1.016; Breadth do....... 1.013; Distance between supports .... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.035	+
224	.072	+
336	.116	.006
448	.161	.010
560	.210	.014
672	.258	.019
784	.315	.026
896	.379	.040
924	broke	

∴ Ultimate deflection =.393. Broke ½ an inch from the centre.

Experiment 4th. Depth of Bar...... 1.036; Breadth do........1.005; Distance between supports.......2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.033	+
224	.070	+
336	.110	.005
448	.156	.009
560	.201	.012
672	.248	.017
784	.300	.025
896	.363	.036
952	.395	
1008	broke	

∴ Ultimate deflection =.423. Broke ¼ of an inch from the centre.

Experiment 3rd. Depth of Bar .... 1.039; Breadth do........1.024; Distance between supports....... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.069	+
56	.138	.019
112	.287	.039
168	.460	.064
224	.641	.091
280	.828	.123
336	1.039	.168
392	1.259	.224
448	1.516	
476	1.657	
490	broke	

∴ Ultimate deflection =1.719. Broke ½ an inch from the centre.

Experiment 2nd. Depth of bar.... 1.025; Breadth do....... 1.018; Distance between supports .... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.069	+
56	.139	.014
112	.291	.039
168	.478	.068
224	.674	.094
280	.868	.131
336	1.090	.187
392	1.348	.260
448	1.637	

Broke one inch from the centre after the weight (448) had been replaced.

Experiment 1st. Depth of Bar.... 1.016; Breadth do......1.025; Distance between supports.... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.070	+
56	.139	.013
112	.286	.030
168	.459	.053
224	.642	.080
280	.838	.112
336	1.048	.159
392	1.282	.219
448	1.544	
455	broke	

∴ Ultimate deflection =1.574. Broke ⅜ of an inch from the centre.

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs. per square inch.	Breaking weight (*b*.)	Ultimate deflection (*d*.)	Product *b* X *d* or power of resisting impact.
Experiment 1st, bar 4ft. 6in. between supports	7007	14340600	430.0	1.599	687.6
Experiment 2nd, bar 4ft. 6in. between supports		13821000	418.9	1.678	702.9
Experiment 3rd, bar 4ft. 6in. between supports		13376000	443.2	1.786	791.7
Mean		13845866	430.7	1.687	727.4
Experiment 4th, bar 2ft. 3in. between supports			934.5	.4382	409.5
Experiment 5th, bar 2ft. 3in. between supports			883.6	.3993	352.8
Mean			909.0	.4187	381.1

The fracture of this iron is remarkable for its regularity, all the particles being nearly of equal size.—It is a free open iron, combining fluidity and softness under the chisel and the file.

No. XXI.

ENGLISH IRONS.

Wall-Brook, No. 3, Pig Iron, Dudley Worcestershire.

Experiment 1st.
Depth of Bar 1.025
Breadth do....... 1.026
Distance between supports......4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.064	
56	.127	.006
112	.256	.017
168	.407	.031
224	.559	.050
280	.722	.073
336	.910	.110
392	1.092	.139
448	1.198	—
	broke	

∴ Ultimate deflection =1.293
Broke $1\frac{1}{2}$ inch from the centre.

Experiment 2nd.
Depth of Bar...... 1.011
Breadth do....... 1.044
Distance between supports..... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.060	
56	.127	+
112	.253	.012
168	.400	.029
224	.555	.049
280	.721	.072
336	.902	.104
392	1.090	.141
428	1.300	.190
476	broke	

∴ Ultimate deflection =1.398.
Broke $\frac{1}{2}$ an inch from the centre.

Experiment 3rd.
Depth of Bar......1.038
Breadth do.. ....1.029
Distance between supports.... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.061	
56	.122	+
112	.248	.010
168	.397	.023
224	.553	.047
280	.718	.069
336	.894	.095
392	1.082	.134
448	1.300	.182
476	1.412	—
497	broke	—

∴ Ultimate deflection =1.490.
Broke $\frac{3}{8}$ of an inch from centre.

Experiment 4th.
Depth of Bar.....1.031
Breadth do 1.024
Distance between supports .... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.030	+
224	.064	+
336	.095	.005
448	.134	.006
560	.173	.009
672	.214	.014
784	.259	.020
896	.309	.030
952	.337	
1008	.366	

Broke $\frac{1}{4}$ of an inch from the centre.

Experiment 5th.
Depth of bar......1.038
Breadth do.. ......1.012
Distance between supports ....2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection Load removed.
112	.030	+
224	.062	+
336	.099	.006
448	.137	.007
560	.176	.010
672	.218	.015
784	.264	.024
896	.317	.034
952	broke	

∴Ultimate deflection =.340.
Broke $\frac{3}{4}$ of an inch from the centre.

Results reduced to those of bars 1.00 inch square.					
	Specific Gravity.	Modulus of elasticity in lbs.	Breaking weight (*b*.)	Ultimate deflection (*d*.)	Product *b* X *d* or power of resisting impact.
Experiment 1st, bar 4ft. 6in between supports	6979	15587600	415.6	1.325	550.7
Experiment 2nd, bar 4ft. 6in. between supports		15148400	431.9	1.459	630.1
Experiment 3rd, bar 4ft. 6in. between supports		15448300	448.3	1.546	693.1
Mean		15394766	431.9	1.443	624.6
Experiment 4th, bar 2ft. 3in. between supports			926.1	.3773	349.4
Experiment 5th, bar 2ft. 3in. between supports			873.1	.3529	308.1
Mean			899.6	.3651	328.7

This Iron when fractured is very similar in appearance to the Pant; it is pretty uniform in its texture, but works with a feeling of hardness.—Colour light gray intermixed with blue.

No. XXII.

ENGLISH IRONS.

Oldberry, No. 3, Pig Iron, Hot Blast, (Patent Iron,) Shropshire.

Experiment 1st.
Depth of Bar.... .992
Breadth do......1.000
Distance between supports.... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.055	
56	.105	
112	.198	
168	.295	+
224	.399	.010
280	.501	.014
336	.610	.020
392	.716	.027
448	.821	.032
504	.938	.040
560	1.058	.051
588	broke	—

∴ Ultimate deflection =1,116.
Broke at centre.

Experiment 2nd
Depth of bar.... 1.010
Breadth do...... .996
Distance between supports 4ft. 6in

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.049	
56	.097	
112	.189	+
168	.281	.008
224	.384	.010
280	.487	.012
336	.588	.016
392	.690	.021
448	.790	.029
504	.904	.036
532	broke	

∴ Ultimate deflection =.957.
Broke ¾ of an inch from the centre.

Experiment 3rd.
Depth of Bar 1.006
Breadth do.......1.006
Distance between supports....... 4ft. 6in,

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.050	
56	.099	+
112	.190	+
168	.283	.008
224	.384	.010
280	.488	.016
336	.590	.020
392	.698	.029
448	.800	.032
504	.911	.042
518	broke	

∴ Ultimate deflection =.938.
Broke ⅝ an inch from the centre.

Experiment 4th.
Depth of Bar...... .991
Breadth do........ .991
Distance between supports......2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.026	
224	.052	+
336	.075	+
448	.100	+
560	.131	+
672	.158	+
784	.187	.005
896	.215	.006
1008	broke	

∴ Ultimate deflection =.244
Broke ¾ of an inch from the centre.

Experiment 5th.
Depth of bar...... 1.004
Breadth do....... .993
Distance between supports 2ft. 3in,

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.024	
224	.045	
336	.068	
448	.091	
560	.117	+
672	.143	+
784	.168	+
896	.194	.005
1008	.220	.005
1036	broke	

∴ Ultimate deflection =.227.
Broke ⅜ of an inch from the centre.

Results reduced to those of Bars 1.00 inch square.					
	Specific Gravity	Modulus of elasticity in lbs.	Breaking Weight, (b)	Ultimate deflection (d)	Product $b \times d$ or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	7300	22810700	597.5	1.107	661.5
Experiment 2nd., bar 4ft. 6in. between supports		22733000	523.6	.966	506.0
Experiment 3rd., bar 4ft. 6in. between supports		22656500	508.8	.9436	480.1
Mean		22733400	543.3	1.0055	549.2
Experiment 4th., bar 2ft. 3in. between supports			1036	.2414	250.5
Experiment 5th., bar 2ft. 3in. between supports			1035	.2279	235.9
Mean			1035	.2346	243.2

Only one sample of this Iron was obtained, and portions of it when viewed with the naked eye presented a speckled white appearance. When examined with a microscope it seems to be a metal unequally mixed, and presents in the same fracture two distinct processes of crystallization, the greater proportion being pure white, and the other a bluish gray, projecting more prominent than the rest on the face of the fracture. In the above samples, the white band of crystals prevented them being worked.

The results obtained from the preceeding experiments on the English irons, seem to furnish the best evidence that can be procured on the strengih andother qualities investigated in this enquiry.

On examination it will be found that considerable differences exist between one iron and another, but not more than the nature of the ores and their products would indicate. During the smelting process, the same qualities of iron are not always produced, as the Nos. 1, 2, and 3, and sometimes No. 4, are obtained from the same ores. M. Dufrenoy in his report to the Directors General of the mines of France, on the use of hot air in the Iron works of this country, states, " that the iron obtained from a furnace is generally a mixture of No. 1 and No. 2; that which first issues from the hearth is No. 1. The two sorts of pigs are known by the manner in which they flow, and above all by the disposition of the streaks which mark the surface of the metal as it cools. "

In addition to No. 1 and No. 2 mentioned by M. Dufrenoy, No. 3 is frequently produced; it generally contains less carbon than No. 1 or

No. 2, and presents greater rigidiy than either of the former qualities.—From the circumstances thus stated, it will be noticed that, in comparing two irons together, it will be necessary to observe the quality, and as often as possible to compare the No. 1 of one iron with No. 1 of another iron; and in order to ensure the correct value or point of difference, this method should also be adopted in the Nos. 2 and Nos. 3.

