THE

INDUSTRIES OF WIGAN.

BY

H. T. FOLKARD,

R. BETLEY,

AND

C. M. PERCY.

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1889.

DEDICATION.

TO

WILLIAM ROGERS, Esq., J.P.,

Mining Engineer,

The Grange, Coppull, Lancashire

First Mayor of Wigan County Borough,

These Articles on Local Industries

Are Dedicated,

As an appreciation of his Professional Abilities

and in

Recognition of his Services to the Town during his

Mayoralty of 1888-89.

WM. ROGERS, ESQ., J.P., MAYOR OF WIGAN,

1888-9.

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PREFACE.

IN offering this record of the Industries of Wigan and the District to the public as a permanent memento of the Industrial Exhibition recently held in our town, a word or two of explanation may be expected and may be necessary, Very serious doubts were entertained by many good citizens as to whether such an Exhibition would arouse sufficient interest and generate the needful co-operation to ensure success, also whether the articles on past and present Industries would attract any special notice. The interest was aroused, the co-operation was obtained, and the Exhibition was visited during the three days it was open by tens of thousands of people; the interest taken in the exhibits was enormous, and the Catalogue including the articles, which we now re-publish, was very popular. There is every reason to believe, from the amount of business then and since transacted, that substantial good has been done. Not only visitors from a distance but many of our own people were surprised at what Wigan and District could do, and how well it was done. To improve the industrial welfare of an industrial community such as ours is the highest ambition that can animate a citizen. That has been the ambition of the Committee who organised and carried to a successful issue the Industrial Exhibition. That has been and is the ambition of the writers of these articles; that is the reason for the present re-publication, which it is hoped may find a home not only in our own town, but in many other parts of the United Kingdom interested in those important industrial operations in which Wigan excels.

Wigan, September, 1889.

INTRODUCTION.

AN Industrial Exhibition in connection with an Agricultural Show being somewhat of an unusual feature, the question might be put, Why has such an Exhibition been organised at Wigan? The answer is not far to seek, and is twofold. *First*, there has been a very general, indeed we might say a unanimous, desire that an event which can only happen about once in a generation should have every possible opportunity of success; and it was agreed that Wigan being not only a great and convenient Agricultural centre, but even more an important Industrial centre, additional interest would attach and increased attraction be afforded by the establishment of an Industrial Section in connection with the Show held by the Royal Manchester, Liverpool, and North Lancashire Agricultural Society during the month of July, 1889. It will be readily appreciated that there must be substantial difference between an Exhibition extending over several weeks or months and one which would only cover three days. Hence what has been brought together is comparatively limited in extent, and it has been impossible to do much as regards Machinery in Motion. *Second*, it was generally felt that in courtesy to our very numerous visitors some effort should be made to show that Wigan is not merely a coal producing or cotton manufacturing town of between 50,000 and 60,000 people, but the living centre of near upon a quarter of a million of a homogeneous population, carrying on important, extensive, and varied Industries.

And not only in courtesy to our visitors, but we may frankly say that in so far as endeavouring to increase our Industrial prosperity can be said to be selfish, the idea had its selfish side.

Probably the Show of 1889 will bring, at any rate we hope it will bring, a larger number of outsiders than are likely to come to us on many other occasions. Why not take the opportunity of showing what the district can do?

But even an Exhibition, large or small, and a collection varied or not varied, would not be sufficient to give the information and arouse the interest desired. And it was believed that a few special Articles, which, after making reference to days long gone by, should make an effort to explain our most important Industries as they are, would meet the case; and whilst affording matter of some interest even now, might remain for generations to come a permanent Industrial Record of Wigan in 1889. It may perhaps be said that, although the Industries referred to are all of sufficient importance to deserve mention, that a good many others might appropriately have received consideration. That is so, but in this busy age it is not easy for men best qualified to spare the needful time. At some future time may be this unpretentious work may receive improvement and extension.

The Editor wishes here to express his indebtedness to his friend, Mr. R. Betley, for his Article on "*Coal Mining*," and his friend, Mr. H. T. Folkard, for his Article on "*Early Industries.*" Also to the Chairman of the Industrial Exhibits Committee, Mr. Thomas Brown, for kind assistance as regards the Article on "*Cotton.*"

C. M. PERCY.

Wigan, July, 1889.

EARLY INDUSTRIES.

BY H. T. FOLKARD.

THE "ancient and loyal" borough of Wigan has earned its well known title by an historical existence which may be traced from the days when it formed an important Roman station. Passing through a stirring career during the middle ages which culminated in the reign of Henry VIII., the town gradually declined in importance, until its revival in almost contemporary times. Its first Charter, granted in the reign of Henry III. (1245), was followed by nine others, giving to the borough many special privileges. It has been suggested these very honours, to some extent, had an unfortunate effect in retarding the modern development of the town. Since the days of Edward I. the borough has sent members to Parliament, its contributions to the Crown at various periods in its history, both in money and in military service, comparing favourably with boroughs which have in modern days shot far ahead of it in wealth and population.

One of the earliest detailed references to Wigan is given in the 7th volume of the Itinerary of John Leland, the antiquary, who wrote in the reign of Henry VIII. "*Wigan*," he says, "pavid as bigge as Warrington and better buildid. There is one Paroch Chirch amidde the towne. Summe marchauntes, sum artificers, sum fermers. Mr. *Bradeshaw* hath a place caullid *Hawe* a myle from *Wigan*. He hath found moche canal like se coole in his grounde, very profitable to hym; and *Gerarde* of *Ynse* dwellith in that Paroch." Holinshed, a writer of Elizabeth's time, also mentions Wigan, where, he says, the inns were well provided with "naperie, bedding and tapisserie. Each commer is sure to lie in cleane sheets wherein no man hath been lodged since they came from the laundresse. If the traveller have an horse, his bed doth cost him nothing, but if he goe on foote he is sure to paie a penie for the same.; but whether he be horseman or foote, if his chamber be once appointed, he may carry the keye with him, as of his owne house, so

longe as he lodgeth there." At this time the parson of Wigan, Mr. Fleetwood, ordered the innkeepers of Wigan not to charge more than one penny for a quart of ale. Through the long struggle of the Civil Wars, the borough was loyal to the King, earning especially the second adjective in its well known title, and receiving at the Restoration a charter from King Charles the Second. The opening out of the great Wigan coalfield in the last century marks the revival of its importance, substituting commercial prosperity for feudal power. Scattered through various books of travel and topographical description, glimpses of old Wigan may be seen.

In 1788 an anonymous writer states that Wigan was *formerly* famous for the manufacture of coverlets, rugs, blankets, and bed-ticks, "but," he adds, "there is no such kind of bedding manufacture carried on now." He continues, "very considerable quantities of linen, checks, calicoes, fustians, &c., are manufactured here; and the braziery, pewtery, brass-foundry, iron-foundry, and iron-forgery businesses find employment for a great number of hands. In the Cloth Hall, erected in 1784, are exposed for sale (by the makers) during the Ascension and St. Simon and St. Jude fairs, very large quantities of Yorkshire and Lancashire woollen cloths, bedding, flannels of all sorts, calamancos (?), muslins, Irish linens, and a variety of heavy, well-made fustians; as also hardware of all kinds, with jewellery and many other sorts of goods. Formerly the clothiers who now occupy this place, were obliged to expose their wares in the open streets, which, besides the inconvenience to themselves and their customers, from heavy rains, cold, winds, etc., was sometimes attended with considerable damage to their goods." After giving a description of the Cloth Hall itself, the writer adds, "the gates are opened at ten o'clock in the mornings and closed at five in the evenings at the October, and at nine in the mornings and seven in the evenings, at the May fairs. For the safety of the goods, a guard with fire-arms, parades from the shutting to the opening of the gates. In the same book we find "Wigan Spaw, or New Harrogate," described as a strong sulphureous water, lately discovered in boring for coal in a field near to Scholes Bridge. It greatly resembles the water of Harrogate, in Yorkshire, only that it does not contain so much saline matter as that does. It holds a considerable quantity of a very fine sulphur, and has been found useful in most complaints for which sulphur waters are recommended. A very elegant building has been erected for the use of those who resort to this spring, with conveniences for drinking the water, and for using it either as a hot or cold bath." Only a few months since this old resort of bygone Lancashire invalids was rediscovered.

Another small industry, which perhaps might be revived with some advantage, is thus described:—"All the neighbourhood for miles round abounds with excellent pit coal, and in Haigh, Aspull, Ince, and several places near the town are plentiful mines of cannel coal. Besides the clear flame it yields in burning, it is also curiously polished into the appearance of black marble, and formed into busts of great men, urns, vases, candlesticks, sugar basins, snuff boxes, inkstands, etc., which are sold and presented as curiosities, and meet with good acceptance, both at home and abroad." This writer concludes his account of Wigan by a rather involved description of the old "burning wells." "Some years since, near the town was a well, which did not appear to be a spring, but rather rain-water; at first sight there was nothing about it that seemed extraordinary, but upon emptying it there presently broke out a sulphureous vapour, which made the water bubble up as if it boiled. When a candle was put to it it presently took fire, and burned like brandy; the flame in a calm season, would continue sometimes a whole day, by the heat whereof they could boil eggs, meat, etc., though the water was cold. This burning well is now lost (in 1788), supposed to be owing to the coal sinking about the Hawkley estate (near where it was). Similar experiments may be made in many places in Wigan and the neighbourhood, and it is said by the miners that these places are generally found where there is what they call a "fault," which may be perceived by little bubbles of water on the ground or in the ditches, which will immediately take fire on applying a lighted candle thereto. From such exhalations proceed the Will-with-a-Wisp, or Jack-with-a-Lanthorn, or, as they are commonly though vulgarly called in Lancashire—*a going fire.*" A list of Wigan traders is attached to this old sketch of the town, and from it is shown that in 1788 the important trades represented in the borough were fustian manufacturers, cotton manufacturers, pewterers, whitesmiths, loom and wheel makers, leather cutters, hat makers brass founders, reed makers, linen and check manufacturers, and clock, gun, and steel-bow manufacturers.

