ined, which are partly refined, and partly consumed as a manure, ed with other substances. Alum and sulphate of alumina are also made n sulphuric acid and clay, or shale, but not to any extent. The quanty produced annually is 4,000 tons. Some improvements in the details ave been introduced to economise labour and save materials. The precipitation of the iron from aluminous liquors by means of prussiate of iron, was first employed here by Messrs. Lee and Co., and the Guisbro' Alum Company have introduced an aluminous cake, containing sulphate of magnesia, which has been found to answer very well in dying certain colours, and in the manufacture of all kinds of coarse paper.

Carbonate of Magnesia.—This compound has long been produced in this district. The old process has been largely superseded by that of the late Mr. H. L. Pattinson, which consists in submitting calcined magnesian limestone to the action of carbonic acid and water, under pressure. The magnesia dissolves out as bi-carbonate of magnesia, from which the neutral carbonate of magnesia is precipitated by the application of heat. The quantity manufactured is said to be about 250 tons per annum.

Superphosphate of Lime.—The manufacture of this article was commenced at Blaydon in 1844. Various materials are employed as the source of phosphate of lime, viz., bones, bone ashes from South America, exhausted animal charcoal from the sugar refineries, coprolites from Suffolk and Cambridgeshire, phosphate from Spain, Sombrero guano, &c. Improvements have been introduced in the manner of mixing the acid with these substances, and in the riddling of the superphosphate. The quantity produced amounts to between 1,500 and 1,600 tons per annum.

Sulphate of Iron.—The first manufactory for the production of green copperas in England was founded about the year 1579. The quantity at present manufactured is about 2,000 tons per annum, and the process is still the same, but Mr. Barnes has applied the refuse crystals to a novel purpose. This refuse is generally thrown away, but Mr. Barnes uses it as a manure on his farm, on the thin soil, which lies on the Magnesian Limestone.

Sulphate of Copper.—This salt was formerly produced by roasting old copper in a reverberatory furnace, and then dissolving the oxide in sulphuric acid, but it is now obtained in carrying out Longmaid's process for decomposing common salt by means of cupreous pyrites. The quantity made is about 100 tons per annum, which is all produced at the works of Messrs. J. and W. Allen.

REPORT ON THE METALLURGY OF THE DISTRICT.

This paper, by Messrs. J. L. Bell, T. Sopwith, Dr. Richardson, and T. Spencer, may be conveniently divided into the three following heads :—

The Manufacture of Iron in connection with the Northumberland and Durham Coal-field.

There is probably no district where the manufacture of iron is carried on which presents more features of interest, and embraces within its range greater variety, than that which is worked in connection with the coal-field of Northumberland and Durham. Notwithstanding this, the iron metallurgy of the north, which it will be the province of this paper to explain, owes none of its importance to the existence of any of the ores of iron being found in those measures which belong more immediately to the coal formation. In Scotland, Staffordshire, and South Wales, the shales of the Coal-measures contain bands and nodules of ironstone in sufficient quantity to supply immense works, established in these localities, for smelting iron. The coal-field of the north of England, on the contrary, extensive and productive in mineral fuel as are its strata, is singularly deficient in those ores of iron which distinguish many other carboniferous districts. An explanation, then, of the prominent position occupied, as a seat of the iron trade, by the locality under consideration, must be looked for in another direction, and a very brief mental survey of the geology of the adjoining country will furnish the necessary information. Starting from the coal-field itself, which, as containing the fuel required for smelting, may be considered as the keystone to the whole, we arrive within no great distance at strata which abundantly compensate for that poverty in ironstone already spoken of as inherent to our Coal-measures themselves.

The district known as the Newcastle and Durham coal-field contains an area of something like 700 square miles, and in shape may be roughly considered as an isosceles triangle, having its apex coincident with the coast line at Warkworth. As the sea principally forms its eastern barrier, our observations are necessarily almost exclusively confined to those formations bounding it on the west and south. In the former direction, *i.e.*, towards the west, a narrow strip, having a width of four or five miles of the Millstone Grit rising up from under the coal formation, separates this latter from an extensive tract of country, of which the Mountain Limestone is the prevailing rock. From the south-west corner of our coal-field, and separated from it by a great expansion of the Millstone Grit accompanied by Mountain Limestone, we pass over a thin wedge of the Old Red Sandstone, and enter upon the New Red, to the west of which the Carboniferous Limestone again appears as a long, narrow, and curved-shaped district, extending from Penrith to Whitehaven, and of importance in describing our subject. On the south, and skirting the coal-field on the south-east, we have the Magnesian Limestone, some half-dozen miles in width. Beyond it, forming for some distance the valley of the Tees, is the New Red Sandstone, separating, by an interval of twenty miles, our collieries from the hills of Lias in Yorkshire.

Many of the numerous beds of shale associated with the coal formation in this neighbourhood contain, interspersed in their thickness, nodules of ironstone, but these have rarely been sufficiently abundant to lead to their being worked for smelting purposes.

Above the seam of coal known on the Wear as the High Main, and separated from it by a distance of 18″, is a continuous band of this ore. It is 4½″ thick, and was formerly wrought on Waldridge Fell for the Whitehill Ironworks, and subsequently at Urpeth and its vicinity, for the furnaces at Birtley. Another thinner band, only 2″ in thickness, formed the roof of the Hutton Seam, near Birtley. From the fact that both these were extracted by simply bringing down the roof of the old coal workings, it was expected to supply the furnaces there at a very cheap rate, and this might have been so had the quantity per acre been larger. As it was, the ironmasters had to seek far and wide for supplies, and, in consequence, the cost of stone was ruinously high. In 1812, the ironstone per ton of iron cost the Tyne Iron Company 2*l.* 18*s.* 10*d.*

Near Wylam a mine was opened in 1836, out of which, from a section of 4′, four bands, measuring together 10½″, were obtained. This cost, it was stated, 7*s.* 6*d.* per ton, and yielded 30°/₀ of iron. Another working supplied nodules, having a percentage of from 35 to 37, and costing 11*s.* 6*d.* per ton. The united produce, however, of both did not suffice to supply 150 tons weekly; and these mines were speedily abandoned when a less precarious mode of obtaining ironstone offered itself, although the cost of the latter would, at the period of its first introduction, have not been less than 2*l.* on the ton of iron.