In pursuance of these views I have endeavoured to procure the irons as much alike as possible, and to render the comparison still more perfect, I have selected the medium, or No. 2 quality, as the most suitable for the purpose. In every instance, the No. 2 iron could not be obtained, but in most cases I have kept as close to it as circumstances would admit. We may therefore, safely compare similar qualities and numbers together, either in reference to their transverse strength, or power to resist impact.

The following short summary of results may be useful in exhibiting the relative values of the No. 2, English Irons, in reference to their powers of resisting a transverse strain: their powers to resist impact and other properties

will be reserved until the close of the experiments; when an exposition of the whole will take place, and such deductions be made, as may appear indicative of the observations and trials to which they were severally subjected.

ABSTRACT OF RESULTS FROM THE No. 2 ENGLISH IRONS.

		Breaking Weight.
Butterley,	No. 2	489.3
Horace St. Pauls,	No. 2	481.9
Low Moor	No. 2	461.6
Apedale,	No. 2	457.0
Oldberry,	No. 2	453.5
Elsecar,	No. 2	446.0
Lane End,	No. 2	444.5
Adelphi,	No. 2	441.0
Old Park,	No. 2	440.7
Corbyn's Hall,	No. 2	430.7
Carrol,	No. 2	430.3
Level,	No. 2	418.8
W. S. S.	No. 2,	413.0
Eagle Foundry,	No. 2	408.3
Bierly,	No. 2	404.1

In the above, the breaking weights are taken from the bars, in each case reduced to exactly 1 inch square.

No. I.

WELSH IRONS.

Blania, No. 3, Pig Iron, Cold Blast, Monmouthshire.

Experiment 1st. Depth of Bar .....1.042 Breadth do....... 1.016 Distance between supports......4ft. 6in.			*Experiment 2nd.* Depth of Bar...... 1.037 Breadth do....... 1.012 Distance between supports..... 4ft. 6in.			*Experiment 3rd.* Depth of Bar.....1.039 Breadth do.. ....1.025 Distance between supports.....4ft. 6in.			*Experiment 4th.* Depth of Bar.....1.050 Breadth do ......1.019 Distance between supports .... 2ft. 3in.			*Experiment 5th.* Depth of bar.. ....1.014 Breadth do.. .....1.020 Distance between supports ....2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection load removed	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection Load removed.
28	.069	—	28	.070	—	28	.069	—	112	.032	—	112	.034	—
56	.131	.005	56	.138	.007	56	.136	.006	224	.064	+	224	.068	.003
112	.262	.019	112	.278	.018	112	.271	.016	336	.110	.006	336	.107	.006
168	.413	.036	168	.442	.032	168	.438	.037	448	.134	.008	448	.151	.008
224	.591	.057	224	.619	.059	224	.610	.060	560	.184	.013	560	.197	.013
280	.770	.090	280	.809	.091	280	.801	.097	672	.229	.020	672	.247	.020
336	.972	.134	336	1.032	.147	336	1.020	.142	784	.284	.031	784	.305	.034
392	1.160	.179	392	1.276	.208	392	1.260	.203	896	.349	.048	896	.379	.053
448	1.473	.273	448	1.582	.302	448	1.549	.294	952	.384		952	.416	—
476	broke		476	broke		476	broke		1008	broke		1008	broke	
∴ Ultimate deflection =1.593. Broke at the centre.			∴ Ultimate deflection =1.714. Broke ½ an inch from the centre.			∴ Ultimate deflection =1.677. Broke ¾ of an inch from centre.			∴ Ultimate deflection =.413. Broke ¼ of an inch from the centre.			∴ Ultimate deflection =.448. Broke ⅜ of an inch from the centre.		

Results reduced to those of bars 1.00 inch square.					
	Specific Gravity.	Modulus of elasticity in lbs.	Breaking Weight, (*b.*)	Ultimate deflection (*d.*)	Product *b* x *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	7159	14640000	431.5	1.660	716.2
Experiment 2nd., bar 4ft. 6in. between supports		14053000	437.39	1.777	777.2
Experiment 3rd., bar 4ft. 6in. between supports		14151400	430.1	1.742	749.2
Mean	7159	14281466	432.99	1.726	747.5
Experiment 4th., bar 2ft. 3in. between supports			897.2	.4336	389.0
Experiment 5th, bar 2ft. 3in. between supports			961.1	.4543	436.6
Mean			929.1	.4439	412.8

Blania, No. 3, presents an exceedingly uniform appearance. Colour a bright gray with a considerable admixture of blue.

This iron works with less freedom than the Apedale, and indicates more stiffness under the file.

No. II.
WELSH IRONS.
Plaskynaston, No. 2, Pig Iron, Hot Blast.

Experiment 1st. Depth of Bar .....1.000; Breadth do....... .990; Distance between supports......4ft. 6in

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.080	
56	.160	.007
112	.330	.020
168	.529	.039
224	.728	.061
280	.950	.093
336	1.180	.127
364	broke	

∴ Ultimate deflection =1.290. Broke $\frac{7}{8}$ of an inch from the centre.

Experiment 2nd. Depth of Bar...... 1.015; Breadth do....... 1.015; Distance between supports..... 4ft. 6in

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.077	
56	.150	.008
112	.314	.023
168	.500	.043
224	.690	.069
280	.889	.092
336	1.109	.127
392	1.339	.168

Broke $\frac{1}{2}$ an inch from the centre.

Experiment 3rd. Depth of Bar......1.011; Breadth do.........1.012; Distance between supports.....4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.078	
56	.151	.006
112	.317	.019
168	.504	.039
224	.700	.062
280	.907	.090
336	1.128	.124
392	1.375	
406	broke	

∴ Ultimate deflection =1.433. Broke $\frac{3}{8}$ of an inch from centre.

Experiment 4th. Depth of Bar.....1.005; Breadth do ......1.000; Distance between supports .... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.042	+
224	.089	.005
336	.145	.010
448	.199	.014
560	.258	.020
672	.324	.031
728	broke	

∴ Ultimate deflection =.353. Broke $\frac{1}{8}$ of an inch from the centre.

Experiment 5th. Depth of bar ......1.005; Breadth do.........1.034; Distance between supports ....2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection Load removed.
112	.040	+
224	.081	.005
336	.131	.007
448	.184	.010
560	.238	.015
672	broke	

∴ Ultimate deflection =.288. Broke $\frac{7}{8}$ of an inch from the centre.

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs. per square inch	Breaking weight (*b*.)	Ultimate deflection (*d*.)	Product *b* X *d* or power of resisting impact.
Experiment 1st, bar 4ft. 6in between supports	6.916	13495500	367.7	1.290	474.3
Experiment 2nd, bar 4ft. 6in. between supports		13229600	374.8	1.359	509.4
Experiment 3rd, bar 4ft. 6in. between supports		13299800	392.5	1.449	568.7
Mean	6.916	13341633	378.3	1.366	517.4
Experiment 4th, bar 2ft. 3in. between supports			720.8	.3547	255.7
Experiment 5th, bar 2ft. 3in. between supports			628.8	.2894	182.0
Mean			674.8	.3220	218.8

Plaskynaston Hot Blast, No. 2, is rather a weak iron, and presents an appearance technically called *kishie*, which means a clear porous fracture, emitting a brilliant light. It produces a slippery sensation under the action of the file.

No. III.
WELSH IRONS.
Pant, No. 2, Pig Iron.

Experiment 1st.
Depth of Bar.... 1.030
Breadth do.......1.028
Distance between supports .... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.066	
56	.124	.007
112	.266	.018
168	.415	.030
224	.567	.048
280	.729	.062
336	.896	.082
392	1.074	.106
420	broke	

∴Ultimate deflection =1.157.
Broke ¼ of an inch from the centre.

Experiment 2nd.
Depth of bar.... 1 028
Breadth do...... 1.026
Distance between supports .... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.062	
56	.124	.006
112	.255	.012
168	.390	.02
224	.540	.039
280	.695	.057
336	.858	.073
392	1.030	.098
448	1.215	.127

Broke ¾ of an inch from the centre, after the weigths 448 had been replaced.

Experiment 3rd.
Depth of Bar 1.044
Breadth do.......1·028
Distance between supports....... 4ft. 6in,

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.062	
56	.118	+
112	.242	.011
168	.382	.022
224	.529	.039
280	.678	.058
336	.829	.073
392	1.002	.095
448	1.174	.119
476	broke	

∴ Ultimate deflection =1.259.
Broke ¼ an inch from the centre.

Experiment 4th.
Depth of Bar...... 1.020
Breadth do........1.022
Distance between supports......2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.030	
224	.065	+
336	.100	.005
448	.140	.006
560	.181	.008
672	.223	.013
784	.265	.016
896	.313	.024
952	.338	
980	broke	

∴Ultimate deflection =.349
Broke ¾ of an inch from the centre.

Experiment 5th.
Depth of bar...... 1.039
Breadth do....... 1.025
Distance between supports 2ft. 3in,

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.030	+
224	.061	+
336	.096	.005
448	.134	.006
560	.174	.008
672	.212	.011
784	.254	.015
896	.296	.021
952	.320	
994	broke	

∴ Ultimate deflection =.336.
Broke ¾ of an inch from the centre.

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs.	Breaking Weight, (*b*.)	Ultimate deflection (*d*.)	Product *b* x *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	6.975	14755500	385.1	1.192	459.0
Experiment 2nd., bar 4ft. 6in. between supports		15512200	413.2	1.249	516.0
Experiment 3rd., bar 4ft. 6in. between supports		15575000	424.8	1.314	558.2
Mean		15280900	407.7	1.251	511.0
Experiment 4th., bar 2ft. 3in. between supports			921.7	.356	328.1
Experiment 5th, bar 2ft. 3in. between supports			898.3	.3491	313.6
Mean			910.0	.3525	320.8

Pant iron is very similar in appearance to the Apedale, both in the brilliancy and compactness of its crystals when viewed with the microscope it presents rather a duller appearance round the edges, but in other respects is closely identified with that iron. It resists chipping with tenacity, but yields with greater freedom to the file.