In a rare work, entitled "Remarks Made in a Tour from London to the Lakes of Westmoreland and Cumberland, in the Summer of 1791," by A. Walker, 8vo., London, 1792, we get the following singular notice of "Wigan and its Trade in 1791:"—"Wigan is not much increased in building this last thirty years. Its Corporation feuds have moderated into peace; for the electors, doubtless, have discovered that beating out the brains did not contribute to the honesty, or worth of the elected. That excellent coal, called cannel, is got under the town

and its neighbourhood in great abundance. Besides making the most brilliant fire, this coal is capable of being turned into snuff-boxes, and many other useful and ornamental toys. Many families have a cannel pit in their back-yard; and when they are in want of coals, they send down a collier, who will dig as many in a few hours as will serve the family many months—the pit is then shut up. Wigan has produced many excellent self-taught mechanics. Dick Melling simplified the steam engine; gave a windmill an equable motion, and the means of turning itself to the wind. His bucket engine drained a valuable cannel mine for many years, at a small expense; and many other contrivances of his challenge equal merit in simplicity and effect. Mr. Barker, of this place, was for many years the only maker of steel cross-bows, also of the best fowling-pieces in the kingdom. Indeed, the machinery necessary in such extensive coal-work has called forth the genius and invention of many more mechanics, that do honour to human abilities."

From a letter in the Free Library describing the state of the town in 1816, we find that at that date there was no regular water supply in the borough. A few of the main streets were supplied with water brought from the "Whitley Pond" by wooden pipes; [some of which the present Borough Engineer has recently unearthed]. In 1816 there was a windmill for grinding corn in the Scholes, and a water-mill at Scholes Bridge; and a few years later there was a large steam corn mill in the Commercial Hall Yard, which was subsequently destroyed by fire. Sedan Chairs were used by ladies in Wigan in 1816-18. About this time Miss Leigh, the sister of Sir Robert Holt Leigh, Bart., of Hindley Hall, was, we are told, the last lady in Wigan who rode pillion fashion on horseback behind her groom to Wigan on Market days and Sundays. A few brief notices of the early history of the various Wigan Industries follow. If time and space permitted, the accounts now roughly strung together might be considerably amplified, as fresh material is continually brought to light.

COAL.

The Coal Trade of Wigan ranks first amongst its industries. In early and mediæval times, although coal was well known to exist, little use was made of it, and what there was belonged exclusively to the Lord of the Manor. In the Rector's History of the Manor and Church of Wigan will be found numerous references relating to his ancestor's coal-pits, one of which is given as a specimen. In November, 1619, Bishop Bridgeman, rector of Wigan, gave permission "to Peter Platt, of Wigan, chandler, to drain the

water from his coal-pit near the Millgate into the street for a short time, to see if that would enable him to get rid of the water and work the pit. And a few months later his widow, Ann Platt, begged for leave to continue this privilege, so that the water might run down the side of the street to the river, and agreed with the Bishop to pay a rent of 52s., that is 12d. a week, and 50 loads of coal, and to pave the way all along so that the water from the pit should not hurt the said highway of Millgate." An interesting notice of the working of a Wigan colliery in 1600 was forwarded some years ago to the *Wigan Examiner* by the late Mr. J. Eglinton Bailey. 'It gives us,' he says, 'the debit and credit account of the working of a colliery nearly three centuries ago.' "Though not very minute, the accounts are of value on the score of completeness. We can follow the workmen at the sinking of the pit, at the merry-making at the finding of the coal, at the removal of the stone and water, at the 'scouring' of the pit; and we may see the sale of the coals. The figures extend over about ten weeks; and when the pit was in working order the out-put was about 25 'loads,' perhaps horse loads, per day. The cost of sinking a pit at that primitive era of the coal trade is likewise to be ascertained, with the value of labour and materials. The coal in the pit under notice seems to have been of two kinds, for it was sold about 4d. and 2d. per load respectively. The exact situation of this pit is now unknown, but it was probably somewhere on the property of Ralph Worsley, of Worsley Hall and Worsley Mesnes, Pemberton and Wigan. The names of early Wigan colliers and other workmen introduced into these accounts will have an interest for local readers.

Layde downe for workmen's wages and other necessaries for the Coal Pitte:

3 M'ch., 1600 [Tuesday]	for viij. yards and halfe sinckinge	xvijs.
	for tymberings of it	xijd.
	for more worke done...	xijd.
	for drincke and breade at the fyndinge of the coale	xijd.
	three men's wages ij. dayes and a halfe...	iiijs. ijd.
	for windinge water	ijs. ixd.
	for makinge a torne (?)	vid.
9 M'ch	for wyndinge water on Mondaye	xvjd.
	for wyndinge water on Twysdaye	vijd.
	for three workemen on Twysdaye	xxijd.
	for three workemen on Wednesdaye	xxijd.
	for wyndinge water on Wednesdaye	vjd.
	to John Smethurste for a propp	iijd.
16 M'ch.	from Wednesdaye at night till Mondaye morninge drawinge water	iiijs. vjd.
	to the getters ij. dayes and a halfe...	iijs. ivd.
	to Robte. ffarymond, for getting of coales	xvjd.
	to John Nayler, for wyndinge of them	xjd.

to James Topping, for wyndinge coale and stone on Thursdaye	xjd.
for wyndinge coale and stone on Fryday	xijd.
for wyndinge stone on Satterday	ixd.
for iij. ponds of candles	xiiijd.
for ij. ropes and a trundle for a wheelebarrow ...	vd.
for a wheelebarrow	xxd.
for a rope for the coale pitte	iijs. vid.
to John Turner upon Mondaye	xvid.
upon Wednesdaye	xd.
upon Thursdaye	xiijd.
Jt. to Robte. ffarymond for getting coales on Mondaye	xviijd.
Jt. to John Nayler for wyndinge coale and stone both nighte and daye, Mondaye	xviijd.
Jt. to James Taylor for wyndinge stone and coales	xviijd.
and one basketh wch had of him same tyme... ...	iijd.
Richard Pye for wyndinge stone	vid.
James Topping for wyndinge stone	ijd.
John Nayler for wyndinge stone	ijd.
Humffrey Taylor for wyndinge stone	vid.
for wyndinge water upon Thursdaye	iijd.
Jt. one wheelebarrowe	vid.
	[£3 2 3]

Receyved backe agayne of	xvijs. iijd.	vijs. viijd.
Payed to my cozen Worseley for the scowringe of the pitte agayne to be payed to John Turner ...		xiijs. iiijd.
More payed to my said cozen by James Howe xxs. for the same use		xxs.
		[£1. 13. 4.]

Given to Richard Rylands xxs.	Payed hereof for wyndinge water a weecke to John Nayler... ... ... and for other work iiijd. to Rowndell Leghe for plate	vijs.
for xxxviij loade of coales getting		iiijs. ixd
		[£0. 12. 1.]

by Mr. Worseley to John Turner for worke done by him	xviijd.
Jt. to John Southworthe for worke done by him ...	iiijs. ijd.
Jt. for xxiiij li of iron	iijs. vjd.
more payed te John Smethurst for his worke ...	vs.
	[£0. 14. 1.]

Soulde fyftie loade of coales gotten by Roundell Birchall all for fyfteen shillings ten pence ...	xvs. xd

Gotten and Soulde by Richard Rylands } Soulde xxxviij loade of coales first weecke
Second weecke four score and fourteene loades
Third weecke fyftie two loades
Fourth weecke six score and three loades
Fifte weecke xij score and two loades
Sixte weecke x score and ten loades
Seventhe weecke viij score xvij loades
In the waye three score and thirteene loades .
[Total 859.]

Jt. thirteene dayes getting in the foreseid waye
the gettinge of the coales in the waye cometh to more han the coales do amount to xvs. xd.
and for wyndinge water xlixs.
for tymberinge the pitte lxs. xd.
for making the plate xxd.
for wyndinge stone xiijd.
for gettinge vij loades of coales xxv. vijd.
for wyndinge the seid loades iijs. vid.
all this to be repayed
for c. [100] loades of coales xvs. xd.
for viijc. [800] fortie nyne loades xijliiijs.
for halfe a hundred layed up xviijd.

A local writer, with philological proclivities, informs us that to Scholes must be given the honour of first working Wigan coal. 'Coal used to be *quarried* in Scholes," he says. "It crops out in several places about Greenough Street, and is nowhere many feet deep. It must therefore have been worked at a very early period, and the heaps of *shows* (refuse and cinders, &c., the same name with the same meaning is still in use in our kitchens in the shape of *scow-rake*, for raking up ashes), would naturally give a name to the place. The natives also generally describe it as '*Th' Scows*, that is *the Scholes*." In the year 1802 cannel coal was sold in the Wigan district at 5d. per hundredweight at the pit's mouth.*

COTTON.

The early history of the Cotton Trade of Wigan is involved in considerable obscurity. Cotton was certainly manufactured in Wigan in the 17th century. The material was imported principally from the Levant, and, there being then no mills, the weaving was done on hand looms in the houses of the people, the weavers working usually in cellars under their cottages. Some of these old dwellings may still be seen in Wigan Lane and Chapel Lane, with long flights of stone steps up the front of them to the living rooms above.

* Tour through the Northern Counties of England, etc., by the Rev. Richard Warner, Bath, 1802, 8vo.