At Shotley Bridge, on the western edge of the coal-field, is a deposit of ironstone which has been far more extensively worked than any other seams found in these Coal-measures. According to a description by the late

Mr. William Cargill, in a working having a section of about 7′ in height, 12″ to 15″ of stone was obtained from six or seven bands. The ironstone from it cost 7*s.* to 8*s.* per ton. At a depth of 4½ fathoms below it, and lying above 20″ of coal, is a bed of shale about 3′ feet thick, containing 6″ to 7″ of ironstone. The total yield of both seams contained in an acre of ground Mr. Cargill estimated at 5,324 tons. In later years, however, according to a detailed report communicated by Mr. Edward T. Boyd, the average produce of the first-mentioned seam, "The Ten Band," as it was called, at that time was 8″ of ironstone, in a working of 5′ 9″ high, and in the other bed his section gives—

	ft.	in.	ft.	in.
Good coal	1	6		
Splint ditto	0	7		
			2	1
Ironstone	0	4½		
Shale	3	6		
			3	10½
			5	11½

For a limited supply, the quantity of ironstone found in this neighbourhood might have sufficed; but an immense work having been erected upon it, comprising fourteen blast-furnaces, serious inroads were soon made on its resources. From information formerly received, it would not appear, whatever might be the richness of clean stone, that its yield, as delivered to the furnaces, exceeded 26°/₀. A small quantity of ironstone continues to be extracted from a landsale colliery at Hedley, which is smelted at Wylam, and some is still worked by the Weardale Iron Company, near Tow Law. In a general sense, however, it may be assumed that ironstone of the coal formation of the north of England forms no element at the present day in the consumption of the blast-furnaces of that district.

In the deposits of ironstone connected with the Mountain Limestone, there occurs a bed of shale 30′ in thickness, in the whole of which considerable quantities of nodules of ironstone are interspersed. This deposit has been somewhat extensively wrought at Hareshaw and Ridsdale, as well as attempted at other places. In all these localities, however, the workings have been discontinued.

At Chesterwood, about two miles from Haydon Bridge, there was opened out, some years ago, a seam of what in some measure resembled the famous "Blackband ironstone" of Scotland, containing, however, much more coal than the celebrated ore of this name. It varied from 2′ to 4′ in thickness. The raw stone contained 20 to 24°/₀ of iron, but instead of 2 tons of raw mineral producing 1 ton of calcined, as in the case of Scotland, 3 tons were required at Chesterwood; so that the richness of the calcined stone was about the same, viz., 60°/₀. The deposit has been traced to other places, but in each case it is thin and poor in metal.

In Alston Moor many of the mineral veins traversing the Mountain Limestone contain a considerable quantity of a hydrated peroxide of iron as well as amrophous carbonate of iron. A bed of the latter lying on the surface, but of very limited extent, was worked at Nent Head, and smelted at Wylam. The iron produced from it, as well as from other carbonates and oxides from the same district, was of excellent quality; but the supplies were too uncertain and too costly. The ore in the veins themselves at one time was tolerably pure carbonate, yielding perhaps 30°/₀ or more of iron; but it gradually passed into carbonate of iron, from which it was with difficulty distinguished. At present only a small quantity is worked at Alston. On the other hand, at Weardale the veins contain so much carbonate and oxide of iron that furnaces have been erected at Tow Law, by Messrs. Attwood and Baring, for their reduction.

The small district of Mountain Limestone stretching from Penrith to Whitehaven contains very large quantities of most valuable red hematite, containing 60% and upwards of iron. It is sold at Whitehaven at about 10*s.* per ton. Its position is uncertain in a mining point of view, occurring in detached masses of varied thickness. This locality, as well as that near Ulverstone, of a similar character, is of importance in connection with the northern coal-fields, inasmuch as considerable quantities of the hematite ore are brought over to the east coast as a mixture with our own ironstone; while, to the furnaces smelting the produce of the Whitehaven mineral field, coke from our side is conveyed.

The Lias rocks of Yorkshire constitute by far the most important source from which the needful supplies for our furnaces are derived. The seams of ironstone belonging to this formation crop out on a considerable extent of the coast line of the shale beds, which, in addition contain large balls of the same ore. In rocks so liable to disintegration from atmospheric influence these have fallen away, and in consequence considerable quantities of ironstone, freed from the adhering shale, are to be found on the beach as rounded pebbles, and even as masses of rock. In modern times the ore so separated from its parent bed attracted the attention of those ironmasters who commenced smelting the ironstone of the coal-field. The exposed character of the Yorkshire shores and want of shelter rendered the conveyance of ironstone to the Newcastle furnaces a task of great difficulty and of some danger; and it was, therefore, not until the stratum furnishing it was discovered inland on a line of railway, at that time recently opened, that any large quantity of this Lias ironstone was consigned to the ironmasters of the Tyne. It is stated that the discovery of this bed is due to a Mr. Wilson, who pointed out its position at Grosmont, about five miles from Whitby, in 1836. The seam, being 4½′ thick, was cheaply worked, sent down the railway, and shipped at all seasons for the Tyne, where it would at that time cost about 9*s.* per ton. It is probable that ultimately as much as 80,000 to 100,000 tons of it were annually smelted in the north country furnaces.

Much surprise has been expressed at the time which elapsed between this discovery in 1836, and the period when the importance of the bed of ironstone became so immensely increased by the large quantity of ore extracted from mines opened in it since 1850. This is not so difficult of explanation as might at first appear. The Whitby ironstone, as it was then generally called, was known over a distance of coast not far short of ten miles, and its character to the west, five miles inland, had been also sufficiently explored. Over the whole of this area, its yield of metal had been uniform, namely, about 25%. No doubt the owners of the blast furnaces, which had been built on the Tyne for smelting local ores, were too glad to obtain a cheaper stone elsewhere, particularly when hot blast increased the consumption of their furnaces, already indifferently supplied, and competition with Scotland ran down the price of iron. Whitby harbour, for these firms, was more convenient than the Tees, because vessels coming down in ballast more easily ran into the former than up the somewhat intricate navigation of the river, and there was no reason to suppose that a seam of ironstone which had so uniformly maintained a low percentage over fifteen miles of country should, in this respect, as well as in others, change so rapidly in the next dozen miles. That the introduction of the stone from Whitby did not confer any great advantage on the Tyne smelters is proved by the fact that, for fourteen years after its discovery, only two furnaces, and those built under somewhat peculiar circumstances, were added to the five in blast previous to the importation of this ore. The fact was that, with the exception of one or two years, the Tyne never could compete in selling "mine" iron against the market price of the Glasgow makers. Between 1840 and 1850, the cost of ironstone on the ton of iron was never, at the Birtley Iron Company's works, less than 26*s.* 3*d.* The average selling price of iron at Glasgow over eleven years was within 6*d.* of the cost at the Birtley Iron Works, and to obtain this the owners must have charged the coal from their own pits at less than 2*s.* per ton laid down at the furnaces.