No. IV.
WELSH IRONS.

Beaufort, No. 2, Pig Iron, Hot Blast.

Experiment 1st			*Experiment 2nd.*			*Experiment 3rd.*			*Experiment 4th.*		
Depth of Bar .....1.034 Breadth do....... 1.036 Distance between supports......4ft. 6in Weight of Bar 5 feet long......15lbs. 14oz.			Depth of Bar...... 1.039 Breadth do....... 1.036 Distance between supports.....4ft. 6in. Weight of Bar 5 feet long......16lbs. 3oz.			Depth of Bar......1.037 Breadth do.........1.028 Distance between supports.....4ft. 6in. Weight of Bar 5 feet long......15lbs. 15oz.			Depth of Bar.....1.060 Breadth do......1 020 Distance between supports .... 2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.056		28	.055		28	.056		112	.033	.006
56	.116		56	.114		56	.118		224	.060	.010
112	.235	.007	112	.230	.010	112	.240	.008	336	.100	.018
168	.354	.016	168	.356	.020	168	.372	.016	448	.131	.021
224	.492	.029	224	.494	.032	224	.504	.030	560	.166	.024
280	.640	.046	280	.629	.050	280	.656	.050	672	.201	.026
336	.794	.071	336	.780	.074	336	.817	.075	784	.235	.029
392	.960	.100	392	.940	.100	392	.990	.108	896	.273	,034
448	1.140	.129	448	1.120	.130	448	1.180	.148	1008	.319	.042
476	1.240		504	1.140	.178	504	1.394	.194	1064	.345	.050
504	broke		560	1.415	.250				1078	broke	
			588	broke							
∴ Ultimate deflection =1.331. Broke 1⅓ of an inch from the centre.			∴ Ultimate deflection =1.651. Broke ½ an inch from the centre.			When the weight 504 was replaced, it broke ⅛ of an inch from the centre.			∴ Ultimate deflection =.351. Broke ¼ of an inch from centre.		

Results reduced to those of Bars 1.00 inch square.

	Specific Gravity	Modulus of elasticity in lbs. per square inch.	Breaking Weight, (*b*)	Ultimate deflection (*d*.)	Product *b* X *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	7.122	16381000	455.0	1.376	626.0
Experiment 2nd., bar 4ft. 6in. between supports	7.080	16497000	525.7	1.715	901.5
Experiment 3rd., bar 4ft. 6in. between supports	7.122	16025000	455.9	1.446	659.2
Mean	7.108	16301000	478.8	1.512	728.9
Experiment 4th., bar 2ft. 3in. between supports			940.6	.372	349.9

No. V.
WELSH IRONS.
Beaufort, No. 3, Pig Iron, Hot Blast.

Experiment 1st. Depth of Bar.... 1.550 Breadth do......1.490 Distance between supports .... 4ft. 6in. Weight of Bar 5 feet long.......... 35¾lbs			*Experiment 2nd.* Depth of bar.... 1.070 Breadth do...... 1.003 Distance between supports .... 4ft. 6in Weight of Bar 5 feet long ......16lbs. 2oz.			*Experiment 3rd.* Depth of Bar.... 1.092 Breadth do.......1.025 Distance between supports....... 4ft. 6in. Weight of Bar 5 feet long......16lbs. 7oz.			*Experiment 4th.* Depth of Bar...... 1.048 Breadth do........1.004 Distance between supports.....2ft. 3in.			*Experiment 5th.* Depth of bar...... 1.067 Breadth do....... 1.030 Distance between supports .... 2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection laod removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection, Load removed.	Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.046		28	.052		28	.050		112	.025		112	.025	
224	.095	+	56	.078	+	56	.101	+	224	.051		224	.051	
336	.146	.005	126	.235	.007	126	.228	+	336	.080		336	.079	+
448	.200	.006	182	.352	.014	182	.340	.010	448	.110	+	448	.107	+
560	.256	.009	238	.476	.027	238	.458	.021	560	.143	+	560	.139	.006
672	.315	·015	294	.602	.041	294	.582	.034	672	.177	.006	672	.169	.009
784	.374	.022	350	.745	.060	350	.707	.052	784	.214	.010	784	.201	.012
896	.444	.035	406	.892	.082	406	.853	.074	896	.251	.013	896	.235	.015
1008	.508	.046	462	1.052	.111	462	1.006	.101	1008	.295	.022	1008	.272	.021
1120	.583	.060	518	1.229	.150	518	1.171	.134	1120	.351	.039	1120	.315	.030
1232	.654	.075	574	1.432	.209	574	1.350	.185	1176	broke		1232	.363	.045
1344	.735	.095	581	broke		602	1.453	.217						
1456	.826	.120				616	broke							
1568	.924	.154												
1624	.975													
1652	broke													
∴ Ultimate deflection =.999. Broke at the centre.			∴ Ultimate deflection =1.458. Broke 1⅝ of an inch from the centre.			∴ Ultimate deflection =1.501. Broke ⅝ of an inch from the centre.			∴ Ultimate deflection =.376. Broke ¾ of an inch from the centre.			Broke ⅝ of an inch from the centre, after the weigth 1232 was replaced		

Results reduced to those of bars 1.00 inch square.					
	Specific Gravity.	Modulus of elasticity in lbs. per square inch.	Breaking Weight, (*b.*)	Ultimate deflection (*d.*)	Product $b \times d$ or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports			461.5	1.549	714.8
Experiment 2nd., bar 4ft. 6in. between supports	7.102	17251000	506.0	1.560	789.3
Experiment 3rd., bar 4ft. 6in. between supports	7.038	16353000	504.0	1.639	826.0
Mean	7.069	16802000	505.0	1.599	807.6
Experiment 4th., bar 2ft. 3in. between supports			1067.0	.394	420.4
Experiment 5th, bar 2ft. 3in. between supports			1051.0	.387	406.7
Mean			1059.0	.390	413.5

Beaufort, No. 3, is a close fine grained Iron of great uniformity of texture, and in some degree free from a diminution of the crystals as they recede from the centre.

The colour is less sparkling and altogether duller than the Apedale; in appearance it is much akin to the Butterley.—It is a stiff working iron, obdurate to the tool, but yields more kindly to the file.

No. VI.
WELSH IRONS.

Maesteg, No. , Pig Iron, (Marked White,) Glamorganshire.

Experiment 1st.
Depth of Bar.... 1.520
Breadth do......1.480
Distance between supports .... 4ft. 6in.
Weight of Bar 5 feet long.......... 35½lbs

Weight in lbs.	Deflection in inches.	Deflection load removed.
56	.026	
112	.056	+
224	.115	.005
336	.182	.009
448	.255	·017
560	.333	.029
672	.415	.042
784	.505	.063
896	.605	.082
1008	.704	.105
1120	.819	.137
1232	.945	.179
1344	1.083	.238
1400	1.164	
1428	broke	

∴Ultimate deflection =1.201.
Broke 1½ inch from the centre.

Experiment 2nd.
Depth of bar.... 1.047
Breadth do...... 1.020
Distance between supports .... 4ft. 6in.
Weight of Bar 5 feet long..........16lbs.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.062	
56	.130	+
112	.271	.012
168	.424	.029
224	.605	.053
280	.820	.089
366	1.019	.131
392	1.259	.190
448	1.530	.274
504	1.880	.419

Broke ¾ inch from the centre after the weight 504 was replaced.

Experiment 3rd.
Depth of Bar 1.035
Breadth do.......1·035
Distance between supports....... 4ft. 6in,
Weight of Bar 5 feet long..........16lbs.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.062	
56	.133	+
112	.274	.014
168	.435	.032
224	.619	.060
280	.811	.091
336	1.029	.150
392	1.266	.192
448	1.540	.275
504	1.881	.411

Broke ¼ inch from the centre after the weight 504 was replaced.

Experiment 4th.
Depth of Bar...... 1.030
Breadth do........1.027
Distance between supports......2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.030	
224	.069	+
336	.105	.005
448	.149	.007
560	.195	.014
672	.246	.020
784	.304	.031
896	.374	.049
952	.414	
980	broke	

∴ Ultimate deflection =.433.
Broke ¼ inch from the centre.

Experiment 5th.
Depth of bar......1.038
Breadth do.......1.012
Distance between supports....2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection Load removed.
112	.031	
224	.070	+
336	.106	.005
448	.150	.007
560	.199	.011
672		
784		
896	.385	.054
952	.425	
1008	broke	

∴Ultimate deflection =.465.
Broke ⅜ of an inch from the centre.

Results reduced to those of bars 1.00 inch square.

	Specific Gravity.	Modulus of elasticity in lbs. per square inch	Breaking weight (*b.*)	Ultimate deflection (*d.*)	Product *b* X *d* or power of resisting impac.
			417.6	1.825	762.1
Experiment 1st, bar 4ft. 6in between supports	7.038	13897000	450.8	1.968	887.2
Experiment 2nd, bar 4ft. 6in. between supports	7.038	14022000	454.6	1.947	885.1
Experiment 3rd, bar 4ft. 6in. between supports	7.038	13959500	452.7	1.957	886.1
Mean			899.5	.445	400.2
Experiment 4th, bar 2ft. 3in. between supports			924.4	.483	446.4
Experiment 5th, bar 2ft. 3in. between supports			911.9	.464	423.3
Mean					

No. VII.

WELSH IRONS.

Maesteg, No. , Pig Iron, (Marked Red) Glamorganshire.