A Mr. Morris, of Brock Mill, in the early part of the present century, brought the first cotton carding machine to Wigan, and the first cotton mills erected in Wigan were in the meighbourhood of the Wallgate. The old mill in Princess Street was perhaps the first of all. Arriving at the year 1818 we get some definite information regarding the Cotton Trade of Wigan. In that year there were eight small cotton mills working in the town. Taking them altogether they contained no more spindles than would now be found in one of the throstle spinning rooms of the Victoria Mills. Five of these old mills were afterwards destroyed by fire, and the remainder have long since been pulled down. Mr. William Woods, grandfather of the present Mr. Woods, was the first to introduce power looms into Wigan. At that time when riotous mobs were nightly destroying the power looms in East Lancashire, Mr. Woods borrowed two old cannon from Lord Balcarres and planted them at the entrance to his mill in Wallgate, and thus saved his looms. Shortly before this (in 1812) a mill at Westhoughton, near Wigan, was burned down by a riotous mob, for which three men and a boy of fourteen years were hanged at Lancaster. The boy was said to have carried the lighted torch by which the mill was fired. A rare little poem in the narrative form, describing this cruel tragedy, was written by a Mr. John Clough, and published at Bolton in 1882. A copy of it will be found in the Wigan Reference Library. During this time of rioting and burning of power looms, the Wigan troop of yeomanry cavalry were called out for service in the disturbed district. Their commandant, "Captain Lord," of Standish Hall, used to give a graphic account of the harassing duties they had to perform in endeavouring to check the rioters. They were called out nearly every night, often marching to considerable distances, arriving only to find the loom sheds smoking ruins.

POTTERY.

The Pottery Trade of Wigan, a flourishing industry during the 17th and 18th centuries, ceased to exist in the early part of the present one. The last home of the trade was near the canal basin, where were made the old jugs and mugs, rudely ornamented and inscribed with the record of some interesting local event, which still may be met with, treasured as heirlooms in the town. The Wigan Free Library possesses a specimen of this old Wigan pottery, which bears the following inscription. Within a shield beneath the spout of the jug, the name "John Vause, Esqr., Mayor, elected 4th Octr., 1800;" and on the side, "Glorious 4th of October, 1800. Borough of Wigan Emancipated by Elias Chadwick, senr., Edward Topping, James Smith, Elias Chadwick, junr., James Penson, Richard Fogg, William Cooper, Rt. Holt Leigh, James Tayler, John Penson, senr., William Bancks, John Penson,

junr., James Unsworth, Robert Bullock, Robert Fisher, John Chaddock, Independent Burgesses." The names are given in double columns, inclosed in a floral wreath. These "independent burgesses" were the only people in the town who possessed a vote which returned two members to Parliament. Nothing definite seems to be now known as to the cause of this "glorious emancipation," but it doubtless referred to some political contest, in which, it is suggested, the "pocket interest" in the borough was for a time wrested from the noble family of Bradford. In the 17th century the potters of Wigan formed an important industrial community. In 1664 Bishop Bridgeman, the Lord of the Manor, made the following award concerning them :— "I further award that the Potters of Wigan for the tyme being may dig clay in the waste of the said manor as heretofore potters of Wigan have used to doe, provided the places so digged be forthwith after the digging sufficiently amended."

PEWTERERS AND BRAZIERS.

Other important industries of ancient Wigan were those of the Pewterer and Brazier. In 1697 an incidental light is thrown upon the trade by an old document signed by the Mayor of Wigan. "These may certify," it reads, "to all whom it may concern that Mr. Christopher Banckes, of Wigan, is a real worker and maker of all sorts of pewter, and that he has served a lawful apprenticeship to the art, mystery, and calling of a pewterer, and that he is well affected towards the Government and towards the Church of England as by law established. Given under our hand and seal of Wigan, November 12th, in the 9th year of the reign of King William III. over England, etc., and in the year of our Lord God, 1697. James Hervey, Mayor of Wigan." Early in the present century two brass and copper works existed in the borough. They are still working, one of them known as "Roger Bolton and Son," and the other as the "Pepper Mill,"

BELL FOUNDING.

Bell Founding was an important industry in Wigan in the 17th century. An interesting account of a trade long extinct in the borough is given in the first volume of Sinclair's "History of Wigan." The author says :—"It was then customary to take the metal to the place where the bell was wanted, and there melt and pour it into a place prepared for the casting in the churchyard, but with the Wigan bell founders it was not so. All the work was done at their own establishments in the town, and the finished work despatched, with several skilled men to assist in the hanging of it. The carts on which the bells were conveyed were clumsy, and the roads were exceed-

ingly bad, so that the work was always done at very great risk. The hanging of the bell was always a gay occasion, and in many old churchwardens' accounts in different parts of England and Wales the bill for beer to the Wigan workmen is carefully noted. There were several firms in the town, but only one on a very large scale. The largest firm undoubtedly was that of the Scott family, which existed in a prosperous state throughout the whole of the century. The original firm was that of James and John Scott. Their superior workmanship was well known throughout the country, and many bells made by them are still to be seen and heard. It is not recorded that they actually made any bells for Wigan, but several bills have been paid to them for repairing the bells, for even at this time there was an excellent chime of bells in the Parish Church tower. In 1658-59 several items were paid for repairing gate doors, bell clock, ropes, clappers, and finger of clock, etc. From the accounts it is evident there were many bell founders in the town, but the Scotts took the lead in the trade. Their social position was high, and many members of the family took an honourable part in the government of the town. James and John Scott, the original firm of bell founders, were bailiffs in 1627, and in the years 1653, 1688, and 1701 members of the same family were Mayors of Wigan." The bells of the Parish Churches of Wilmslow and Prestbury, and that in the old tower of Lascal Church, were cast in Wigan.

IRON MAKING.

During last century Iron Smelting was carried on in a very small way on the estate of the Earl of Crawford at Haigh, and Iron was made from Ironstone found upon the estate.

H. T. F.

COAL MINING.

BY R. BETLEY.

THE Wigan Coal Field forms an important part of that usually named in the list of Coal Fields of Great Britain as the "South Lancashire Coal Field." For our present purpose we may include under its definition an area corresponding approximately with that of the Wigan Poor-Law Union, and bounded on its westerly side by what is known as the great Upholland Fault which passes through Lathom Park, by Grimshaw Delf, Upholland (where it can be very distinctly seen) to Eccleston.

The geological formations included within this district are, in descending order the new Red Sandstone, the Permian, and the Carboniferous Rocks, the latter being again sub-divide d into the upper Coal Measures, down to and including the Arley Mine, the ower Coal Measures or Gannister Beds, and the Rough Rock or Millstone Grit. The Carboniferous or Mountain Limestone does not appear at the surface at all within the Coal Field. The Millstone Grit is well seen at Parbold and Harrock Hills, and at Grimshaw and Houghton's Delfs, at Upholland, where it has been for many years and is still extensively quarried for side stones, channel stones, and setts for road making. Underlying the beds of grit at the foot of Harrock Hill are shales, including a thin coal seam which some years ago was worked to a small extent, but is not being worked at present. These shales represent practically the lowest beds occurring in this Coal Field.

The lowest Coal Measures or Gannister series include what are known as the Mountain Mine Coals, worked to a small extent at Dalton and Billinge, the Upholland and Billinge flagstones, and one or more beds of fire clay, which are also being worked at Billinge and Upholland. It is made into fire bricks, fire tiles, flooring tiles, boiler seatings, sanitary drain pipes, &c.

The term "gannister," which gives one of the names to this series of strata, is applied to a peculiar close-grained bed, which accompanies some of the mountain mine coals. It is composed mainly of silica, and has excellent fire-resisting properties. In this district it does not appear to be so fully

developed as in some other coal districts, (the neighbourhood of Horwich, for example), where it is largely used in the manufacture of tuyers, &c., for the Bessemer process, and for lining the converters and iron-melting cupolas.

The seams of coal in this series are about six in number, varying in thickness from eight inches to 2½ feet. The coal worked in the neighbourhood of Billinge is an excellent coking coal, and very free from sulphur, consequently producing an excellent coke for metallurgical purposes. It is also equal as a gas coal to any seam in the district. It is at present only worked to a very small extent, although some thirty years ago it was worked at the Bispham Colliery, and made into coke of excellent quality chiefly for locomotive purposes. It may perhaps be mentioned here in connection with the mountain mines, that about 25 years ago the late Mr. James Gidlow, of Arley Hall, sank a shaft from the outcrop of the Arley Mine to win the mountain mine, which would be 250 to 300 yards below, but the character of the seam when found, and quality of the coal, were not at that time considered to be such as to warrant the further working of the seam. A similar result appears to have attended the more recent sinking to the mountain mine by the Barrow Hematite Steel Company at Dalton. In the Burnley district the mountain mines are extensively worked, but there the "upper" mountain mine has a thickness of two feet, and the "lower" one 3 feet 10 inches to 4 feet.

In the greater portion of the area under notice the seams of coal worked are all above the Arley mine or Orrell 4 feet, the number of seams included between this and the surface depending on the position of the particular part of the coalfield in question with reference to the main faults by which the district is intersected. These are chiefly the following, which run in a general N. N.-W. direction, fairly parallel to each other, and at distances from each other of about 1,400 yards :—The great Pemberton fault from Ashton-in-Makerfield to Shevington, a downthrow on the east varying from 250 to 470 yards; the great Shevington fault, traceable from Edge Green to Heskin, a downthrow to the east of about 600 yards; the Giant's Hall fault, from Abram to Standish Church, a downthrow on the west of about 600 yards; the great Standish fault passes by Amberswood Colliery, under St. Catharine's Church and past Boar's Head, a downthrow to the east of about 160 yards; the great Haigh fault, running past Bickershaw Colliery, Kirkless Hall, Haigh, and Ellerbeck, a downthrow to the west of 600 yards. With a view of giving the names, thicknesses, and relative positions of the principal workable seams, the following list is shown of those sunk through in the 18 feet pit of the Pemberton Colliery, belonging to Messrs. Jonathan Blundell

and Sons, but it must be understood that the thicknesses of the seams, as also the distances between any two, vary in different portions of the coal field.