In 1840, Messrs. Bolckow and Vaughan, who had built a rolling-mill at Middlesboro' in 1840, added, at Witton Park, in 1846, the process of smelting to their operations. They were induced to do so by an offer of ironstone to be supplied from the coal-field near Bishop Auckland. In these expectations, as had happened to their colleagues on the Tyne, they were disappointed, and like them, they had recourse to Whitby. Examination of large detached masses which had fallen from the cliff led Messrs. Bolckow and Vaughan to Skinningrove on the coast, at which place they found the bed had thickened out from 4½′ to nearly 14½′, and instead of 25°/₀ of iron, it contained 31. So far was accident, but that firm experiencing the usual inconvenience arising from an exposed place of shipment, sought for, and found in 1850, the position of the ironstone inland. The Lias rocks contain other beds of ironstone, to which reference will be hereafter made, when the composition of the Main Cleveland Seam and its uses as an ore of iron are spoken of.

Thus, in a district embraced within the four counties of Northumberland, Durham, Cumberland, and Yorkshire, the coal formation contains the usual clay ironstone; the Mountain Limestone has furnished, to a limited extent, some black-band and nodules of ironstone, and is now affording spathose ore and brown hydrated peroxide of iron, as well as very large quantities of the finest red hematite; lastly, in the Lias beds of Yorkshire, there are found inexhaustible deposits of an argillaceous ore. Besides these, some small quantities of other ores, both foreign and British, are conveyed to the Tyne, but not to an extent to render them worthy of especial notice.

Notwithstanding the varied character of the different ores of the district, and the want of metallic contents of some, the property that even these have of "rusting" on exposure to air and moisture appears to have made known the existence of all at a very early period. There is little doubt that the smelting of iron ore was carried on to a considerable extent in this part of the country during its occupation by the Romans. Vast heaps of iron scoriæ may be seen on the moors of Durham, and in the valleys of the Reed and the Tyne, on the Mountain Limestone, in Northumberland. The same observations respecting an early use are, to some extent, applicable to the Lias ironstone, and no doubt proper investigation would indicate a similar state of things wherever iron ores were near the surface, and the state of society required the metal they contained. Of course, all these smelting operations have reference to the small bloomery or hearth in which, with a little ore and some charcoal blown by the wind in exposed situations, or subsequently by rude bellows, a "bloom" of malleable iron was obtained.

The German colony of ironworkers at Shotley Bridge established themselves at that place in the reign of William III. At some time or another afterwards a small high-blast-furnace, 5′ or 6′ in the boshes, was erected there, the remains of which are still visible. Wallis, in his *History of Northumberland*, published in 1769, mentions an ironwork which existed some years previously at Lee Hall, near Bellingham, under the management of a Mr. Wood, "who made a good deal of bar-iron, but charcoal becoming scarce he removed to Lancashire, where he attempted (unsuccessfully) to make it with pit coal." Although bar-iron only is mentioned, there is no doubt, from the remains still existing, that Wood also produced pig-iron. Charcoal iron was also smelted from some of the bands of clay ironstone at Bedlington, where the old calcining kilns are still visible, or were so until very recently. No iron, however, has, as far as can be ascertained, been made there for more than a hundred years.

The inroads which iron smelting, together with other metallurgical operations, &c., had made upon the forests were such, that in the reign of Queen Elizabeth four Acts of Parliament were passed to restrict the consumption of timber, especially when applied to the manufacture of iron. To supply the deficiency thus occasioned, schemes were proposed so early as 1612, and subsequently in 1621, for smelting iron with pit coal. The unsuitability, however, of the arrangement in use for smelting with charcoal when applied to mineral fuel, in all probability delayed this important amelioration taking effect for a hundred years after its first suggestion. The small furnaces and bellows of very limited power, which did very well with charcoal, would be literally useless when applied to coal or to coke. After various ineffectual attempts about 1713, the Darbys of Staffordshire reduced the application of pit coal to one of practical utility in that county. Darby's progress, however, must have been slow and his success limited, for the number of blast-furnaces in the country had, in the meantime, decreased from 300 to 59, so that in 1740 the make of pig-iron in England had fallen to 17,850 tons, from about 180,000 tons; the chief portion of our requirements being imported from Sweden and Russia. To Mr. I. Cockson the merit belongs of erecting and working the first blast-furnace with coked coal, in the north of England. The Whitehill furnace was 35′ high, 12′ across the boshes, and produced 25 tons of iron per week. The blast was supplied by the bellows, worked by a water-wheel. Its supply of ironstone was from the thin bands on Waldridge Fell and from Robin Hood's Bay; the coal, of course, was obtained from the immediate vicinity. The iron was used for colliery castings, and latterly for Government ordnance. Frequent interruptions for want of water to drive their wheel, led at length to the furnace being ultimately abandoned, about the close of the last century.

Whatever advantages, in point of ores, any district might stand possessed of, its powers for turning them to profitable account depended at that time on the existence of a fall of water sufficient to drive the needful blowing apparatus. The discoveries of Watt prevented the want of hydraulic power being any longer an impediment, and in a short time the obedient steam-engine was appointed to supply the necessary blast to iron furnaces. Notwithstanding the poverty of our coal-field in ironstone, the high price of iron—8*l.* per ton—and the small quantity of ore required for a furnace, when 40 tons of iron was the usual week's make, induced the Tyne Iron Company, in 1800, to erect their two furnaces and a steam blowing engine at Lemington.

In 1825, pig-iron rose to the unprecedented price of 12*l.*, and as a considerable portion of the stone smelted by the Tyne Iron Company was the produce of pits at Urpeth and its neighbourhood, Messrs. Perkins, Hunt, and Thompson, who were extensively engaged in coal mining in that locality, blew in two furnaces in 1830, which they had built at Birtley.

In 1836, the furnace at Wylam was put into blast by Messrs. Thompson Brothers, to smelt ironstone expected to exist in great abundance there.