Experiment 1st. Depth of Bar .....1.500 Breadth do....... 1.470 Distance between supports......4ft. 6in Weight of Bar 5 feet long..........34lbs.			*Experiment 2nd.* Depth of Bar...... 1.045 Breadth do....... 1.011 Distance between supports.....4ft. 6in. Weight of Bar 5 feet long......15lbs. 14oz.			*Experiment 3rd.* Depth of Bar......1.008 Breadth do........1.014 Distance between supports.....4ft. 6in. Weight of Bar 5 feet long......15lbs. 2oz.			*Experiment 4th.* Depth of Bar.....1.028 Breadth do......1.014 Distance between supports .... 2ft. 3in.			*Experiment 5th.* Depth of bar...... 1.036 Breadth do....... 1.026 Distance between supports 2ft. 3in,		
Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection loadremoved.	Weight in lbs.	Deflection in inches.	Deflection, Load removed.
			28	.070		28	.071		112	.033	+	112	.034	
56	.029	+	56	.139	+	56	.147		224	.075	.005	224	.072	+
112	.060	+	112	.279	+	112	.298	.014	336	.117	.008	336	.113	.005
224	.120	.006	126	.319	.019	168	.480	.040	448	.164	.011	448	.160	.010
336	.190	.012	182	.487	.041	224	.680	.070	560	.213	.016	560	.210	.014
448	.267	.021	238	.675	.070	280	.905	.110	672	.272	.025	672	.261	.025
560	.352	.033	294	.881	.112	336	1.129	.165	784	.340	.040	784	.330	.044
672	.440	.050	350	1.115	.169	392	1.459	.260	896	.421	.068	896	.404	.066
784	.536	.070	406	1.385	.245	448	1.810	.390	952	broke		952	.452	
896	.647	.096	462	1.702	.370	462	broke					980	broke	
1008	.764	.128	476	broke										
1120	.890	.169												
1232	1.050	.239												
1344	1.190	.300												
1372	broke													
∴ Ultimate deflection =1.225. Broke ½ inch from the centre.			∴ Ultimate deflection =1.788. Broke 1¼ inch from the centre.			∴ Ultimate deflection =1.892. Broke ⅞ inch from the centre.			∴ Ultimate deflection =.459. Broke at the centre.			∴ Ultimate deflection =.473. Broke at the centre.		

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs. per square inch.	Breaking Weight, (*b.*)	Ultimate deflection (*d.*)	Product *b* x *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports			414.8	1.837	762.0
Experiment 2nd., bar 4ft. 6in. between supports	7.059	13697000	431.2	1.868	805.4
Experiment 3rd., bar 4ft. 6in. between supports	7.017	14246000	448.4	1.907	855.1
Mean	7.038	13971500	439.8	1.887	830.2
Experiment 4th., bar 2ft. 3in. between supports			888.4	.472	419.3
Experiment 5th, bar 2ft. 3in. between supports			889.9	.490	436.0
Mean			889.1	.481	427.6

The relative properties of this iron are nearly the reverse of the preceding, the texture is considerably more open, accompanied with a dark blue tinge, and seems altogether a richer iron than the Beaufort; it is more porous and works softer than the Apedale; in filing it is marked by the same adhesive properties as the Low Moor.

Maesteg *(white mark*)* is similar to the Adelphi in its granulated appearance, porous in the centre, and encased by a frame of small crystals; the colour approaches to a deep grey with a more luminous appearance in the fracture than that iron. It is rather softer than the Adelphi, and files similar to the No. 3 Beaufort.

* In all probability the iron marked white is No. 2 and the red No. 1, but whether they are of hot or cold blast is uncertain.

No. VIII.

WELSH IRONS.

Pontypool, No. 2, Pig Iron.

Experiment 1st.
Depth of Bar.... 1.510
Breadth do......1.480
Distance between supports .... 4ft. 6in.
Weight of Bar 5 feet long.......... 34¼lbs.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.014	
56	.028	
112	.060	+
224	.128	.010
336	.210	.020
448	.277	.031
560	.362	.042
672	.449	.060
784	.540	.076
896	.636	.096
1008	.745	.125
1120	.876	.164
1232	1.002	.218
1344	1.160	.284

After the set had been taken, and the weight (1344) placed on again, the deflection had increased from 1.160 to 1.173. The weight was left on at night, and in the morning the bar was found broken, one inch from the centre.

Experiment 2nd.
Depth of bar.... 1.037
Breadth do...... 1.025
Distance between supports .... 4ft. 6in.
Weight of Bar 5 feet long ....15¾lbs.

Weight in lbs	Deflection in inches.	Deflection load removed.
28	.062	
56	.131	.005
112	.286	.019
168	.450	.036
224	.631	.063
280	.826	.095
336	1.030	.139
392	1.270	.203
448	1.549	.292
476	broke	

∴Ultimate deflection =1.689.
After the set had been taken and the weight (448lbs) had been placed on again, the deflection had increased from 1.549 to 1.565, the bar broke at the centre.

Experiment 3rd.
Depth of Bar.... 1.047
Breadth do.......1.01[illegible]
Distance between supports........4ft. 6in.
Weight of Bar 5 feet long ....15¾lbs.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.064	
56	.135	.005
112	.296	.021
168	.465	.040
224	.652	.067
280	.850	.100
336	1.060	.145
392	1.303	.206
448	1.594	.300
476	1.754	
497	broke	

∴Ultimate deflection =1.874.
Broke 1⅛ inch from the centre.

Experiment 4th.
Depth of Bar...... 1.052
Breadth do........1.028
Distance between supports......2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection, Load removed.
112	.030	
224	.062	
336	.096	+
448	.135	.005
560	.176	.009
672	.225	.016
784	.276	.025
896	.336	.040
1008	.411	.065
1064	broke	

∴ Ultimate deflection =.445.
Broke ¼ inch from the centre.

Experiment 5th.
Depth of bar 1.025
Breadth do.......1.025
Distance between supports ....2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection Load removed.
112	.034	+
224	.071	+
336	.111	.006
448	.159	.010
560	.207	.015
672	.263	.025
784	.330	.040
896	broke	

∴Ultimate deflection =.392.
Broke ¼ inch from the centre.

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs. per square inch.	Breaking Weight, (*b*.)	Ultimate deflection (*d*.)	Product *b* x *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports			398.3	1.752	697.8
Experiment 2nd., bar 4ft. 6in. between supports	7.080	13487000	431.9	1.752	756.6
Experiment 3rd., bar 4ft. 6in. between supports	7.080	12786000	446.7	1.962	876.4
Mean	7.080	13136500	439.3	1.857	816.5
Experiment 4th., bar 2ft. 3in. between supports			935.2	.468	437.7
Experiment 5th, bar 2ft. 3in. between supports			832.0	.402	334.4
Mean			883.6	.435	386.0

There is considerable closeness and uniformity in this iron: it presents a dull blue tinge intermixed with grey, and exhibits less lustre in its crystalline parts than the Maesteg; it very much resembles that metal in its working properties, accompanied with the same adhesion to the file.

No. IX.
WELSH IRONS.

Varteg Hill, South Wales, No. 2, Pig Iron, Hot Blast.

Experiment 1st.
Depth of Bar 1.010
Breadth do....... 1.015
Distance between supports......4ft. 6in
Weight of Bar 5 feet long..........15¾lbs.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.278	.012
126	.313	.017
182	.480	.035
238	.652	.061
294	.846	.090
350	1.050	.132
406	1.280	.189
462	1.550	.261
476	1.620	broke

Broke at the centre.

Experiment 2nd.
Depth of Bar...... 1.025
Breadth do....... 1.002
Distance between supports..... 4ft. 6in.
Weight of Bar 5 feet long.....15lbs. 14oz.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.275	.010
126	.310	.013
182	.472	.029
238	.645	.054
294	.835	.081
350	1.040	.115
378	1.160	.150
392	broke	

∴ Ultimate deflection =1.225.
Broke ¾ of an inch from the centre.

Experiment 3rd.
Depth of Bar......1.029
Breadth do.. ....1.031
Distance between supports.....2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.031	
224	.067	
336	.104	+
448	.144	.006
560	.185	.009
672	.225	.014
784	.273	.023
896	.339	.050
952	.365	
980	broke	

∴ Ultimate deflection =39.5.
Broke at the centre.

Experiment 4th.
Depth of Bar.....1.029
Breadth do 1.025
Distance between supports .... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.032	
224	.068	
336	.109	+
448	.153	.008
560	.199	.013
672	.251	.020
784	.311	.033
896	broke	

∴ Ultimate deflection =.367.
Broke ¼ inch from the centre.

Results reduced to those of bars 1.00 inch square.					
	Specific Gravity.	Modulus of elasticity in lbs. per square inch	Breaking weight (*b.*)	Ultimate deflection (*d.*)	Product *b* X *d* or power of resisting impac.
Experiment 1st, bar 4ft. 6in between supports	6.997	15166000	471.0	1.644	774.3
Experiment 2nd, bar 4ft. 6in. between supports	7.017	14858000	372.3	1.256	467.6
Mean	7.007	15012000	421.6	1.450	620.9
Experiment 3rd, bar 2ft. 3in. between supports			897.7	.406	364.5
Experiment 4th, bar 2ft. 3in. between supports			825.6	.378	312.0
Mean			861.6	.392	338.2

Varteg Hill is a more obdurate and dense iron than the Apedale; it is analogous to the Wind Mill End metal, but inferior to it in strength and power to resist impact.—On viewing the fracture the crystals appear close, but not so clearly developed as those in the Adelphi and Apedale.—The working of this iron is rather of a harsh and crumbling nature, and occasional slips are felt as if filing a polished surface.

No. X.
WELSH IRONS.
Pentwyn, No. 2, Pig Iron.