Name of Mine.	Thickness. Yds.	Ft.	In.		Depth from Surface. Yds.	Ft.	In.
Thin Coal	0	1	3	...	14	2	3
Yard Mine	0	3	2	...	33	2	7
Pemberton 5 feet	1	0	10	...	111	2	6
„ 2 feet	0	1	11	...	117	2	10
„ 4 feet	1	0	8	...	129	2	10
Wigan 5 feet	0	4	1	...	274	0	9
„ 4 feet	1	1	1	...	307	1	3
„ 9 feet	0	8	2	...	339	1	4
Cannel	0	0	7	...	425	2	10
King Coal	0	3	4	...	426	1	11
Queen Coal	0	1	5	...	427	2	10
Ravine Mine	0	7	9	...	470	0	1
Yard Coal	1	0	0	...	506	2	10
Orrell 5 feet	1	1	9	...	567	0	7
Orrell 4 feet or Arley	1	0	6	...	629	1	2

Above the strata represented in this section we have also the following mines occurring in this district :—

Riding Mine	3	8
Ince Yard Coal	3	0
Ince 4 feet „	3	7
Ince 7 feet „	7	0

In all we have about 80 or 85 feet thick of coal, of which about 60 feet is of average quality, in about 2,600 feet of strata.

Each seam varies somewhat in quality and thickness at different parts of its area, and the different seams taken as a whole include all the gradations from a very free burning coal like the Pemberton 4ft. or 2ft. to the very bituminous or coking coal like the Arley. One of the seams, the cannel, has had its name connected with the district for a couple of centuries or more, as an excellent gas producing material, one supposed derivation of the name being "candle" coal, from the facility with which a fragment could be lighted, and the long time it would give off gas and flame. In the early history of practical gas lighting at the beginning of this century, we find the Wigan Cannel already in use as a gas producing material. In 1805 the Mills of Messrs. Phillips and Lee, of Salford, were lighted with gas (being

the first mills so lighted) by Messrs. Boulton and Watt, of Soho, Birmingham, under the superintendence of Mr. William Murdock, the material used being Wigan Cannel, which at that time cost 22s. 6d. per ton delivered. About 7,500 cubic feet of gas per ton of cannel was the production, together with about 12cwts. of coke, which sold for 1s. 4d. per cwt. It still keeps up its reputation as a gas producing material, but unfortunately the quantity remaining in the district is comparatively small. It is very variable in thickness, but as a general rule thins away in all directions from Wigan as a centre.

The Arley or Orrell 4ft. Coal is, taken altogether, the most important coal in the district. It is a good gas coal, and an excellent coking coal. The slack of this seam along with a portion of Yard Coal Slack has been coked in the immediate neighbourhood of Wigan for many years, first for locomotive purposes, and afterwards for the supply of the iron smelting furnaces, first erected at Kirkless about 30 ago. The seam varies in quality, considerably, at different parts of the coalfield; in some cases the proportions of sulphur and ash are too high to allow it to be used for coking, and in all cases the slack is carefully washed before coking. The Yard Coal is also a very fair coking coal, and its slack is often mixed with Arley Slack for this purpose. It is, however, a somewhat freer burning coal than Arley.

As an example of a free burning and only slightly bituminous coal we have the Pemberton 4ft. and the Pemberton 2ft. These, as will be seen from the list of seams given, are about 12 yards apart at the Pemberton Colliery, but at Abram they run together, and form what is known as the Bickershaw 7ft., which is well understood to be excellent steam coal.

The Wigan 4ft. Seam possesses considerable interest on account of its extraordinary variations in quality. Over a good part of the district it is an ordinary coal of about 4 feet in thickness. In the direction of Ashton and Abram, however, the coal composing it, which varies much in thickness, is accompanied by a material somewhat resembling in many of its properties the noted Boghead Coal or Cannel of Scotland. This also varies much in thickness, from an inch or two, to several feet, making this, where the latter thickness prevails, by far the most valuable seam in the coalfield. It has extraordinary gas producing qualities, and is very tough; it is thus admirably adapted for export, or for sending long distances for enriching purposes.

The Wigan 9ft., or 6ft. as it is also called, needs a special word here on account of its "fiery" character. It has been the scene of a series of very fatal explosions within the last twenty years.

It was from this seam that the gas was supplied for the long series of experiments on safety lamps carried out at Garswood Hall Colliery some years ago, under the supervision of Mr. William Smethurst, and in presence, on several occasions, of members of the Royal Commission on Accidents in Mines. The seam at that time was not being worked, and the gas was brought in a pipe to the surface from behind the brickwork where the shaft passed through the seam. As the 9ft. is now being worked the supply of gas is done away with.

None of the other seams of the district call for any special remark, suffice it to say that the coal field furnishes coal suitable for all purposes for which it is required, whether household, steam, coking, or gas.

The coal of this district has not been placed on the Admiralty Steam Coal List, as it is not considered sufficiently "smokeless," preference being given to the South Wales coal, which is much less bituminous and more anthracitic in character. With a view of showing the suitability of Lancashire Coals for steam purposes an extensive series of experiments were carried out at Kirkless about 25 years ago, under the supervision of the late Dr. Richardson, of Newcastle, and Mr. L. E. Fletcher, Chief Engineer of the Manchester Steam Users' Association. A duplicate of the Admiralty testing boiler was used, and it was found that it was quite possible to burn these coals without producing visible smoke, and without any special "smoke-consuming" appliances, but merely with careful firing, and a due regard to the admission of air both above and below the bars. Also that many of these coals compared very favourably with those of South Wales, both as regards water evaporated per hour, and water evaporated per pound of coal. In fact, two of the coals tried, viz., the Bickershaw 7ft., and the Haigh Yard, gave results which were not surpassed by any of the South Wales results. Another set of experiments and more recently carried out at Kirkless, under Mr. Fletcher, proved the great capacity of the "Lancashire" boiler as a good steam raiser, and the possibility of firing these boilers with the production of little visible smoke. Our colliery and factory chimneys do not, unfortunately, as a rule, advertise the coal of this district as "smokeless."

The coal field is at some disadvantage compared with several of the others, in not producing ironstone and limestone for iron smelting, consequently the supply of these materials to the blast furnaces at Kirkless has to come from a distance.

Brick clay is plentiful over most of the district, affording material for an important industry, and at the Wigan Coal and Iron Co.'s works, refuse

which would be ordinarily tipped to the pit heap, is converted into bricks of excellent quality.

As regards methods of working carried out in this district, any remains of the very old shallow workings show that the coal was got in a somewhat irregular fashion, considerable areas of the coal being taken away, leaving at intervals portions of the seam to support the roof, the proportions of coal got depending on the character of the roof, the worse the roof, the smaller the excavations, and the larger the pillars. These old shallow workings have often been met with in the district, and even within the borough. In sinking the tank for the last but one of the holders at the Wigan Gasworks some of these were met with and had to be filled up.

Up to some twenty or twenty-five years ago the system in use in this district was almost exclusively the "pillar and stall," in some of its modifications. This method consists in driving through the coal a series of excavations, drifts, or "stalls," parallel to each other, and at intervals regulated by considerations as to character of roof, floor, &c., and at right angles to those, another set, also running parallel to each other, the effect of the two sets of drivings being to divide the coal into a series of rectangular blocks or "pillars," which support the roof and superincumbent strata, the coal in the pillars being afterwards either wholly or partially removed. In the older days of coal mining it was customary to leave permanently a proportion of each pillar for support, but later the whole of the coal was removed during the operations of "bringing back the pillars." Under this system, therefore, the coal was got at two distinct operations, separated by, in most cases, a considerable interval of time, during which the coal in the pillars was subjected to considerable crushing from the weight of the strata above, and also suffered considerable deterioration in quality, from the action of the air on the exposed surfaces of the coal, so that, when the pillars came to be taken, a considerable quantity of small coal resulted, over and above what should have been the case if the coal could have been taken out fresh.

At present, however, a large proportion of the coals in this district is obtained by what is termed the "Long Wall" method. By this system the whole of the coal is removed at one operation, by having a long and continuous working face divided, step-like fashion, into a series of places, each worked by a set of men. In working, supports are set at a very short distance behind the men, or from the working face, just allowing sufficient room for work to go on, and as the coal is removed these are moved forward,

allowing the roof to sink almost immediately behind the workmen. The roads are maintained by packing. It is found that by this methed a considerably greater proportion of round coal is obtained than by pillar and stall, and that the weight thrown on the working face assists to bring down the coal after holeing. Also, that the ventilating is simplified, from the fact that the air has to pass along fewer channels than in the other method. This Long Wall method was formerly thought to be suitable only for thin seams, but it is now applied in the working of seams of very considerable thickness.

Whatever system is adopted it should be, and, no doubt is, with a full knowledge that the objects in working coal are to win the greatest possible proportion of that existing in the seam, in the best condition practicable, as regards round coal or slack, at the least cost, and last, but not least, with the greatest regard to safety.

The seams in this district are mostly not far removed frem the horizontal, the dips being very moderate, the principal obstacles to even and straightforward working being the minor faults and steps, which are met with more or less at every colliery in the district, and which appear to be in particularly great force in and near that where the workings of the Douglas Bank Colliery are situated.