We have now arrived at that period in the history of the iron trade which was followed by a gradual, but ultimately an entire change in the sources from which the furnaces of this district derived their supplies of ironstone. So early as 1836 a cargo of that ore was sent from Grosmont, near Whitby, to Birtley. In the year 1833, and up to 1839, pig-iron had ranged from 4*l.* 10*s.* to as high as 9*l.* per ton in Wales. The demand for iron in this neighbourhood was so vastly on the increase that the ores of the coal strata could not meet the growing requirements, and the Whitby stone had not inspired much confidence either for economy or quality of the iron it produced. In consequence, speculators began to pay attention to those deposits of ironstone spoken of as being connected with the Mountain Limestone, and Ridsdale was the place selected, where coal could be obtained from a seam from 2′ to 2½′ thick, situated in the same geological formation.

Although pig-iron had fallen in 1840 to 3*l.* 12*s.* 6*d.* at Glasgow, and in 1841 was selling at 3*l.* 5*s.* per ton, a second work, to smelt the same bed of ironstone with the coal 2½′ thick, lying 70 fathoms below the ironstone, was put in blast at Hareshaw; a second furnace was subsequently built at Ridsdale, and two more at Hareshaw. There is no doubt that the iron produced from this bed of ironstone was of a very excellent description. Both works, however, were nearly twenty miles from a railway, and twenty more from a market, so that their iron cost 12*s.* per ton for carriage to the consumer. After some years of fruitless struggle to meet the competition offered by Glasgow, both of these establishments were closed, and finally dismantled.

About 1840, Messrs. Bigge, Cargill, Johnson, and others, who had purchased the Ridsdale Works, had their attention directed to the beds of ironstone lying in the Coal-measures, near Shotley Bridge. A pair of furnaces were speedily erected, and set in blast. A larger company was formed, and an immense establishment was constructed. Twelve blast-furnaces were built, large rolling-mills, and all the necessary mines, mining villages, &c., followed in rapid succession. Until 1850, the furnaces went on devouring the ores found in the neighbourhood at an alarming pace, having in the meantime made extensive trials of those from the lead veins of Weardale. In 1850, the recent discoveries in Cleveland promised relief from the impending famine, and in a very short time, in spite of a distance of about fifty miles, the ironstone from that district, with some hematite for a mixture, entirely superseded the stone lying adjacent to the furnaces.

In 1842, Messrs. Losh, Wilson, and Bell, who for fifteen years had been making bar-iron, built a blast-furnace at Walker for producing forge-pig by smelting their mill-furnace cinders with Whitby stone, and this was followed by a second one in 1844, so that these were the first furnaces ever built expressly for smelting the recently discovered ironstone at Whitby.

About this period Mr. Attwood, in concert with Messrs. Baring and Co., purchased a small furnace then recently erected at Stanhope by Mr. Rippon, and built five others at Tow Law for smelting the "rider ore" (carbonate and oxide) of the lead veins. There is no doubt that, owing to the extreme irregularity of this kind of material, immense labour and expense were at first incurred, and, as regards the quality of the produce, frequently with very unsatisfactory results. Better acquaintance, however, with the veins and their contents has enabled that firm to produce iron of a very high class—so good indeed as closely to resemble in composition and quality the celebrated German "Spiegeleisen." For bar-iron purposes it bears a high name, and has, like its prototype in Germany, been found well adapted for the manufacture of the finer kinds of steel.

Although only remotely connected with our subject, it may as well be mentioned that a company of gentlemen had erected at Cleator Moor, near Whitehaven, a couple of blast-furnaces for smelting the hematite iron ore of that district, an example which has been somewhat extensively followed since. The iron made is of good quality, and the ore being rich, an immense quantity, as much as 500 tons weekly, or more, from one furnace is said to have been run.

Mention may also be made of other trials to render available the bed of ironstone nodules of the Mountain Limestone. This was attempted at Brinkburn, on the Coquet, but after a very short trial the works were closed. Another experiment was made at Haltwhistle with a similar view, but it also was abandoned soon after the erection of the works. At Bedlington two furnaces were constructed to smelt the same bands formerly used at the charcoal works in that locality, with an admixture of Yorkshire stone, mill cinder, and other materials, but these also were only a short time in operation.

Notwithstanding the varieties of coal which occur in the northern coal-field, the whole, with few exceptions, are more bituminous in character than the produce of other localities in this country. The caking property, although very valuable for many purposes, entirely unfits the coal of this district for use in the raw state in blast-furnaces, where its fusing property, by impeding the blast, causes the contents of the furnace to hang and slip, and thus to descend at irregular intervals. Against this disadvantage, however, possessed by our coal, may be placed the extreme hardness and strength of the coke it produces, which is thereby rendered capable of resisting the crushing effect of a high column of materials as they exist in blast-furnaces.

The purity of the coal is by no means an infallible indication of its fitness for the manufacture of a suitable coke for iron furnaces. Not only is comparative freedom from ash and sulphur indispensable, but there must be concurrently the power, which depends on some circumstance not clearly understood, of producing coke sufficiently compact to come down to the region of fusion in the furnaces, without being much crushed on its way.

The Magnesian Limestone, although differing little in colour, &c., from the rock in other localities, is nearly entirely carbonate of lime, and the Mountain Limestone almost invariably, from its purity, satisfies the conditions required by the iron smelter. These two, but principally the latter, with a little chalk, brought by coasting vessels as ballast, constitute the flux in the iron-furnaces.

Mr. Bewicke gives the dimensions of the field of ironstone of the Lias as thirty miles by sixteen, from which he deducts sixty miles for denudation, giving a net area of 420 square miles; he roughly considers the yield to be 20,000 tons per acre, and hence infers that close on 5,000 million tons are contained in the Main Cleveland Seam, within the limits laid down. In some places this seam is more or less split up by bands of shale, which, of course, interferes greatly with its commercial value. At Grosmont, near Whitby, there are found two seams of ironstone known as the pecten and the avicula bands. The former consists of 3′ of ironstone, divided in the middle by a bed of shale of 1¼′ thick. Separated from this by 30′ or more of shale, is the other seam, the avicula, embracing 4½′ of ironstone, along with 2′ of shale, and it is by these two bands uniting, as well as increasing in thickness, that we have further north the Main Cleveland Seam, as it is termed. At Codhill the bed has an extended height, but is so interspersed with foreign matter that it is found necessary to confine the mining to a section of 5½′; and the produce, from the circumstance of more or less shale bands running through the ironstone itself, only yields about 28 °/₀ of metal. A little to the east of Codhill are the Belmont mines, where the shales thin out, and in consequence the yield of iron is about 30 °/₀, the seam at the same time having increased in height to 7¼′. At Skelton, still further east, a marked improvement, both in thickness and in quality, is again discernible. The workings there are frequently 10′ high, and a recent analysis of the entire section of stone gave about 36 °/₀ of iron. The north side of the vale of Guisbro' is formed by an elevated ridge of land separating this valley from that of the Tees. At the western edge of this ridge are the Normanby mines, where the stone is worked at an average thickness of about 8′, containing 31½ °/₀ of iron. There is a general dip of the seam to the east from this point, and in its progress in that direction there is a gradual increase in thickness, and a little improvement in percentage of iron. It continues in this way past Eston and Upleatham, until it reaches Rockcliffe, where it attains a thickness of nearly 18′, after which it splits again into bands, and, as far as is known, resumes towards the east and south the character formerly observed as attaching to it at Grosmont, near Whitby.