Experiment 1st.
Depth of Bar 1.042
Breadth do....... 1.020
Distance between supports......4ft. 6in.
Weight of Bar 5 feet long..........16lbs.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.056	
56	.117	+
112	.247	.009
168	.373	.020
224	.520	.030
280	.680	.048
336	.850	.071
392	1.034	.101
448	1.236	.143
504	1.461	.201

When the weight 504 was placed on again, the bar broke 1⅝ inch from the centre.

Experiment 2nd.
Depth of Bar 1.065
Breadth do 1.028
Distance between supports..... 4ft. 6in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.056	
56	.116	+
112	.238	.008
168	.372	.016
224	.510	.030
280	.669	·048
336	.838	.076
392	1.011	.102
448	1.207	.136
476	1.310	
490	broke	

∴ Ultimate deflection =1.359.
Broke 1¾ of an inch from the centre.

Experiment 3rd.
Depth of Bar......1.040
Breadth do.. ....1.010
Distance between supports......2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.028	
224	.060	+
336	.098	+
448	.135	+
560	.171	.008
672	.215	.011
784	.260	.018
896	.308	.025
980	broke	

∴ Ultimate deflection =.344.
Broke ⅜ from the centre.

Experiment 4th.
Depth of Bar.....1.030
Breadth do 1.020
Distance between supports .... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.031	
224	.069	+
336	.106	+
448	.140	.005
560	.180	.009
672	.222	.017
784	.270	.024
896	.322	.035
1008	.381	.050
1078	broke	

∴ Ultimate deflection =.415.
Broke ½ inch from the centre.

Results reduced to those of bars 1.00 inch square.

	Specific Gravity.	Modulus of elasticity in lbs. per square inch.	Breaking weight (*b*.)	Ultimate deflection (*d*.)	Product *b* X *d* or power of resisting impact.
Experiment 1st, bar 4ft. 6in. between supports	7.038	15468000	455.0	1.522	692.5
Experiment 2nd, bar 4ft. 6in. between supports		14918000	420.2	1.447	608.0
Mean		15193000	437.6	1.484	650.2
Experiment 3rd, bar 2ft. 3in. between supports			897.1	.358	321.2
Experiment 4th, bar 2ft. 3in. between supports			996.2	.427	425.4
Mean			946.6	.392	373.3

Pentwyn Iron, No. 2, stands rather low in the scale of strength, and appears from experiments to be one of the weakest of the Welsh irons which were tried. It has a closer texture than the Apedale, a grey blue tinge, and is attended with considerable hardness underneath the file. In mixtures it might be safely used as an alloy to the softer metals.

No. XI.
WELSH IRONS.
Bute, No. 1, Pig Iron, Cold Blast.

Experiment 1st. Depth of bar...... 1.040 Breadth do....... 1.026 Distance between supports .... 4ft. 6in, Weight of Bar 5 feet long......15lbs. 14oz			*Experiment 2nd.* Depth of bar.... 1.021 Breadth do...... 1.030 Distance between supports .... 4ft. 6in. Weight of Bar 5 feet long.. ..15lbs. 10oz.			*Experiment 3rd.* Depth of Bar .... 1.020 Breadth do.......1-015 Distance between supports....... 4ft. 6in, Weight of Bar 5 feet long ....15lbs. 10oz.			*Experiment 4th.* Depth of Bar ...... 1.00 Breadth do ....1.02 Distance between supports.. ....2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection, Load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection, Load removed.
28	.161		28	.063		28	.065		112	.035	+
56	.125	+	56	.128	+	56	.130	+	224	.075	+
112	.255	.010	112	.264	.009	112	.268	.010	336	.117	+
168	.404	.020	168	.419	.021	168	.426	.025	448	.161	.007
224	.564	.040	224	.587	.041	224	.583	.045	560	.205	.011
280	.723	.061	280	.761	.069	280	.760	.071	672	.252	.020
336	.905	.092	336	.940	.096	336	.947	.105	784	.303	.025
392	1.100	.126	392	1.143	.135	392	1.149	.137	896	.363	.038
448	1.318	.176	448	1.373	.189	448	1.380	.190	952	.400	.048
504	1.570	.244	504	1.632	.265	504	1.637	.264	994	broke	
532	1.710		525	broke		532	broke				
546	broke										
∴ Ultimate deflection =1.772. Broke 2 inches from the centre.			∴ Ultimate deflection =1,724. Broké 1¾ inch from the centre.			∴ Ultimate deflection =1.659. Broke 1 inch from the centre.			∴ Ultimate deflection =.428. Broke ¼ inch from the centre.		

Results reduced to those of Bars 1.00 inch square.					
	Specific Gravity	Modulus of elasticity in lbs per square inch	Breaking Weight, (b)	Ultimate deflection (d)	Product b X d or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports.....	7.059	14981000	492.0	1.842	906.2
Experiment 2nd., bar 4ft. 6in. between supports.....	7.059	15234000	488.9	1.760	860.4
Experiment 3rd., bar 4ft. 6in. between supports.....	7.080	15274000	503.7	1.692	852.3
Mean.....	7.066	15163000	494.8	1.764	872.9
Experiment 4th., bar 2ft. 3in. between supports.....			974.5	.428	417.09

Bute, No. 1, Cold Blast, presents the usual appearance of the larger crystals in the centre of the fracture. It is finer grained than the Apedale, but more open than the Beaufort; in its power of being worked it is much akin to the latter. Colour a bluish grey.—From its tenacity and power to resist impact, I should pronounce this an excellent metal when applied to millwork and framing, subject to heavy strains.

No. XII.
WELSH IRONS.
Brimbo, No. 2, Pig Iron, Cold Blast.

Experiment 1st.
Depth of Bar.... 1.025
Breadth do......1.015
Distance between supports .... 4ft. 6in.
Weight of Bar 5 feet long...... 16lbs. 3oz.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.063	
56	.130	+
112	.265	.014
168	.423	.030
224	.595	.055
280	.079	.084
336	.976	.120
392	1.191	.165
448	1.427	.225
476	1.561	
497	broke	

∴ Ultimate deflection =1.651.
Broke ⅜ inch from the centre.

Experiment 2nd.
Depth of bar........1.017
Breadth do.........1.033
Distance between supports....4ft. 6in.
Weight of bar 5 feet long....15lbs. 11oz.

Weight in lbs.	Deflection in inches.	Deflection Load removed
28	.065	
56	.135	+
112	.277	.014
168	.447	.034
224	.630	.061
280	.824	.090
336	1.033	.126
392	1.248	.175
448	1.513	.245
476	1.660	
504	broke	

∴ Ultimate deflection =1.788.
Broke ¾ inch from the centre.

Experiment 3rd.
Depth of Bar........1.020
Breadth do...........1.020
Distance between supports......4ft. 6in.
Weight of Bar 5 feet long.....15lbs. 14oz.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.066	
56	.136	.005
112	.274	.014
168	.440	.034
224	.620	.059
280	.811	.089
336	1.018	.126
392	1.241	.175
448	1.490	.241
476	1.637	
490	broke	

∴ Ultimate deflection =1.700.
Broke at the centre.

Experiment 4th.
Depth of Bar.....1.034
Breadth do......1.013
Distance between supports .... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.032	+
224	.068	+
336	.104	+
448	.146	.007
560	.188	.011
672	.233	.017
784	.284	.025
896	.340	.038
1008	.405	.059

Broke ⅛ of an inch from the centre after the weight had been laid on again.

Experiment 5th.
Depth of Bar...... 1.030
Breadth do....... 1.010
Distance between supports..... 2ft. 0in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.023	
224	.048	+
336	.078	+
448	.108	+
560	.138	.007
672	.169	.011
784	.205	.016
896	.243	·023
1008	.288	.035
1064	.310	

Broke at the centre.

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs. per square inch.	Breaking Weight, (*b*.)	Ultimate deflection (*d*.)	Product *b* x *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	7.038	15221000	466.0	1.692	788.5
Experiment 2nd., bar 4ft. 6in. between supports	7.017	14648000	471.7	1.818	857.5
Experiment 3rd., bar 4ft. 6in. between supports	6.997	14866000	461.7	1.734	800.6
Mean	7.017	14911666	466.4	1.748	815.5
Experiment 4th., bar 2ft. 3in. between supports			930.7	.419	390.0
Experiment 5th, bar 2ft. 3in. between supports, reduced from 2ft.			882.7	.403	355.7
Mean			906.7	.411	372.8

On comparing this iron with the Apedale specimen, there appears no sensible difference in colour or texture: it ranks next to Beaufort, No. 2, in the scale of strength, and is inferior only to the Ponkey, next following, in its power of resisting impact. In being worked it is very much like the Maesteg and Adelphi manufacture.

This iron may be used with safety for general purposes, and that more particularly when reduced by a slight admixture of metals of greater fluidity.

No. XIII.

WELSH IRONS.

Ponkey, No. 3 Iron, Cold Blast.