So far as ventilation is concerned we have examples of the best appliances possible, whether as regards furnace or mechanical ventilation. Up to comparatively recent years the furnace was exclusively used; but now several of the newest of the collieries opened out have adopted mechanical ventilation exclusively, and at some of the older collieries this has either partially or entirely supplanted the furnace. Whatever motive power is used, the object to be accomplished is to secure a constant current through the workings to dilute and render harmless all noxious gases, and if this be done there will always be more than sufficient for the respiration of men and horses, and for the burning of lamps. The power is actually required for the purpose of overcoming the friction of the air in the shafts and workings, and when we consider the enormous amounts of air dealt with continually, and dragged through the passages of the mine, we need not wonder at the expenditure of power required. Take the by no means uncommon case of 250,000 cubic feet of air per minute circulating through a mine; as in round numbers 13 cubic feet of air weigh one pound, this will represent 19,230 pounds, or over 8½ tons dealt with and passed through the workings every minute, or over 12,000 tons of air per day.

The action of the furnace is pretty well understood. It creates a current by rarefying the air in the upcast by heating it, and so reducing the pressure at the bottom of the upcast, as compared with the bottom of the downcast; a current therefore sets in from the downcast to the upcast, and each particle of air as it reaches the furnace in its turn becomes heated and rises. Mechanical ventilators, chiefly fans, are placed on the surface, their inlets being connected with the covered over top of the upcast, so that they act by sucking or exhausting the air from the shaft, and thus produce a current. The particular kind of fan which is doing most work in this district is the Guibal. At Pemberton Colliery, Abram Colliery, and Messrs. Ackers, Whitley, and Co. are large fans of this kind from 40 to 46 feet diameter, and 10 to 15 feet wide, capable of giving at 40 to 50 revolutions a minute 250,000 to 450,000 cubic feet of air per minute, and working against a resistance of 2 to 4 inches of water gauge, equal to $10\frac{1}{2}$ to 21 pounds per square foot. These are all driven direct by horizontal engines. We have also examples of the Shiele fan driven by strap, and Mr. Cockson's modification of the Guibal driven by rope gearing. The object of the latter two forms is to enable a smaller and less costly fan by running at a higher speed to do the work of a larger and more costly one running at a lower speed, and in this both forms appear to succeed fairly well.

The Guibal Fan is furnished with a sliding shutter to the outlet so as to regulate its area to speed of the fan and prevent re-entry, also with a chimney gradually increasing in area so as to gradually reduce the velocity of the issuing air on its way outwards. Messrs. Walker, of Wigan, who have put up a number of these fans of various sizes down from the largest, have made an improvement in the shutter, furnishing it with a Λ shaped opening reaching some distance up the shutter, by which it is found the noise and vibration due to the working of the fan are much reduced.

In the matter of Safety Lamps for lighting, the district has not been behind any other in endeavouring to find out the safest lamp, and then in adopting it. Reference has already been made to the important experiments carried out at Garswood Hall Collieries with natural gas, and other series of experiments have been carried out at several of the larger collieries, as, for example, Wigan Coal and Iron Company, Garswood Coal and Iron Company, Douglas Bank Collieries, &c., where apparatus for testing lamps has been fixed. Besides these appliances it is the custom at several of the collieries to test each lamp before it goes down the pit by putting it when lighted into a small chamber into which coal gas and air are admitted in suitable proportions. Although this method of guarding against sending down an imperfect

lamp into the mine is not general, and has not been carried out anywhere for many years, it is noteworthy that Sir Humphrey Davy, soon after he introduced his lamp, advised that it should be done. The ordinary Davy lamp is still used to some extent without any shield, but in other cases where this lamp is preferred, it is either shielded with a glass cylinder round the lower part of the gauze, like the "Jack" lamp, or enclosed entirely in a tin casing with glass front like the "Tin Can" lamp. There is, however, an increasing tendency to use lamps in which the flame itself is not surrounded with gauze, but with a well annealed cylinder of thick glass, on account of the very much better light they give. The two forms of such a lamp which appear to be most in use are the Mueseler and the Marsaut. In the former of these, besides the protection offered by the cylinder of wire gauze, round the upper part of the lamp, the inlet of air and the outlet of products of combustion are restricted by an internal chimney, so that if gas gets into the lamp, the increased combustion set up gives rise to more combustion products than can escape, and the light under ordinary circumstances goes out. In the Marsaut additional protection is sought for, by using two or three cylinders of gauze, one inside the other, instead of one. In both cases the gauzes are shielded so as to prevent the impact of a current of air at right angles to the gauze. Various modifications of one or other of these forms are in use, several of the collieries adopting modifications of their own, which they have found by experiment to give satisfactory results.

Electric lamps for lighting the workings are, or have been, very little used in the district, in any case, only experimentally. For lighting the pit stages, particularly when the coal requires carefully picking, arc lights have been used in one or two instances, and in one instance at any rate the lighting has been extended to the intake down below. A very useful and intense light coming into increased use for lighting the pit banks, is known under slightly different modifications and names as the "Lucigen," "Wells," &c., but all on the same principle. The material burnt is any form of heavy oil from tar distillation, &c.; this is put into a pretty strong sheet iron receiver, and by means of compressed air is driven out through a narrow jet, and when lighted burns with a very intense and steady light, not liable to be blown out even in a high wind.

In no branch of Colliery Mining operations has more progress been made than in the machinery by which the fuel is hauled from the working-places to the pit bottom, and afterwards raised to the surface; and also as to the machinery for pumping. In the old days little, if any, mechanical appliances were needed underground, and little, if any, were used, because the quantities

were small and the extent of the workings of any mines very limited. In the Staffordshire district it was no uncommon thing for half-a-dozen shafts to be sunk in a field of small area, which in itself is a proof that in no case had coal to be brought any considerable distance; but as the depth of the mine increased it became necessary to make the operations more extensive to justify the outlay, and, as is well known in the district of Wigan, coal is got more than a mile away from the shaft up which it is to be raised.

UNDERGROUND HAULAGE.

Appliances for hauling coal below-ground may be divided into several classes:—

(1st) We have what are called self-acting jigs, in which, by reason of a sufficient fall to the pit bottom from the working places, the coal will run by gravitation, and all that is required is brake power to regulate the speed. In such a case, of course, no mechanical power is required; but such an arrangement is the exception, and power has to be provided for overcoming such resistances with which, in consequence of the flatness of the gradient or the gradient being the wrong way, gravitation cannot deal.

(2nd) DIRECT HAULAGE.—By which we mean an arrangement in which the fall is from the pit bottom, and of sufficient magnitude to enable the empty gangs to run in, all the power being required to bring out the coal.

(3rd) WHAT IS CALLED TAIL ROPE HAULAGE.—It is made necessary under the following conditions. The roadways are either level or their inclination is so slight that the tubs, either loaded or empty, will not run by gravitation. This necessitates drawing the loaded tubs out and the empty tubs in, and we not only have what we call a main rope to draw the loaded tubs out, but we have a tail rope attached behind the gangs which can draw the empty tubs in. The tail rope system is very popular in the North of England, and by means of it any number of branches can be worked, and the coal drawn in detachments to the main road, in which it is taken on to the pit bottom. Sometimes we have only a gang either coming out or going in on a single rope, but in the best appointed collieries we have the double main and tail rope, requiring two ropes, and we have always an empty gang going in on one rope as the loaded gang is going out on the other.

(4th) "THE ENDLESS SYSTEM" is probably the most generally used in this district, and is an arrangement by which we have two roads and an endless rope covering both. The tubs are placed at intervals, the loaded tubs

on one road and the empty tubs on the other, and the result is slow but continuous delivery of loaded tubs at the pit bottom and empty tubs at the working places. A very excellent arrangement of endless rope haulage now in use at a good many of our collieries is to place the hauling engines at the surface, and take the ropes down the shaft into any part of the workings that may be required. This system avoids the danger and inconvenience of steam in mines, and also of the necessity of using compressed air, which, although perfectly safe and applicable anywhere, is somewhat of a luxury.

"WINDING ARRANGEMENTS."—In early days winding was slow and our engines small and imperfect, and the quantities raised inconsiderable and from small depths; but as we have in this district shafts approaching half a mile in depth, dealing with quantities exceeding 1,000 tons a day, it is evident that powerful and perfect winding appliances were necessary. The Wigan district offers some excellent examples of powerful winding engines, generating 1,000 horse power, and drawing the cage at a maximum velocity of a mile a minute, being equal to the speed of a mail train. In winding ropes also we have advanced from the heavy and cumbersome hemp, first of all to iron wire, and then to the higher qualities of steel, and we have now winding ropes in use in this district the wires of which have a tensile breaking strength of 100 tons per square inch. Formerly there were no guides or conductors, the speed of winding scarcely requiring them, but now every pit shaft is fitted with guides on which the cages run; sometimes on wood, sometimes on iron rails, but more frequently on wire. The increased power and speed have necessitated safety appliances, of which there are those known as detaching hooks, which in the case of the cage passing beyond the pit bank, is detached and suspended in the headgear. Then we have safety cages, which in the event of a rope breaking the cage grips the conductors and prevents it from falling. A more recent class of safety appliances is intended to prevent the cage going too far by automatically shutting off the steam and putting on the brakes.