It will be thus seen that, although the quantity of ironstone in the Main Cleveland Seam is practically inexhaustible, the portion which, in recent years, has yielded such immense quantities of rich mineral, as far as we can at present judge, occupies comparatively a very limited area. Commencing at Swainby, near Osmotherley, which is the most western point where the bed is worked, its thickness is not much above 3′, and the percentage of iron under 28. It improves gradually in a north-eastern direction past Kildale, where a working was attempted, and abandoned, by the writer's firm. It is not until we reach Codhill, thirteen miles from Osmotherley, that the seam is considered worth extracting; and a line from this point to Rockcliffe, on the coast, a distance of twelve miles, will probably be found as forming the southern boundary of the best stone, so that after making the necessary allowance for denudation, twenty to thirty square miles may be assumed as the extent of the area, of which a considerable portion lies at a great depth.

Much more irregular in its features is the so-called top seam. At Normanby and Eston little more than its position can be recognised, and throughout the entire field it varies from a few inches to many feet in thickness. In richness of iron it is not less changeable, giving from 20 to 35 °/ₒ of metal, according to the locality from which the sample may be taken. In the main seam there exists a certain degree of uniformity, even in the change of thickness and richness; but in the top seam both alternate very frequently in a most unlooked-for manner. On the western side of the district Ingleby Greenhow is the most northern, and indeed the only place where the top seam has been wrought in that direction. In the mine there its thickness was 2′, and richness in iron 34·75 °/ₒ. On the other side of the valley it thinned away to a few inches, containing 37·65 °/ₒ of metal. Near Osmotherley the seam is several feet thick, and in it a few inches at the top contain 41 °/ₒ of iron; this is succeeded by 3′ of stone, with 24·5 °/ₒ lying upon the top of 10′, giving 16·70 °/ₒ of iron. On the east coast, at Port Mulgrave, Messrs. Palmer formerly worked a small district of the top seam, 4′ to 4½′ thick, which on analysis gave 30·99 °/ₒ of iron. In Goadland Dale, Glazedale, Fryup Dale, and Danby Dale, this seam varies from 5′ to 8′ or 9′ in thickness, and yields from 20 to 25 °/ₒ of iron. In one case it is as low as 9·33, and in another case as high as 30·11°/ₒ, but both of these results were from a very limited area. Unless the magnetic ironstone worked at Rosedale Abbey is a portion of this top seam, about which some doubt has been expressed, all the workings in connection with this bed have been abandoned.

A word or two respecting the mode of extracting the ironstone from the main Cleveland seam in the northern portion of the field, *i.e.*, near Middlesbro', will not be altogether superfluous. There is a portion of the bed at the top 3′ thick, over and above the heights of the seam formerly given, and separated by a parting from the remainder of the bed, which parting varies from being a mere point of separation to a thickness of 6″ or 7″. When it attains this latter thickness, or even less, its contents are so impregnated with bisulphide of iron as to give 28°/ₒ of sulphur. This band being easily detached from the ironstone, was applied in the chemical works at Washington as a substitute for ordinary pyrites, and continued to be so used until a manufactory at Middlesbro' was able to consume all the produce of the district on the spot. The 3′ is left in the workings to form the roof of the mine. The remainder of the seam varies from 8′ to 10′ in height, and, indeed, occasionally reaches 16, or even more. In extracting the stone, headways are driven 9′ wide and 90′ apart, from which, at intervals of 30′, boards are excavated 15′ wide.

By this system "pillars" are left 90′ long by 30′ wide. When the limits of the royalty are reached, or when, from any other cause, it is deemed necessary to work the pillars, they are removed with something like a loss of 10°/$_{\circ}$ of their contents, so that in a good working, free from faults, the whole of the ironstone within perhaps 7½°/$_{\circ}$ can be brought away.

The relationship existing among the earthy constituents of the Cleveland ironstone varies somewhat in different localities. This is not to be wondered at, for in fact the seam itself in the same section is by no means uniform in its composition. A moment's inspection of the furnaces working the ironstone of the district, enables a practised eye to perceive a very marked difference in the general character of the slag compared with that usually seen at ironworks. Although it flows hot and fluid, it is extremely stony in its fracture, with scarcely a vestige of a vitreous nature. On comparing the composition of the slags from the Welsh, Staffordshire, and South Yorkshire works with those from the furnaces in Cleveland, the great dissimilarity in constitution is at once perceived, and examination will show, that with the composition of our ores no mere addition of lime can ever imitate the vitreous slags of those localities just mentioned.

The uniform practice in the whole district is to blow the furnaces with heated air. Sufficient data are not possessed to enable us to speak with any degree of certainty respecting the application of cold blast; but as far as actual experience goes, it is in favour of the idea that Lias ironstone would prove very intractable under that mode of smelting. In the year 1841, from some reason or another, cold air was used during four months at Birtley. The furnaces only ran 42 tons per week of white iron, produced by a consumption of 3½ tons of coke to the ton. At Clarence an attempt recently was made to operate on the Cleveland ore in the same way; twice the quantity of coke was used which is required when making foundry iron, and only white pig was obtained. A more elevated temperature being wished for than is easily commanded by means of heated iron pipes, various experiments were tried at the Clarence works, and ultimately Cowper's stoves were introduced. At the Wylam and Wear Ironworks an arrangement has been adopted by which the blast is heated by means of the waste heat from the coke ovens.