Experiment 1st. Depth of bar...... 1.018 Breadth do....... 1.021 Distance between supports .... 4ft. 6in, Weight of Bar 5 feet long...... 16lbs. 2oz.			*Experiment 2nd.* Depth of bar.... 1.024 Breadth do...... 1.024 Distance between supports .... 4ft. 6in. Weight of Bar 5 feet long...... 16lbs. 2oz.			*Experiment 3rd.* Depth of Bar .... 1.000 Breadth do........1-020 Distance between supports........ 4ft. 6in, Weight of Bar 5 feet long .... 15¾lbs.			*Experiment 4th.* Depth of Bar...... 1.028 Breadth do........1.025 Distance between supports.... 1ft. 10in.		
Weight in lbs.	Deflection in inches.	Deflection, Load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection, Load removed.
28	.056		28	.056		28	.056		112	.013	
56	.119	+	56	.121	+	56	.119	+	224	.030	
112	.242	.011	112	.240	.009	112	.240	.009	336	.050	+
168	.368	.020	168	.374	.020	168	.377	.020	448	.070	+
224	.509	.032	224	.518	.031	224	.517	.031	560	.088	+
280	.651	.049	280	.662	.050	280	.658	.044	672	.105	.005
336	.801	.069	336	.812	.069	336	.809	.065	784	.124	.006
392	.963	.093	392	.982	.098	392	.970	.090	896	.145	.008
448	1.145	.127	448	1.161	.130	448	1.149	.121	1008	.165	.010
504	1.341	.173	504	1.361	.177	504	1.342	.162	1120	.191	.014
560	1.560	.235	560	1.590	.238	560	1.565	.226	1232	.216	.019
588	broke		581	broke		588	1.690		1344	.241	.025
						616	broke		1456	.272	.034
									1568	.310	.049
∴ Ultimate deflection =1.664. Broke ⅜ inches from the centre.			∴ Ultimate deflection =1.670. Broké 1¾ inches from the centre.			∴ Ultimate deflection =1.802. Broke 3⅝ inch from the centre.			Broke ¾ inch from the centre after the weight 1568 had been replaced.		

Results reduced to those of bars 1.00 inch square.					
	Specific Gravity.	Modulus of elasticity in lbs. per square inch	Breaking weight (*b*.)	Ultimate deflection (*d*.)	Product *b* X *d* or power of resisting impact.
Experiment 1st, bar 4ft. 6in between supports	7.164	16914000	555.7	1.694	941.3
Experiment 2nd, bar 4ft. 6in. between supports	7.080	16708000	541.1	1.710	925.3
Experiment 3rd, bar 4ft. 6in. between supports	7.122	18011000	603.9	1.838	1110.0
Mean	7.122	17211000	566.9	1.747	992.2
Experiment 4th, bar 2f. 3i. between supports reduced from 1f. 10i.			1180.0	.480	566.4

Ponkey, No. 3, stands No. 1 as regards the breaking weight and the power of resisting impact: it is of a white grey colour, exceedingly close grained, of high specific gravity, and remarkable for the dense uniformity of its appearance when fractured. Notwithstanding the tenacity of this metal, it is not of a hard obdurate character, but yields with comparative freedom to the chisel and file; it is a good mixing iron in combination with some of the more tender metals.

No. XIV.

WELSH IRONS.

Frood, No. 2, Pig Iron, Cold Blast.

Experiment 1st.
Depth of Bar.... 1.014
Breadth do...... 1.014
Distance between supports .... 4ft. 6in.
Weight of Bar 5 feet long ...... 15lbs. 7oz.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.070	
56	.141	+
112	.289	.015
168	.459	.032
224	.639	.058
280	.829	.089
336	1.049	.128
392	1.282	.178
448	1.558	.250
476	1.718	
504	broke	

∴ Ultimate deflection =1.857.
Broke $\frac{1}{8}$ inch from the centre.

Experiment 2nd.
Depth of bar...... 1.000
Breadth do...... 1.012
Distance between supports .... 4ft. 6in.
Weight of bar 5 feet long .... 15lbs. 6oz.

Weight in lbs.	Deflection in inches.	Deflection Load removed
28	.078	
56	.151	+
112	.309	.013
168	.481	.024
224	.670	.046
280	.881	.079
336	1.116	.121
392	1.390	.183
448	1.709	.280
462	broke	

∴ Ultimate deflection =1.783.
Broke $\frac{1}{8}$ inch from the centre.

Experiment 3rd.
Depth of Bar...... 1.020
Breadth do...... 1.020
Distance between supports ...... 4ft. 6in.
Weight of Bar 5 feet long ..... 15lbs. 6oz.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.070	
56	.141	+
112	.295	.019
168	.470	.039
224	.661	.064
280	.860	.098
336	1.099	.144
392	1.350	.202
448	1.650	.289
469	broke	

∴ Ultimate deflection =1.753.
Broke $\frac{1}{4}$ inch from the centre.

Experiment 4th.
Depth of Bar...... 1.005
Breadth do 1.030
Distance between supports .... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.038	+
224	.075	+
336	.116	.005
448	.160	.009
560	.208	.013
672	.260	.019
784	.318	.030
896	.381	.046
952	broke	

∴ Ultimate deflection =.412.
Broke $\frac{3}{8}$ inch from the centre.

Experiment 5th.
Depth of Bar 1.017
Breadth do 1.020
Distance between supports..... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.038	+
224	.081	+
336	.126	.007
448	.175	.014
560	.231	.025
672	.292	.038
784	.355	.055
840	.400	.069
868	broke	

∴ Ultimate deflection =.416.
Broke 1 inch from the centre.

Results reduced to those of bars 1.00 inch square.	Specific Gravity.	Modulus of elasticity in lbs. per square inch.	Breaking weight (*b*.)	Ultimate deflection (*d*.)	Product *b* X *d* or power of resisting impact.
Experiment 1st, bar 4ft. 6in. between supports	7.080	14431000	483.4	1.883	910.2
Experiment 2nd, bar 4ft. 6in. between supports	7.017	14100000	456.5	1.804	823.5
Experiment 3rd, bar 4ft. 6in. between supports	6.997	13807000	441.9	1.788	790.1
Mean	7.031	14112666	460.4	1.825	841.2
Experiment 4th, bar 2ft. 3in. between supports			915.1	.414	378.9
Experiment 5th, bar 2ft. 3in. between supports			822.8	.423	348.0
Mean			868.9	.418	363.4

Frood, Cold Blast, No. 2, presents less brilliancy, but more uniformity, than the Apedale; it is a free and rather open iron, and might be depended upon in castings exposed to vibratory motion; its power of resisting impact is next to that of the Low Moor, and its working properties are much the same as that metal.

Pursuing the same method with the Welsh as already adopted with the English Irons, we have their comparative valucs in the No. 2 qualities, as under :—

ABSTRACT OF RESULTS FROM THE No. 2 WELSH IRONS.

Beaufort	No. 2	478.8
Brimbo	No. 2	466.4
Frood	No. 2	460.6
Maesteg*	No. 2	452.7
Pontypool	No. 2	439.3
Pentwyn	No. 2	437.6
Varteg	No. 2	421.6
Pant	No. 2	407.7
Plaskynaston	No. 2	378.3

The breaking weights are taken, in this and every other instance, on the bars reduced by calculation to one inch square.

* "Maesteg White Mark," is supposed to be No. 2 Iron.

No. I.
SCOTCH IRONS.
Gartsherrie, Hot Blast, No. 3, Pig Iron.

Experiment 1st. Depth of bar...... 1.025 Breadth do....... 1.035 Distance between supports .... 4ft. 6in. Weight of Bar 5 feet long.....15lbs. 10oz,			*Experiment 2nd.* Depth of bar.... 1 020 Breadth do...... 1.024 Distance between supports .... 4ft 6in. Weight of Bar 5 feet long......15lbs. 8oz.			*Experiment 3rd.* Depth of Bar .... 1.015 Breadth do.......1·015 Distance between supports....... 4ft. 6in, Weight of Bar 5 feet long......15lbs. 7oz.			*Experiment 4th.* Depth of Bar...... 1.020 Breadth do........1.035 Distance between supports....2ft. 3in.			*Experiment 5th.* Depth of Bar .....1.015 Breadth do....... 1.022 Distance between supports......2ft. 3in.		
Weight in lbs.	Deflection in inches.	Deflection, Load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection, Load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.067		28	.070		28	.070		112	.036		112	.035	
56	.140	+	56	.147	+	56	.147	+	224	.072	+	224	.072	+
112	.280	.015	112	.297	.020	112	.299	.019	336	.114	+	336	.115	.005
168	.444	.030	168	.465	.038	168	.470	.034	448	.156	.007	448	.156	.009
224	.618	.051	224	.649	.060	224	.650	.058	560	.200	.011	560	.200	.014
280	.798	.077	280	.830	.086	280	.839	.081	672	.250	.018	672	.250	.021
336	1.000	.109	336	1.040	.118	336	1.051	.116	784	.303	.028	784	.304	.030
392	1.216	.150	392	1.268	.159	392	1.278	.157	896	.361	.039	896	.365	.045
448	1.450	.201	448	1.510	.211	448	1.533	.216	952	broke		1008	.430	.060
			469	broke								1036	broke	
Broke ⅝ inch from the centre.			∴Ultimate deflection =1 599. Broké ½ inch from the centre.			Broke at the centre.			∴Ultimate deflection =.390. Broke 1¼ inch from the centre.			∴ Ultimate deflection =.446. Broke ½ inch from the centre.		

Results reduced to those of Bars 1.00 inch square.					
	Specific Gravity	Modulus of elasticity in lbs per square inch	Breaking Weight, (b)	Ultimate deflection (d)	Product b X d or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	7.017	14127000	412.0	1.486	612.2
Experiment 2nd., bar 4ft. 6in. between supports		13661000	440.2	1.631	718.0
Experiment 3rd., bar 4ft. 6in. between supports		13894000	428.4	1.556	666.6
Mean	7.017	13894000	426.8	1.557	998.4
Experiment 4th., bar 2ft. 3in. between supports			884.0	.398	351.8
Experiment 5th, bar 2ft. 3in. between supports			983.9	.456	448.6
Mean			933.9	.427	400.2

Gartsherrie, No. 3, Hot Blast, presents an appearance similar to the Apedale, with rather more lustre; it has great uniformity in its granulated texture, like most of the Scotch Irons. Its characteristics are fluidity, accompanied with a moderate degree of softness, when submitted to the chisel and file.

I should consider this to be a useful metal when improved with an admixture of strong Welsh.

No. II.

SCOTCH IRONS.

Duudaven, No. 3, Pig Iron, Cold Blast.