"PUMPING APPLIANCES."—All the earlier pumping engines were of the type known as the beam engine, because a beam was an important part, and also known as the Cornish engine, so called from its first applications by James Watt in the county of Cornwall. The principle of these engines is that they are placed upon the surface and the pump at the bottom of the shaft, the connection being by means of massive pump rods. The more modern type of pump engine is that which dispenses altogether with pump rods, and the pump and the engines are placed together at the pit bottom. The advantage is that a small engine will raise more water and will remove the

pumping engine from its inconvenient position for the pit. The sad accident at Hartley nearly 30 years ago was caused by the breaking of the beam of the old type of pumping engine; the broken portion fell down the shaft, blocking it up, and as in those days mines had only one outlet, several hundreds of lives were sacrificed.

"Steam Boilers."—The all-important appliance in connection with the engines at collieries is the steam boiler, that which is most generally used, and probably the most efficient, being the Lancashire boiler, so called from its first introduction into this county. These boilers, until recently, had their usual dimensions about 30 feet long and about 7 feet diameter, and having two flues running through and capable of working at a steam pressure of some 40 or 50lbs., but the steel industry referred to in another article has placed at our disposal a much better material than that formerly used, and we now have Lancashire boilers made of steel, their length being about the same as before, their diameter increased to 8 feet, and their working pressure advanced to 100lbs. There is probably no colliery district in the United Kingdom which affords better examples of high class modern machinery for hauling and pumping and winding than our own, and in no other district can such machinery be better produced.

Coal-Cutting Machinery.—Attempts have been made from time to time by local inventors—notably Mr. John Scarisbrick Walker, Mr. John Melling, Mr. Edward Fidler, and Mr. Robert Winstanley—and with considerable success, to apply machinery for getting coal.

With regard to explosives for use in mines considerable attention has been given in the district to experiments by which to select the one which should combine the element of safety with a capability of bringing down coal in the best possible condition. There seems to be little or no doubt that, if the second of these requisites were the only one to be considered, gunpowder in one or other of its modifications would answer perfectly. The first requisite is, however, an all-important one, hence the necessity which has arisen for a safer substitute. In any explosive it is necessary that there shall be one or more combustible elements present, together with a sufficient amount of oxygen to allow of their complete combustion when explosion takes place, and if there be any other element which on explosion is also converted into permanent gas, so much the better, as regards the total increase in volume from the solid explosive to the gaseous products of its combustion.

In gunpowder the combustible elements are carbon and sulphur, and the oxygen is supplied by the nitrate of potash. In what are known as the high explosives, like gun cotton, nitro-glycerine, dynamite, tonite, roburite, &c., the combustible elements are carbon and hydrogen, and the oxygen is supplied either by converting cotton, or glycerine, or benzine into what is known as a nitro-compound by treatment with nitric acid in the first portion of its manufacture, or by mixing with some nitrate, as of potassium, barium, or ammonium, or a combination of both methods, as in tonite and roburite. These high explosives differ from gunpowder also in requiring the use of a "detonator," or fulminate of mercury cap, which is inserted in the cartridge, and fired by fuse or electric spark, so as to produce by its explosion that combination of heat and concussion without which these compounds cannot under ordinary circumstances be got to explode. To render the use of any explosive even comparatively safe in coal working we must evidently try to diminish as far as possible the actual production of flame. For this purpose two methods have been proposed, one the use of the water cartridge, that is surrounding the explosive in the shot hole with water, with which any flame produced must of necessity first come into contact; the other so compounding the explosive that one of its products of combustion shall be a gas which is very active in extinguishing flame, as is understood to be the case with roburite. The arrangement of water cartridge adopted by Mr. Miles Settle, of Bolton, has been much used with success, in connection with some of Nobel's explosives, and numerous trials have been made with roburite with considerable success as regards suppression of flame, but not with entire satisfaction, owing to some danger in handling the naked material, and the unpleasant effects said to be experienced from the gases given off by its explosion, particularly if its combustion has not been perfect.

It is to be hoped that the result of the numerous experiments which are being made on explosive materials may result in the production of one the use of which shall be entirely safe and satisfactory.

APPLICATIONS OF ELECTRICITY TO MINING.

The following notes have been kindly supplied by Mr. Sidney F. Walker, electrical engineer, of Cardiff, &c., who is at present fitting several collieries in the district with electric appliances:—

ELECTRIC SIGNALLING.

The earliest application of electricity in mines was for the purpose of signalling.

THE ENGINE PLANE SIGNAL.—On long engine planes this method of signalling is of great service, as by its means a signal can be transmitted instantaneously from any distance to the engine-house, and the same signal can be repeated simultaneously at as many stations on the road as may be required. In the Wigan Coal and Iron Company's collieries, 3, 5, and 8 bells are caused to ring together when a signal is given at any part of the engine plane.

The method adopted is as follows :—A battery of Le Clanché or other cells is placed in the engine-house, and near them a bell, loud enough to be heard above the noise of the engine. Other bells are placed in bye, at junctions, or wherever may be required to signal to. The whole are connected by wires, and are so arranged that two naked iron wires, which run all down the engine plane within a few inches of each other, when pressed together or connected metallically, complete the electric circuit, a current of electricity then passes from the battery through all the bells, causing them to ring.

SHAFT SIGNALS.—Electric signals are also used for ringing the cage up and down. A battery and bell are placed in the engine-house as before, a second bell on the bank, a third bell and usually a battery at the pit bottom. These are connected by wires in the shaft to ringing keys on the bank and at the bottom, that at the bottom causing the bell at bank and in the engine house to ring together, that on the bank rings the bell at the bottom.

SURFACE LOPPER SIGNAL.—Another signal, which is of great service, is the lopper signal. It is used between collieries and siding weigh-houses or land sale wharves. A lopper bell, that is a bell with a ringing key attached, with a battery, are placed at each station, and are connected by a naked galvanised iron wire, run on poles overhead. The key at either end rings the bell at the other.

The great secret of success with electric signals for mines is, to have every part of the apparatus very strong indeed, and to have a large reserve of power everywhere.

Mr. W. Armstrong, jun., of Wingate Grange Colliery, in County of Durham, has arranged a plan for signalling from the cage. An insulated wire is laid up inside the rope, and is connected to a bell and battery in the engine-house, and to a key on the cage, so that the latter rings the bell.

LIGHTING BY ELECTRICITY.—This is another very useful and very important application of electric science. There are two forms of electric light—the Arc Lamp and the Incandescent Lamp.

In the Arc lamp, two carbon rods are held with their ends a fraction of an inch apart, and across this gap the electric current passes, in the form of a spark, consuming, in doing so, a portion of the carbon rods themselves; the consumed portion being raised by the beating effect of the current to an intense heat, which is unobtainable in any other way, and causing it to give out the bright white light with which all are familar.

As the carbons consume, it is necessary that they shall be fed towards each other, or the light would go out, owing to the sparking distance for the electro-motive force present being exceeded. The apparatus to accomplish this is contained in the box, or case, attached to the lamp, now almost universally placed above the carbons. In some forms of Arc lamp this regulating mechanism consists of clockwork, controlled by an electro-magnet operated by the current, in others, as the brush, the current actuates the carbons directly, by means of some form of electro-magnet.

The Arc lamp is only suitable for large open spaces, such as the sidings at a colliery, a large heapstead, &c. It is only economical also where the attendance does not form a heavy item in proportion to the advantages obtained. Each Arc lamp requires *trimming* with carbons every six to ten hours, according to the construction of the lamp; and its working parts also require frequent attention, especially at a colliery.

The Incandescent or Glow lamp consists of a carbon loop attached to platinum wires at each end, and hermetically sealed inside a glass bulb, from which all the air has been exhausted. The exhausting process is carried so far as even to exclude the air from the pores of the carbon loop, or filament as it is called, itself.

Wires, from a source of electric supply, are connected to the platinum wires before mentioned; and, when a current is allowed to pass through the filament, it becomes red, yellow, or pure white according to the temperature to which it is raised, this latter varying roughly with the square of the current passing.

As the carbon filament simply glows in a vacuum, it is not consumed, and does not therefore require renewing until the filament breaks. This happens after periods varying from 1,000 hours of burning to 7,000, 2,000 hours being a fair average for small lamps in the present state of their

manufacture. The operation of charging a lamp usually occupies only a few seconds, they being arranged now with brass collars on their necks, which slip into bayonet-pointed holders; the latter being affixed to brackets of various patterns.

Incandescent lamps are now made of all powers, from 5 candle power up to 1,500, the larger lamps, from 200 candle power and upwards being known as "Sunbeams." The "Sunbeam" lamp is rapidly taking the place of the Arc lamp, for collieries and many other places, it being found cheaper to work and having the enormous advantage of requiring no attendance, beyond changing the lamp at the end of its life. The life of a "Sunbeam" lamp varies from 500 hours of burning to 2,000 hours.

Electric lighting of collieries may now be said to be exceedingly simple; all that is required being a dynamo driven by an engine at one uniform speed, two cables let out from it to wherever a light is required; and at that point a lamp is attached, just as a gas burner might be to a gas pipe, except that the lamp may be of any power from 5 candle power up to 1,500 candle power, provided the supply is sufficient to furnish the necessary current.

Incandescent lamp makers now construct their lamps to suit all forms of supply up to 110 volts, so that anyone requiring a lamp of a certain candle power has merely to state this and the voltage or pressure at which his other lamps are working to get what he requires. In connection with electric lighting, a dynamo electric machine is required. This consists merely of an arrangement of electro magnets; one portion of which, generally the armature or bobbin as it is termed, is capable of motion, and is driven by a steam, gas, or water engine, the only requirement being that the speed shall be uniform no matter what the load.

All modern dynamos run at one uniform speed, or approximately so, whether the load be one lamp of 16 candle power or 200, or whatever the full load may be.

The power required is usually one-horse per lamp for the Arc lamp generally in use, one-tenth to one-eighth horse power per lamp for each glow lamp of 16 candle power, the larger lamps, up to 100 candle power in proportion. The "Sunbeam" lamps take rather less power.