In shape, the blast-furnaces present no novelty worthy of notice. The width of the boshes varies from 14′ to 18′, and the height from 42′ to 55′, in one case 75′ having been reached with beneficial results. An average proportion will, probably, be three diameters of the boshes to the entire height, but no great importance can be attached to this ratio, inasmuch as the furnaces continue to work well long after the destruction of the lining has greatly altered the dimensions just given. One attempt has been made here to employ Alger's furnace, in which the circular horizontal section is replaced by one of an elliptical character. In this form the iron is tapped, and the slag allowed to run from the back as well as from the front of the furnace. At the Stockton Ironworks, where the system has been tried, the major axis of the ellipse is 12′, and the minor 5½′ in the hearth—the higher part of the furnace (which is an old one altered) remains circular. The blast in the north of England is introduced generally by three or four twyers, at a pressure varying from 3 to 4 lbs. per square inch, and at a temperature of about from 600° to 700° Fahr. The production of a furnace is from 200 to 220 tons weekly, although more than this quantity has been frequently obtained.

Malleable iron was of course the description of metal produced at those bloomeries the remains of which are indicated by heaps of scoriæ. With cheap fuel and water-power in sufficient quantity to drive small hammers, forges were erected at Swalwell, Beamish, Lumley, Bedlington, and other places. In the year 1800 a small rolling-mill was erected at Lemington, and in 1827 a mill was erected at Walker, capable of rolling from 80 to 100 tons per week.

It is needless to follow up at any length the increase in the manufacture of malleable iron during the time which intervened between 1827 and that of the discovery of the main seam of Cleveland ironstone. This being of so recent a date, the second stage of manufacture has not, as yet, received that complete amount of development which the great advantages possessed by the district are calculated to confer upon it. There would be, previous to 1850, in the district about 300 puddling furnaces, capable of turning out 150,000 tons of finished iron per annum. At present, the number will be about 560, with a power of producing about 280,000 tons of finished iron. At first a much stronger opinion existed in favour of refining pig-iron previous to puddling it than is the case at the present moment. In fact, it may be said that this mode of working has been all but abandoned as more wasteful than simply puddling the pig-iron direct. At the new works no refineries are built, and at the older establishments the refineries are discontinued. There are probably less mill and forge-cinders used in the manufacture of pig for bar-iron, or other purposes, than in any other district in the kingdom, and this obviously from the greater abundance and cheapness of ironstone. The extra loss in puddling and depreciation of quality in malleable iron being more than an equivalent for any saving in the blast-furnace, by the substitution of a material into which the major part of the phosphorus of the pig finds its way. It is also not improbable that the admixture of mill and forge-cinders might, with the constitution of the Cleveland ores, be more detrimental to the quality of the result than is the case in other districts. At all events our bar-iron makers seek to avoid any risk of this by its very sparing use. Some bar-iron manufacturers prefer pig having an admixture of a little hematite in the blast-furnace, or they seek to secure the advantages resulting from the use of this class of iron by using hematite pig in the puddling furnaces. It is highly probable some good results from such a course of procedure, as well from the acknowledged excellence of hematite pig as from the advantage generally allowed of using different varieties in the manufacture of malleable iron. The fact, too, that the tendency of the Cleveland iron is towards cold shortness, while that of the hematite is in the opposite direction, increases the probability of the soundness of these views. At the same time by careful puddling and subsequent manufacture, bar-iron of a very high class of excellence can be produced from pig obtained from Cleveland ironstone alone. Many of the mills being of recent construction, embrace all the recent improvements. Very powerful steam hammers forge down the puddled balls so rapidly into blooms or slabs, that two of these are frequently taken simultaneously to the puddling mill and rolled out by "doubling" into a single bar, of dimensions varying with the subsequent destination of the product. Finishing mills of great power have been constructed, capable of rolling rails, bars, angle and girder iron of any section, and of the greatest lengths produced in this branch of manufactures.

In the puddling furnaces different materials are employed in different localities for protecting the iron bottoms. In some places the plastic hematite from Lancashire is used, in others limestone. In most cases, however, "bulldog," *i.e.*, calcined mill furnace scoriæ, ground and mixed, frequently with a small quantity of red ore, is found a good covering, and capable of resisting the corroding action of puddling pig, which is more rapid than where refined metal, or a mixture of refined metal and pig, is used.

A few words to indicate in a statistical point of view the present position of this important branch of our local industry must bring this paper to a close. Were all the blast-furnaces already constructed or in process of building actually in operation, they would be capable of producing double the quantity of iron estimated from the returns of the geological survey; but accepting those returns as the basis of calculation, there will have been consumed during the year 1861, as follows:—

Ironstone	1,690,000	tons
Coal	2,380,000	„
Limestone	345,000	„
	4,415,000	„

The capital employed in mines, furnaces, works, &c., will be a little under..	£2,000,000	per annum
The annual amount of wages will be about ..	950,000	„
Dues paid to railways for carriage	350,000	„

Lead Metallurgy of the District.

These mining districts are chiefly situated in or near the centre of that narrow portion of Great Britain, which is formed by the counties of Northumberland, Durham, Cumberland, and Westmoreland, and may be considered as being nearly in the central portion of the whole island, being situated nearly midway in its length from north to south as well as from east to west between the German Ocean and the Irish Channel. Under the level lands which lie near to the eastern and western coasts, the upper portion of the carboniferous series of rocks contains numerous and valuable beds of coal. From beneath this coal strata the "lead measures," as they are locally termed, that is to say, the several beds of limestone and other rocks in which veins of lead ore are chiefly found, gradually rise in a westerly direction with an inclination exceeding that of the general rise of the surface until they bassett or crop out at the surface over a wide range of country, reaching their highest elevation at the mountain of Cross Fell in Cumberland, and other adjacent fells or mountain moorlands which extend in a north and south direction so as to form a western limit to the lead mining districts.