Experiment 1st.
Depth of Bar.... 1.010
Breadth do........1.018
Distance between supports .... 4ft. 6in.
Weight of Bar 5 feet long 15lbs. 12oz

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.064	
56	.128	
112	.252	.006
168	.400	.018
224	.550	.031
280	.713	.051
336	.889	.080
392	1.079	.111
448	1.290	.162
476	broke	

∴ Ultimate deflection =1.390. Broke 3 inches from the centre.

Experiment 2nd.
Depth of bar.......1.000
Breadth do.. ......1.008
Distance between supports ....4ft. 6in.
Weight of bar 5 feet long ....15lbs. 12oz.

Weight in lbs.	Deflection in inches.	Deflection Load removed
28	.068	
56	.139	
112	.272	.010
168	.430	.020
224	.597	.039
280	.766	.061
336	.959	.092
392	1.170	.134
448	1.408	.192
476	broke	

∴ Ultimate deflection =1.520. Broke ¾ inch from the centre.

Experiment 3rd.
Depth of Bar.......1.020
Breadth do.. ......1.028
Distance between supports.....4ft. 6in.
Weight of Bar 5 feet long .....15lbs. 11oz.

Weight in lbs.	Deflection in inches.	Deflection load removed.
28	.069	
56	.139	+
112	.240	.008
168	.429	.024
224	.590	.041
280	.758	.064
336	.948	.096
392	1.148	.132
448	1.377	.188
469	broke	

∴ Ultimate deflection =1.457. Broke ½ inch from the centre.

Experiment 4th.
Depth of Bar.....1.015
Breadth do 1.010
Distance between supports .... 2ft. 3in.

Weight in lbs.	Deflection in inches.	Deflection load removed
112	.031	
224	.070	+
336	.105	.003
448	.142	.005
560	.180	.008
672	.221	.013
784	.265	.020
840	.289	.024
896	broke	

∴ Ultimate deflection =.313. Broke ½ inch from the centre.

Results reduced to those of bars 1.00 inch square.					
	Specific Gravity.	Modulus of elasticity in lbs. per square inch.	Breaking weight (*b*.)	Ultimate deflection (*d*.)	Product *b* X *d* or power of resisting impact.
Experiment 1st, bar 4ft. 6in between supports.....	7.101	16681000	458.3	1.403	643.0
Experiment 2nd, bar 4ft. 6in. between supports.....	7.101	16081000	472.2	1.520	717.7
Experiment 3rd, bar 4ft. 6in. between supports.....	7.059	16840000	438.5	1.486	651.6
Mean.....	7.087	16534000	456.3	1.469	674.1
Experiment 4th, bar 2ft. 3in. between supports.....			861.1	.318	273.8

Duudaven, Cold Blast, No. 3, exhibits a duller fracture than the Gartsherrie; it however possesses the same power of being worked, besides being equally fluid, and superior in strength and power to resist impact.

No. III.

SCOTCH IRONS.

Monkland, No. 2, Pig Iron, Hot Blast.

Experiment 1st. Depth of bar.....1.020 Breadth do.....994 Distance between supports ....4ft. 6in. Weight of Bar 5 feet long..... 15lbs.4oz.			*Experiment 2nd.* Depth of bar....1 009 Breadth do.....1.003 Distance between supports ....4ft 6in. Weight of Bar 5 feet long.....15lbs. 4oz.			*Experiment 3rd.* Depth of Bar ....1.023 Breadth do.....1-007 Distance between supports.....2ft. 3in,		
Weight in lbs.	Deflection in inches.	Deflection, Load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.	Weight in lbs.	Deflection in inches.	Deflection load removed.
112	.345	.025	112	.345	.020	112	.039	
126	.390	.030	126	.390	.025	224	.081	+
182	.598	.053	182	.599	.050	336	.127	.005
238	.824	.086	238	.831	.080	448	.176	.007
294	1.070	.122	294	1.080	.115	560	.230	.011
350	1.352	.179	350	1.365	.170	672	.290	.020
406	1.676	.273	406	1.710	.274	784	.357	.031
			420	broke		840	broke	
Broke 1 inch from the centre.			∴Ultimate deflection =1.800. Broké ½ inch from the centre.			∴ Ultimate deflection =.389. Broke ⅜ inch from the centre.		

Results reduced to those of bars 1.00 inch square.

	Specific Gravity.	Modulus of elasticity in lbs. per square inch.	Breaking Weight, (*b*.)	Ultimate deflection (*d*·)	Product *b* x *d* or power of resisting impact.
Experiment 1st., bar 4ft. 6in. between supports	6.916	12115000	392.6	1.709	671.0
Experiment 2nd., bar 4ft. 6in. between supports.....		12404000	411.3	1.816	747.0
Mean	6.916	12259500	401.9	1.762	709.0
Experiment 3rd., bar 2ft. 3in. between supports			807.3	.397	320.5

On examining the crystallization of the Monkland Iron, it presents a greater degree of richness than either the Apedale or Adelphi; it is porous in the fracture, attended with considerable brilliancy.

The Monkland is remarkable for fluidity and ease of being worked: its properties are similar in many respects to those observable in the Low Moor and Butterly metals.

Before entering on the comparative estimates of the irons of British manufacture, I would offer a few remarks on the subject generally, as also on those points which refer to the strength and other properties of the irons experimented upon. In order to ascertain their values, we must have some measure of comparison as respects their strength, fluidity, flexure, &c. I have already stated that we may safely compare one iron with another, and that comparison will hold good when made between those of the same number and quality. We must, however, be careful in contrasting the No. 1, or first description of one iron, with the No. 3 of another. As regards strength the No. 1 almost invariably exhibits greater weakness, accompanied with a greater degree of flexure than the No. 2 or No. 3. For example, the No. 1 Milton, gives 352.5 for the breaking weight, and 1.525 for flexure; whereas the No. 3 exhibits 427.4 for the breaking weight, and 1.368 for flexure. Again, the Beaufort Nos. 2 and 3 present nearly the same difference, being in the ratio of 478.8 to 505.0 as regards strength, and as 1.512 to 1.599 in the measure of ultimate deflection. On the whole, therefore, it will be found that the richer and more valuable des-

criptions of iron are, generally speaking, weaker, yet more ductile when exposed to heavy strains. They are also better adapted to those objects where the finer outlines and free working properties of the metals are required.

In forming a judgment of the quality of a particular iron, there cannot, however, be any great risk, as we have only to look into the following table of collected results, and there will be found the strength as well as the other properties of each. If, for instance, a strong compact iron was wanted, we have then to look for the number at the head of the list, and from 1 downwards to 15 will be found to partake of that character.—Again, suppose a moderately strong yet fluid iron was required, the numbers 16 down to 26 or 28, will more or less correspond with those qualifications. The same may be said of the lower numbers, all of which are a fluid and easy working class: they are admirably adapted for the finer descriptions of castings, when strength is not reqnired, and must ever be in demand where that object is not considered of importance. In all these cases, it must however be admitted, that, much depends upon using an appropriate mixture, and by judicious combina-

tion to ensure the full value, and other properties necessary to be obtained in the art of casting. With these observations a general summary of results, as obtained from the whole of the irons experimented upon, will now be exhibited.

From the above table or compendium, it appears that we have 581lbs. for the greatest strength, as obtained from the Ponkey iron; and 357lbs. for the weakest, as in the Plaskynaston: equal to 469 as a mean of the two extremes. Or, taking a general mean of the whole irons experimented upon, we have 445.6 as the average value of strength. This number is probably the nearest approach to the transverse strength of cast iron yet given to the public; it is deduced from experiments on nearly the whole of the British irons, and must, from the variety, accuracy, and number of experiments given in the preceding pages, be considered as a fair average value. Taking it therefore as the representative of the transverse strength of a rectangular bar of cast iron, 1 inch square, 4ft. 6in. between supports; and comparing it with the experiments of previous writers on the same subject, we have, instead of approximate results, considerable differences and anomalous contradictions to contend with. These differences are not exclusively applicable to the experiments now under consideration, but variable as respects the conclusions of the experimentors themselves.

Banks in his treatise "On the Power of Machines," made some few experiments on bars one inch square, but as they appear never to have been reduced to that standard, either by calculation or otherwise, we may reasonably infer, from the increase which takes place in casting from models, that they would be rather larger in size than intended, and consequently, give greater results. This seems to be the case in almost every instance where the necessary precautions are not observed, and the bars uniformly reduced to the dimensions indicated in the experiments.

Tredgold in his Essay on the Strength of Cast Iron, gives the experiments of Banks, Rondelet, Ebbels, Reynolds, &c. To these he adds some of his own; but they are not applicable for comparison with ours, as the writer had different objects in view, and never broke the bars. Those of Banks, Rondelet, Reynolds, and some well conducted experiments by Mr. Rennie, recorded by Professor Barlow, are however entitled to consideration.

Banks in four successive experiments on 1 inch square bars, 3 feet between the supports, and the weights suspended from the middle,

gives the mean breaking weight at 971.6lbs. Rondelet, according to Tredgold, presents the most anomalous results. In two experiments on bars 1.066 inches square, and 3.83 between the supports, the breaking weight is given at 482lbs. And, in four other experiments (on bars the same size and the same distance between the supports) the results are 700, 1140, 375, and 605, giving 705lbs. as the mean of the breaking weights. Again, on four other experiments, on the fractured parts of the same bars, at half the distance, or 1.915 feet between the supports, the differences are still greater, being 580, 1063, 1770 and 1360, mean 1193: or, 596.5lbs. as the breaking weight, when the bars are reduced to 3.83 feet between the supports. The great discrepancies which thus exist in Rondelet's experiments, render them unfit for the purpose of comparison with our results.

The other experiments referred to were made on bars 1 inch square, broke on supports 3 feet asunder. Their results are as follows:

Banks from 3 experiments	.....	971.0lbs.
Reynolds " 2 "	.....	755.5lbs.
Rennie " 2 "	.....	869.0lbs.