Electric lamps are all controlled by switches, which are simply circuit breakers. Two pieces of brass enclosed in a wood, slate, or porcelain box, are connected to one of the wires leading to a lamp, in such a manner that when the two pieces of brass are in metallic connection, the current passes to

the lamp, and when their connection is broken no current passes. For indoor use these are made very ornamental. "Sunbeam" lamps when used for sidings, screens, &c., are usually protected from the weather by a shade and an outer globe.

A large number of collieries in this and other countries have now adopted the electric light, it being found not only convenient, but very much cheaper than either gas or oil.

Portable electric lamps are also in use to a limited extent in mines; they consist of a case containing three or four cells of either a primary or secondary battery, with an incandescent lamp of one or two candles power attached, and they are intended to maintain this light at its normal power for from 10 to 12 hours.

So far, no primary battery lamp has entered the field, and the secondary battery lamps do not appear to have quite answered their inventors' expectations.

Following the adoption of the electric light, transmission of power comes quite naturally. The dynamo electric machine before mentioned is not only a generator of electricity when driven by mechanical power, it will also furnish mechanical power when supplied with electricity. Hence, all that is required to transmit power to any distance is to have a dynamo machine arranged to run as a motor, where the power is required, cables to connect it with a generator placed where power can be obtained, and at this latter place a dynamo electric generator and mechanical prime mover of sufficient power to provide for the full work to be done, after allowing for all losses.

The losses to be provided for are :—

Loss in the apparatus driven by the motor and in the gearing between it and the motor, the latter running usually at a high speed.

Loss in the cables.

Loss in the generator.

Loss in the engine and driving gear.

There are several installations at work for pumping in this country, one for hauling, and several for pumping and hauling, on the Continent and in other countries. The useful percentage of the indicated horse power at the engine driving the generator, which has been obtained in work done, in the form of water raised, is from 35 to 40 per cent.

The useful effect between the shaft of the generator and the shaft of the motor should never be less than 50 per cent., and may easily be 70 per cent. It is of far more importance, however, for running work, to have the apparatus very simple and very strong, than to have a high return.

Firing Shots by Electricity.—This also is of great service, both in sinking new pits, and in the regular working of collieries ; inasmuch as it enables blasting to be carried on with safety and without the waste of time necessary in other cases. It also enables several shots to be fired together, so giving the effect of their combined explosive power. The great point which makes blasting by electricity so safe, is the fact that there is no danger in approaching the fuze immediately after the shots have been fired, even if one or more have missed. The plan adopted is to drill in the usual way, and to place a fuze in the bottom of the hole, with wires attached of sufficient length to reach to the outside of the hole and connect. The wires from all the holes are connected together and to the wires leading to the generator. The generator may be a galvanic battery of sufficient power to furnish the current, and kept in a convenient place in the mine, a portable Magneto Exploder carried in the hand and worked in any convenient position, or the current from the dynamo which is furnishing light or power where one is used. The greatest difficulty that has been met with in this application is, the uncertainty in the manufacture of the fuzes

Telephones.—These have not been much used in colliery work, except to communicate between the colliery and the shipping port, or between different collieries belonging to the same firm. They would, however, be of great service for communicating with the pit bottom, and with the workings, especially in case of accidents. The apparatus required consists of a Microphone Transmitter, with call bell and battery and one or two receivers, at each station, and connecting wires. Telephones could be attached to shaft signal wires, and engine plane wires could also be used by arranging a portable apparatus.

IRON, STEEL, ENGINEERING, & BUILDING.

BY C. M. PERCY.

THE article in this series headed "*Early Industries*," makes reference to Iron Smelting on the estate of Lord Crawford, at Haigh, so far back as last century. It was only carried on as a small industry, and passed out of existence a good many years ago. In 1858, the great Blast Furnace Works now so well known as the property of the Wigan Coal and Iron Co., were founded at Kirkless. Some time previously there had been considerable discoveries of valuable hemætite ore, containing a high percentage of iron, in Lancashire and Cumberland. Bessemer had about this time made known his process of steel manufacture, and works had been established to carry it out. The process required a more than ordinarily pure iron ore, and the Lancashire hemætite answered admirably. Four Blast Furnaces were erected in the year 1858, at Kirkless, each having a height of 45 feet, then considered a good average dimension. In 1863, a fifth furnace was added of similar dimensions and at this time the flames passed freely out at the open tops, and gave a gratuitous illumination to the country for a considerable distance around. In 1864, the movement for utilising this enormous amount of heat was making headway, and the blast furnaces were made with closed tops, necessitating, to enable the gases to collect, an additional height of 20 feet, making each furnace 65 high. The gases, which previously went to waste, were piped away to the steam boilers for generating steam, and the Hot Blast Stoves for heating the blast, effecting a very substantial saving in fuel.

In 1865 came a union of the Haigh Collieries of Lord Crawford and the Standish and Shevington Collieries of the Company which bore that name, the Broomfield Collieries, the Collieries of Mr. John Taylor, and the Iron Works and Collieries of the Kirkless Hall Company, forming the concern known as the Wigan Coal and Iron Company, with a capital of near upon £2,000,000, and then as now one of the largest establishments in the United

Kingdom. Almost the first great performance of the new concern was a very large extension of the Blast Furnace Works, namely, the erection and equipment of five additional furnaces, each 80 feet in height, making a complete range of ten furnaces. The reader of this article, who may have no pretensions to being an expert in Iron Manufacture, may be interested in hearing it explained briefly what this smelting operation is which is carried on so extensively at Kirkless, and which necessitates such massive appliances. The metal Iron, which is of such renowned service to mankind, is found in the earth, always in a more or less impure state, in the form of Iron Stone or Iron Ore, and this has to be smelted in the Blast Furnace to separate the Iron from its impurities. To effect this we require a great heat, obtained by using Coal or Coke, and a blast produced at a pressure of several pounds per square inch by means of powerful blowing engines. Those at Kirkless, three of them at any rate, are Compound Condensing Engines, each engine having one high pressure cylinder 45 inches diameter, one low pressure cylinder 66 inches diameter, and two blowing cylinders, each 100 inches diameter and a stroke of 12 feet. In early days all blast used in Blast Furnaces was cold, and for very long there was a mistaken notion that Cold Blast Iron was better than Hot Blast. It is not so. Hot Blast Iron from materials equal in quality is equal to Cold Blast Iron. The special advantages of Hot Blast are—lessened consumption of fuel in the furnace, increased make of Iron, and capability of producing iron from materials over which cold blast had no power. Until some 20 years ago the blast was heated by passing through cast iron pipes having fire outside. But the temperature attainable was limited, the wear and tear upon the pipes was very great, the friction and loss of air was very serious, and the efficiency was very low. What is known as the Regenerative Stove has now very largely taken the place of the cast iron pipes. The Regenerative Stove is very simple and its principle very beautiful. We have an iron shell larger in diameter and height than the old Blast Furnaces, lined with fire brick, and filled more or less with walls or checkerwork of fire brick, which has a great capacity for heat. The gases from the Blast Furnace itself pass through this Regenerator for a certain period, imparting nearly all their heat to the fire bricks. Then the gases are turned off and the blast turned on on its way to the furnace, and percolating or passing through the Regenerator is highly heated. These Regenerative Hot Blast Stoves will heat the blast to a temperature of 1,200 and 1,400 and even 1,600 degrees; they experience practically no wear and tear, there is no leakage, and the efficiency is very high. Very well, we produce and maintain our required heat for smelting in the Blast Furnace by hot blast and coal or coke.

At Wigan, as in most iron districts, coke only is used as fuel; it is dearer and purer. Our readers will probably all know that coke is a residue of coal burned in a certain way and after the gaseous or volatile matter has been burnt off. Formerly in England our coal was so comparatively clean, in at any rate certain districts, that we could tumble it into the coke oven direct from the pit, round and small together. Now we are not so favoured; it has become more and more important to be free from impurities, and our purest seams of coal are scarcely so plentiful as they were. The best practice is to prepare the coal for coking, and this is effectually done by crushing to a uniform size, in addition to thorough washing; the uniform small size enables the coal to coke uniformly, and the washing is to remove the dirt, which, being heavier than the coal, will by proper manipulation pass away by gravitation. In this district of Wigan we manufacture coke in the old-fashioned beehive oven, and in that respect are in common with Durham and elsewhere; South Wales has with much success adopted the Coppée Coke Oven, which is a long rectangular oven with flues all round, and produces coke equal in quality, and gives a much higher yield, in very considerably less time. In crushing the coal by means of rollers we are probably as good as elsewhere, although the disintegrator is said to give better results. In washing we have much to learn, and our Continental friends who have reduced coal washing to a science and almost raised it to the dignity of an art, can teach us much. The conclusion, at which after long and careful research they have arrived, and put into practice, is, that for anything like coal washing, which shall not pass dirt away in the coal, nor coal in the dirt, there must be division and sub-division. In the best coal washing arrangements, in dealing with the smallest coal from which it is most difficult to remove the dirt, there are six or eight sub-divisions between $\frac{3}{8}$ths and dust, and all washed separately. Just as former waste gases of Blast Furnaces are now utilised so are waste gases of Coke Ovens in the same way. Every attempt has been made, and is now being made, to convert coke oven gases into marketable bye-products, such as tar and ammonia, and very large sums of money have been expended in Wigan and elsewhere in connection therewith. The efforts here were not a success, and it has not been proved yet at Wigan, and we may pretty well say in England, that valuable bye-products can be obtained without injuring the coke. But we shall come to it some day, and our coal will be made to yield good Blast Furnace Coke and valuable bye-products as well, which at present serve no purpose except in many cases polluting the atmosphere.