The strata which extend between the outcrop of the lowest of the coal strata and the Cross Fell ridge of mountains are well known in the district as the Carboniferous or Mountain Limestone formation—so called from the abundance of coal so nearly associated with them, and from the numerous beds of limestone which prevail. These lead mining strata lie nearly midway in the series of formations which are known in England, being as much below the tertiary beds of the south-east part of the island as they are above the silurian rocks on the borders of Wales. A lofty range of elevated land extends from the borders of Scotland to Derbyshire, occupying from twenty to thirty miles in width of the middle portion of the north of England. In many parts of this range of hills are extensive lead mines; but the districts may be classed under the following:—1. Mining districts connected with the River Tyne and its tributaries,—the Trent, East and West Allen, and the Derwent, Alston Moor, in the county of Cumberland, East and West Allendale, in the county of Northumberland, Blanchland, and Derwent Valley, in the same county. In addition to these, which form as it were distant mining territories of considerable extent, other valuable mines in detached places have been discovered, and are extensively worked in the valley of the Tyne. 2. The extensive mining district of Weardale, in the upper part of the valley of the River Wear, and its tributary valleys of Burnhope, Kilhope, Wellhope, Ireshope, Rookhope, &c. 3. Another extensive district is Teesdale, in the upper part of the valley of the River Tees, the mines being situated chiefly in the county of Durham, and partly in Yorkshire. From many circumstances Alston Moor is best known as a lead mining district from its having been open to public enterprise, and it forms a good type of the general condition of the lead mining districts. Of its early history, little is known. Traces of ancient smelting places exist, as may be inferred from the scoria yet to be found, but of any detailed operations or exact localities there is not, that I am aware of, any record. It is not until about six centuries ago that any light appears by which to judge of the state of the mining districts, and even then, and for some centuries after, few and far between and vague and undefined are the indications of lead mining. In the time of Henry IV, a lead mine is mentioned as having been in Essex, and Sir John Pettus enumerates the following counties as producing lead ore containing silver: viz., Devonshire, Gloucestershire, Worcestershire, Staffordshire, Leicestershire, Cheshire, Derbyshire, Lancashire, Cumberland, Northumberland, Yorkshire, Bishopric of Durham, Flintshire, Denbighshire, Shropshire, Carnarvonshire, Merioneth, Buckinghamshire, Montgomery, Carmarthen, Brecknock, Monmouth, and Dorsetshire. From this it may be seen that for a long period lead mining operations have been extensively spread over a great part of England and Wales, whilst in Scotland the chief works were almost confined to Lead Hills, a place where gold was formerly obtained in some abundance.

The earliest method of working lead mines appears to have been by shaft, by following the surface indications of ore downwards. The driving of levels for drainage in Dean Forest was of later origin, and probably so in the other mining districts of the kingdom. The work was drawn to the surface in kibbles, or small tubs, and some of the smaller pits on the bassett of inferior beds of coal yet present what probably was the appearance of a respectable mine in the infancy of such operations. The general use of levels or galleries large enough to admit of horses travelling in them, is said to have been introduced into the lead mining districts by Sir Walter Calonby Blackett about one hundred and twenty years ago, but the example was not, as I believe, followed for many years by other mine owners. Cast-iron rails, instead of wood, were first used in Nrent Force Level. Tin pipes were first used for ventilation by Low, Carlisle, and Co., at Tyne Bottom Mine. Mr. Stagg introduced iron pipes at Ramp-gill, and Mr. Dickinson first used lead pipes for the purpose of ventilation in the Nrent Force Level. Any of these materials were an improvement on the wooden boxes, which rapidly decayed, and so rendered the air impure, and which, moreover, could with difficulty be kept water-tight.

In conclusion, one prominent feature may be mentioned, viz., the work called the Blackett Level, commenced by W. B. Beaumont, Esq., M.P., in his manorial property in East Allendale. The shafts on this work were commenced in 1855, and the Adit Level, near Allendale Town, was begun in 1859. The entire length, when completed, will be nearly seven miles. At three of the shafts, and also at the Allenheads mines, are several extensive adaptations of the improved hydraulic engines invented by Sir William Armstrong, and particularly described by him at the meeting of mechanical engineers in this town.

The quantity of lead ore raised in this Northern district and smelted in the different mills, in 1861, was 37,053 tons of lead ore, 27,654 tons of lead, and 140,244 tons of silver.

Various important improvements have been introduced into the treatment of lead ores, among which may be mentioned the substitution of the Spanish Economico Furnace for the slag hearth, by means of which a better produce of lead is obtained from the refuse products of the mills. This Spanish furnace is a miniature blast-furnace, covered at the top, from which a flue conveys the fumes to the condensing chambers of chimney. Another improvement, introduced since 1839, is the celebrated desilverising process of the late Mr. H. L. Pattinson, by which large quantities of both lead and silver have been saved. This process is so well known that we at not think it necessary to describe it on the present occasion, having been fully explained in a previous report to the British Association. A third improvement is the conversion of hard into soft lead by the process of calcining introduced by Dr. Richardson at Blaydon, in 1840. This process consists in exposing the hard lead in a melted state to a current of hot air, by which the antimony and other impurities are oxidised. The oxides float on the surface of the molten lead, and are skimmed off from time to time. This operation is continued until a sample of the lead drawn from the surface is found to be soft and malleable. The late Mr. George Burnett, sen., applied this process to the softening of Spanish lead, and employed a large metal pan, set inside the furnace in which the hard lead is melted. This improvement has been the means of developing a most extensive trade between this country and Spain. The Spanish ores on the east coast of Spain are smelted with the fuel exported from this country, and the hard lead is brought here to be softened and refined.

The total imports of lead into this country in 1861 were 23,109 tons, of which a considerable proportion was from Linares in Spain. This lead contains very little silver, and the average contents may be taken at 40 ozs. per ton on the total imports. The total production of British mines in 1861 was—Lead, 65,643 tons, and silver, 563,731 ozs. Hence, the imports and production of these metals in this district amount to 45°/$_{o}$ of the lead, and upwards of 50°/$_{o}$ of the silver of the whole trade of Great Britain.

This hard lead contains, on an average, about 50 ozs. of silver per ton, so that the quantity of silver extracted on the Tyne is now upwards of 600,000 ozs. per annum.

Several improvements have also been introduced for the condensation of the fumes evolved in the various smelting and refining operations to which lead is submitted. The first in point of time is the horizontal flue or chimney, which was first used by the late Messrs. Crawhall and Johnstone, in Mr. Beaumont's extensive mills. The flues are built of masonry, 8′ in height, and 6′ wide. The aggregate length of the flues in the mills belonging to Mr. Beaumont is nine miles. Another plan, adopted in the mills of the London Lead Company, is the invention of the late Mr. Stagg. It consists in drawing the entire gaseous products of the furnace through water, by means of powerful pumping machinery. The lead is completely condensed, and easily separated from the water on being allowed to collect and remain at rest in suitable tanks. Mr. Stokoe's plan has been introduced at Langley and other smelting establishments. In this plan the lead fumes are driven by a fan blast through a series of ascending and descending columns, partially filled with brushwood on pebble stones, down which a stream of water falls to condense the lead fumes. The water collects in tanks at the bottom of the columns, and the fumes are allowed to subside. We have heard that a small quantity of pure ore is reduced in crucibles by means of iron, similar to the process employed in treating antimony ore, with the object of obtaining a lead of great purity, for the production of red lead for the manufacture of flint glass.