Now if we reduce the distance, 3 feet between the supports, to 4 feet 6 inches, we shall then have—

Banks.....647.7
Reynolds.....503.7 } lbs. as the breaking weight.
Rennie.....579.3

These experiments indicate a greater degree of strength than we have been able to obtain; our strongest iron is considerably weaker than those experimented upon by Banks, and somewhat stronger than the results of Rennie indicate. Reynolds's iron approaches nearest to the mean—though it is somewhat in excess—it is rather stronger than the lower numbers, and may be considered equal to our Butterley specimens. Under all the circumstances, the differences are not great, if we except the variable results obtained by Rondelet from experiments upon the French irons. It may be presumed, too, that authors, when intending to make experiments upon a single iron, would generally choose a strong one.

In closing this research, to which I have devoted much time and attention, it is not my intention to offer any observations tending to

GENERAL SUMMARY OF RESULTS OBTAINED FROM THE PRECEDING EXPERIMENTS ON RECTANGULAR BARS OF CAST IRON;

Each bar being reduced to exactly one inch square.

In the following abstract, the transverse strength, which may be taken as a criterion of the value of each iron, is obtained from the mean of the experiments; first, on the long bars 4ft. 6in. between the supports; and next, on those of half the length, or 2ft. 3in. between supports. All the other values are deduced from the 4ft. 6in. bars.

Number of Iron in the scale of strength	Names of Irons.	Number of Experiments on each.	Specific Gravity.	Modulus of elasticity in lbs. per square inch, or stiffness.†	Breaking weight in lbs. of bars 4ft. 6in. between supports.	Breaking weight in lbs. of bars 2ft. 3in. reduced to 4ft. 6in. between supports.	Mean breaking weight in lbs. (S.)	Ultimate deflection of 4ft. 6in. bars, in parts of an inch.	Power of the 4ft. 6in. bars to resist impact.	Colour.	Quality.
1	Ponkey, No. 3, Cold Blast	4	7.122	17211000	567	595	581	1.747	992	Whitish gray	Hard.
2	Devon, No. 3, Hot Blast*	2	7.251	22473650	537	—	537	1.09	589	White	Hard.
3	Oldberry, No. 3, Hot Blast	5	7.300	22733400	543	517	530	1.005	549	White	Hard.
4	Carron, No. 3, Hot Blast*	2	7.056	17873100	520	534	527	1.365	710	Whitish gray	Hard.
5	Beaufort, No. 3, Hot Blast	5	7.069	16802000	505	529	517	1.599	807	Dullish gray	Hard.
6	Butterley	4	7.038	15379500	489	515	502	1.815	889	Dark gray	Soft.
7	Bute, No. 1, Cold Blast	4	7.066	15163000	495	487	491	1.764	872	Bluish gray	Soft.
8	Wind Mill End, No. 2, Cold Blast,	4	7.071	16490000	483	495	489	1.581	765	Dark gray	Hard.
9	Old Park, No. 2, Cold Blast	5	7.049	14607000	441	529	485	1.621	718	Gray	Soft.
10	Beaufort, No. 2, Hot Blast	4	7.108	16301000	478	470	474	1.512	729	Dull gray	Hard.
11	Low Moor, No. 2, Cold Blast	4	7.055	14509500	462	483	472	1.852	855	Dark Gray	Soft
12	Buffery, No. 1, Cold Blast*	5	7.079	15381200	463	—	463	1.55	721	Gray	Rather hard.
13	Brimbo, No. 2, Cold Blast	5	7.017	14911666	466	453	459	1.748	815	Light gray	Rather hard.
14	Apedale, No. 2, Hot Blast	3	7.017	14852000	457	455	456	1.730	791	Light gray	Stiff.
15	Oldberry, No. 2, Cold Blast	4	7.059	14307500	453	457	455	1.811	822	Dark gray	Rather Soft.
16	Pentwyn, No, 2	4	7.038	15193000	438	473	455	1.484	650	Bluish gray	Hard.
17	Maesteg, No. 2	5	7.038	13959500	453	455	454	1.957	886	Dark gray	Rather Soft.
18	Muirkirk, No. 1, Cold Blast*	4	7.113	14003550	443	464	453	1.734	770	Bright gray	Fluid.
19	Adelphi, No. 2, Cold Blast	5	7.080	13815500	441	457	449	1.759	777	Light gray	Soft.
20	Blania, No. 3, Cold Blast	5	7.159	14281466	433	464	448	1.726	747	Bright gray	Hard.
21	Devon, No. 3, Cold Blast*	4	7.285	22907700	448	—	448	.790	353	Light gray	Hard.
22	Gartsherrie, No. 3, Hot Blast	5	7.017	13894000	427	467	447	1.557	998	Light gray	Soft.
23	Frood, No. 2, Cold Blast	5	7.031	13112666	460	434	447	1.825	841	Light gray	Open.
24	Lane End, No. 2	3	7.028	15787666	444	—	444	1.414	629	Dark gray	Soft.
25	Carron, No. 3, Cold Blast*	5	7.094	16246966	444	443	443	1.336	593	Gray	Soft.
26	Dundavan, No. 3, Cold Blast	4	7.087	16534000	456	430	443	1.469	674	Dull gray	Rather soft.
27	Maesteg (Marked Red)	5	7.038	13971500	440	444	442	1.887	830	Bluish gray	Fluid.
28	Corbyns Hall, No. 2,	5	7.007	13845866	430	454	442	1.687	727	Gray	Soft.
29	Pontypool, No. 2	5	7.080	13136500	439	441	440	1.857	816	Dull blue	Rather soft.
30	Wallbrook, No. 3	5	6.979	15394766	432	449	440	1.443	625	Light gray	Rather hard.
31	Milton, No. 3, Hot Blast	4	7.051	15852500	427	449	438	1.368	585	Gray	Rather hard.
32	Buffery, No. 1, Hot Blast*	3	6.998	13730500	436	—	436	1.64	721	Dull gray	Soft.
33	Level, No. 1, Hot Blast	5	7.080	15452500	461	403	432	1.516	699	Light gray	Soft.
34	Pant, No. 2	5	6.975	15280900	408	455	431	1.251	511	Light Gray	Rather hard.
35	Level, No. 2, Hot Blast	6	7.031	15241000	419	439	429	1.358	570	Dull gray	Soft.
36	W. S. S., No. 2	5	7.041	14953333	413	446	429	1.339	554	Light gray	Soft.
37	Eagle Foundry, No. 2, Hot Blast,	4	7.038	14211000	408	446	427	1.512	618	Bluish gray	Soft.
38	Elsicar, No. 2, Cold Blast	4	6.928	12586500	446	408	427	2.224	992	Gray	Soft.
39	Varteg, No. 2, Hot Blast	4	7.007	15012000	422	430	426	1.450	621	Gray	Hard.
40	Coltham, No. 1, Hot Blast	5	7.128	15510066	464	385	424	1.532	716	Whitish Gray	Rather Soft.
41	Carroll, No. 2, Cold Blast	4	7.069	17036000	430	408	419	1.231	530	Gray	Hard.
42	Muirkirk, No. 1, Hot Blast*	4	6.953	13294400	417	419	418	1.570	656	Bluish gray	Soft.
43	Bierley, No. 2	5	7.185	16156133	404	432	418	1.222	494	Dark gray	Soft.
44	Coed-Talon, No. 2, Hot Blast*	4	6.969	14322500	409	424	416	1.882	771	Bright gray	Soft.
45	Coed-Talon, No. 2, Cold Blast*	5	6.955	14304000	408	418	413	1.470	600	Gray	Rather Soft.
46	Monkland, No. 2, Hot Blast	3	6.916	12259500	402	404	403	1.762	709	Bluish gray	Soft.
47	Ley's Works, No. 1, Hot Blast	3	6.957	11539333	392	—	392	1.890	742	Bluish gray	Soft.
48	Milton, No. 1, Hot Blast	4	6.976	11974500	353	386	369	1.525	538	Gray	Soft and fluid.
49	Plaskynaston, No. 2, Hot Blast	5	6.916	13341633	378	337	357	1.366	517	Light gray	Rather Soft.

The irons with asterisks are taken from the Experiments on Hot and Cold Blast Iron, made by Mr. Hodgkinson and myself for the British Association for the Advancement of Science.—See Seventh Report, Volume VI.

† The modulus of elasticity was usually taken from the deflection caused by 112lbs. on the 4ft. 6in. bars.

RULE.

To find from the above table the breaking weight in rectangular bars, generally, calling b and d the breadth and depth in inches, and l the distance between the supports in feet, and putting 4.5 for 4ft. 6in., we have $\frac{4.5 \times b\, d^2 S}{l}$ = breaking weight in lbs.—The value of S being taken from the table above.

For example: What weight would be necessary to break a bar of Low Moor Iron, 2 inches broad, 3 inches deep, and 6 feet between the supports? According to the rule given above, we have $b=2$ inches, $d=3$ inches, $l=6$ feet, $S=472$ from the table. Then $\frac{4.5 \times b\, d^2 S}{l} = \frac{4.5 \times 2 \times 3^2 \times 472}{6} = 6372$lbs., the breaking weight.

affect the commerce of one iron more than another. The object I had in view was entirely different: it was of a scientific nature, unaccompanied with any other consideration than that of giving, by direct experiment, a correct epitome of the chief properties of each iron, in order to determine its relative value in reference to enlarged and useful application. This has been done to the best of my ability, and, I trust, the classification thus attempted, will fully demonstrate the strength and other properties of this invaluable material. I entertain hopes that what has already been done will stimulate others to further and more successful efforts. There yet remains a wide field for experimental enquiry, and whoever enters upon it with an ardent mind and a strong desire for truth, with a determination to be at the necessary expence and trouble, having first made himself *well acquainted* with what has been done by others, will reap a rich and abundant harvest.