The Manufacture of Steel in Northumberland and Durham.

The history of the manufacture of steel in this locality commences at a very early period, for we find that, probably three hundred years ago, a colony of Germans settled at a place on the river Derwent, within a few miles of this town, and, according to tradition, there established this branch of local industry, where they also attained some celebrity as manufacturers of swords and edge tools.

The manufacture of steel, as at present carried on in this district, comprises the following descriptions:—Blistered, shear, spring and cast steel, to produce which the following materials are required:—Iron, carbon in shape of charcoal, manganese, coal, coke, fire-bricks, and fire-clay—of these the iron and manganese are imported into the district, the former, for the best qualities of steel, being brought from Sweden. The charcoal, coal, coke, fire-bricks, and fire-clay are produced in almost inexhaustible quantities, and of most excellent quality, in the immediate neighbourhood. A small proportion of fire-clay, however, having to be brought from a distance for admixture with that found in the locality.

The mode of manufacture in use here is that known as the cementing or converting process, the furnaces used being large enough to contain from ten to about twenty-three tons of materials at one time; this material consists of selected iron, and known to the manufacturer as being most suitable for the purpose for which it is ultimately intended. It is placed in the cells of the furnaces with bruised charcoal in alternate strata, the whole being covered with a vitreous material to effectually exclude the air, and heat is applied for a period of about eight or ten days, according to the degree of carbonisation required. The mass is allowed to cool for several days, and the bars are then taken out in the form of blistered steel. The change that has taken place in its structure since it was placed in the converting furnace is very marked, for instead of now being of a fibrous nature, it is quite of a crystalline character, and it must be reduced or drawn out under rolls or heavy hammers to bring back to it something of its former nature. It is, however, used in the blistered state for many purposes, such as for welding into hammer faces, and for welding to iron for edge tools, and for spades and shovels, although cast-steel is now fast superseding its use even for these purposes. Spring steel is made by simply reducing with rolls the blistered bars, and shear steel is made by repeatedly drawing down and welding the blistered bars. This last-mentioned description is also being fast superseded since the introduction of mill welding cast-steel.

The most important of what may be termed the secondary processes of this manufacture is that for producing cast-steel, and it is (among the old methods of making steel) of the most recent introduction. Cast-steel is different from all the other descriptions of steel in its fineness of grain, greater strength, and its homogeneity. The first steel used in this country partaking at all of the nature of this description of steel was the Indian wootz, which was much prized by users of steel, especially by the makers of dies for coining presses. Cast-steel is produced by breaking the blistered steel into small pieces, and placing the same in crucibles or melting pots, capable of containing thirty-six to forty pounds weight each, two of which are placed in each melting furnace. A plentiful supply of coke is now filled into the furnaces, and, by the aid of a strong draught of air, an intense white heat is obtained and kept up for three or four hours, according to the nature of the steel required. When it is ascertained that the steel is perfectly melted, the crucibles are taken out, and their contents poured into iron moulds conveniently placed near, and left to stand until in a cool enough state to be taken out as cast-steel ingots. These ingots are afterwards re-heated and hammered or rolled, or, it may be, both hammered and rolled, according to the description of article for which it is intended to be used. To produce large ingots, a number of crucibles containing liquid steel are brought out of the furnaces, quickly following each other, and a continuous stream is kept flowing into the mould. In the year 1839, a great improvement was made in cast-steel by the introduction of manganese.

The method of making steel by the cementing or converting process, as already described, may be called the indirect method, because the object of the process is to deprive, in the first instance, the pig-iron of the whole of its carbon, making the product, as nearly as possible, a pure malleable iron, and afterwards imparting to it again the necessary quantity of carbon to make it into steel. The new methods seem to aim, for the most part, at making steel by a direct process, without depriving the pig-iron of the whole of its carbon, and without reducing it into a malleable-iron condition. This is effected by extracting a large portion of carbon, but taking care to leave in a sufficient quantity to make steel, the object being to save the great waste of metal attending the puddling of iron, as well as the actual cost of that process. Of these last methods, the Uchatius process is one that was extensively experimented on a few years ago, at the Newburn Steel Works, and the following is a short description of the manner in which the process was carried on. Pig-iron of a first-class quality was melted in a reverberatory furnace, and run into a tank filled with cold water, where it was reduced into granules; this granulated cast-iron was mixed with pulverised oxide of iron and some alkaline earths, and the whole put into the ordinary steel-melting crucibles, and then placed in the furnaces, to which heat was applied in the usual way until it was brought into a fluid state. By this method, it was thought that the degree of hardness of the steel was capable of being regulated by the size of the granules, and by the quantity of oxides used, but after a great number of experiments, at a cost of little under a thousand pounds, on attempting to work it in large quantities, it was found that the product was so uncertain in the qualities necessary to good steel, that the process was altogether abandoned. The irregularity of the produce was probably caused by the uncertain quantity of carbon in the pig-iron used.

A method of making "puddled" steel has been tried in this locality, but without success. This process was a patented invention of Riepe, a German, and consists in puddling cast-iron in a furnace constructed especially for the purpose until it is observed to be in the condition of steel. This state is found to exist when a particular form of bubble appears on the surface of the metal.

The Bessemer process of making steel has also been introduced into the district, at Tudhoe, near Ferryhill, but with what success the writer is not able to say. The operation, as is generally known, consists of blowing atmospheric air through a mass of melted cast-iron until the carbon and the whole of the impurities of the iron are burnt out of it. Experiments in making cast-steel from the Taranaki sand from New Zealand, and also from another similar sand from the coast of Italy, have been tried at Newburn, with a result of getting an excellent quality of steel; but although yielding about 51°/$_0$ of metal, the cost of its production, without including anything for the sand, was so great that it would not answer commercially. It may be mentioned that this description of metallic sand appears to possess the remarkable property of not becoming oxydised when kept in a moist condition, and the writer would call the special attention of chemists and metallurgists to the fact, with the view of arriving at what would be an invaluable discovery, the production of iron or steel that would not be subject to the destroying action of the oxygen of the atmosphere.

This district is highly favourable for the development of the manufacture of steel of the best quality, owing to the facility and cheapness with which a supply of iron can be obtained from Sweden, and also owing to an abundant supply of cheap fuel and labour in the neighbourhood. The business requires, however, the most vigilant attention of thoroughly practical and experienced persons in its management to attain any considerable amount of success.