Returning to our Smelting in the Blast Furnace, we have the highly heated blast and the coke, but we want something else to effect the separa-

tion of the Iron from its impurities. This we accomplish by a proportion of Limestone and Aluminous Ore, which, having a greater affinity for the ordinary impurities than for the Iron, and greater than the impurities have for the Iron, form a combination which passes away as cinder or slag, leaving the molten metal comparatively pure. The Molten Iron runs into moulds, and from the form of these moulds takes the well known name of Pig Iron. The slag, unfortunately, has not been applied on a large scale, and great heaps accumulate, but as efforts more or less successful have been made to apply slag as material for bricks, and setts for paving, and the more limey quality for mortar, we may venture to hope for a useful future even for this material.

This completes, at this point at any rate, our remarks on the Smelting operations of Blast Furnaces, which result in material from which respectively Castings, and Wrought Iron, and Steel are afterwards made.

The firm with whom this article has dealt with at considerable length, because no other local firm has Blast Furnaces, always from their formation contemplated adding to their extensive establishment a Steel Works. All persons connected actively with the Iron Industry have realised a good way back that as years went on Iron in its manufactured form would take a less important position, and Steel would eventually take its place. It has not of late years been quite easy to say where the line of demarcation between Iron and Steel comes in; the late Sir Joseph Whitworth described Steel as a superior quality of Iron, and Iron as an inferior quality of Steel, and recommended that a correct division would be by numbers representative of strength; the weaker numbers to be Iron and the stronger numbers to be Steel.

In these modern days, when in England alone we produce Steel in millions of tons a year, and use it for purposes far too numerous to name, including enormous armour plates and shafting, and delicate watch springs, it is difficult to understand, or rather appreciate, that within the lifetime of persons now living our Steel was produced slowly, expensively, and in small quantities from special materials, and when made was applicable only to a very limited range of use. The old method of Steel making was by the *cementation* process, which a few words will describe. Bars of very pure Iron, not made in England, but in Sweden, were deposited in crucibles, and embedded in charcoal, and placed in a furnace where a good red heat could be maintained and extending over several weeks. During this time the heated Iron was absorbing carbon from the charcoal in sufficient amount to

change the Iron bars into a Steel called Blister Steel, and so called from the blisters which formed upon the surface. This Blister Steel was piled, one bar upon another, and heated and hammered and rolled, producing a higher quality of Steel known as Shear Steel. The highest quality of this Steel was obtained by breaking into small pieces and melting in crucibles, producing what is known as Crucible Cast Steel. All this kind of Steel, blister, shear, and crucible, had a very limited use, for tools and such like articles, and even had it by its properties been adaptable to more extensive and general purposes, the expense of production barred the way.

It had been long understood that if Cast Steel was to supersede Wrought Iron for general engineering purposes it would be necessary to cease employing Wrought Iron as a raw material for this otherwise most expensive mode of manufacture. As to the desirability of substituting Cast Steel for Wrought Iron there could be no doubt. Wrought Iron at best is only a built up structure of threads, and layers, more or less intermixed with impurities fatal to perfect coherence, and which no amount of hammering and rolling could entirely remove. But with Cast Steel all these difficulties are removed, and any mass of practically any number of tons can be produced in a molten state in a single block, wholly free from admixture of impurities likely to prevent homogenity, and we get a metal perfect, equal, and coherent in every part; and such a block can be forged into any shape in a few hours, free from welding, and free from crystallisation.

Some 30 years ago, more or less, Mr. Henry Bessemer introduced a process which was to do all that we have just named, and in which raw Pig Iron from the Blast Furnace was to be converted into Cast Steel in large quantities at one single operation. Mr. Bessemer laid down for himself the following requirements that his new metal should fulfil. The Steel must bear a good white heat without falling to pieces under the hammer. The Steel must be tough, so that it could be bent and twisted into almost any form when cold and without fracture. The Steel must have a tensile strength 50 per cent. greater than the best English Wrought Iron. The Steel must be easy to work in the lathe and with the chisel and file. Then an all important condition was that all this must be capable of accomplishment at a cost which would enable it to be generally used. Such was the problem which Bessemer set himself to solve. Many said it was impossible, but he proved it was not, and to-day Bessemer Steel is in use all over the world, and the inventor obtained great renown, and, what most of us would prize more, a princely fortune; he deserved both. Now, after this introduction, we can describe the Bessemer process in a few words. Several bars of molten Pig

Iron, either from a cupola, where Blast Furnaces are not convenient, or direct from the Blast Furnace, where it is convenient, are poured into a specially constructed vessel called a Converter.

A current of blast of about 20 pounds per square inch pressure is passed through this molten Pig Iron, and of course produces a very violent agitation of the metal. In about 20 minutes the effect of this blast has been that impurities, with which the Blast Furnace could not deal, are eliminated, and we have in the vessel the Cast Iron in the crude form of Pig Metal, converted into something approaching Wrought Iron. But we do not want, or rather Bessemer did not want, Wrought Iron; he wanted Cast Steel, and to effect this further change a certain quantity, according to quality of steel required, of the materials known as Ferro-Manganese, or Spiegelisen, was measured into the molten metal, and in about half-an-hour from the commencement of the operation, the several tons of raw Pig Iron can be passed out into ingot moulds as high-class Cast Steel. These Steel Ingots can afterwards be hammered and rolled into rails, and plates, and shafts, or any shape required. Such was and is the Bessemer process, which effected a revolution in the Iron industry, and for years it "ruled the roast" at home and abroad, placing at our disposal a material much more durable than Wrought Iron and at less cost.

But much as Bessemer had done, much still remained to be done, and it is a striking illustration of the march of industrial progress that, had the Wigan Coal and Iron Company laid down a Steel Works 20 years ago, it would have been on the lines of Bessemer; the works actually laid down and now working are substantially different. The great deficiency, if we can apply the term at all to so marvellous an improvement, was that it had no effect in the removal of phosphorous, and in consequence the great bulk of English and German and French and Belgian ores were unavailable in that manufacture; and it was to remedy this defect which led to the introduction of what is known as the *basic* process, which process is now in operation in our locality. The earlier endeavours were to so construct a Bessemer Converter with such a lining that such an operation as the removal of phosphorus could be accomplished without a ruinous attack upon the lining of the Converter; that is, what was wanted was a lining which would stand the operation. Such a vessel was constructed with a lining which was successful, and at once the Iron Ores hitherto non-applicable to the Bessemer process became eligible, but the results were not of a character to satisfy all that was needed. The Steel produced was liable to be more or less uncertain in character, and the basic process, instead of being a mere improvement

upon the construction of the Bessemer Converter, struck out upon new lines on what is known as the open hearth arrangement, and it is on these lines that the Wigan Coal and Iron Company are now operating. The proper admixture of Pig Iron, Iron Ore, Scrap Iron or Steel, and Limestone are placed upon the hearth of a reverberatory furnace, by which we mean a furnace so formed that the flames are compelled to beat down upon the material on the hearth. The heat is supplied not by coal burning direct in the melting furnace, but such coal is first converted into gas in gas producers, it being now known that much more work and much more heat can be obtained from coal as gas than from coal used direct. The gas when made is conveyed to the melting furnace, and combining with air, combustion results, and under its influence an admixture becomes in a period of some eight or ten hours Molten Steel, which is run off into ladles, and poured out into ingot moulds, and the essential part of our Basic Steel process is complete. These ingots can be sold and manipulated elsewhere, but at our local works, as in most other works, the ingots are reheated and rolled into "blooms," and by further rolling can be converted into "billets," and in this shape are ready for the more finished process transforming them into hoops, and bars, and shafts, and rods.

We may state that the Machinery at the Steel Works of the Wigan Coal and Iron Company was made and erected by Messrs. Taylor and Farley, of West Bromwich, as regards the Mill; the Engine by Messrs. Davy Brothers, Sheffield; and the Gas Producers by Messrs. Stevenson and Co., of Preston.

So much, then, for Steel Manufacture, and again we pass on.

The roaring boom of 1871-72-73 in the Iron and Coal Trade, led to a great development of these industries in many parts of England, and our own immediate district came in for its share. As a result the Wrought Iron manufacture was established at Moss Side, Ince; Albion Iron Works, Aspull; the Rolling Mills, Ince; and the Rolling Mills, Wigan.

We have dealt at some length with the first stage of Iron manufacture, namely, Smelting the Iron Ore into Pig Metal. From this we make our departure into the Cast Iron of foundries, the Steel in the various steel processes, and Wrought Iron in forges. Steel has been considered; the operation of converting Pig Iron into castings in foundries is simply the re-melting and pouring into moulds. The conversion into Wrought Iron is more elaborate, and introduces the well known operation of puddling, which, although not nearly so important now as formerly, and owing to the general

application of Steel likely to be less so, is nevertheless an important branch of Iron making. What we say here regarding it will be brief. The Pig Iron, which is not similar in its composition to that used in steel works or in foundries, is placed on the hearth of the puddling furnace. The needful heat is obtained from coal burnt adjoining the furnace, in fact forming part of it. But the puddling process itself is an operation of the workman known as the puddler, who, as the Pig Iron melts, rabbles or stirs the metal up, constantly bringing the metal in contact with the air and the bed of the furnace. In the course of this operation, by the removal of the elements which contribute the difference between Pig Iron and Wrought Iron, the liquidity passes away and a pasty mass begins to form, which change is technically known as "coming to nature," and a ball is gradually formed. (Many endeavours have been made to introduce a mechanical method of puddling, notably by Menelaus in Wales, and by Danks in America, but with only partial success.) This ball at the proper time is removed from the puddling furnace, and placed under the hammer; the object being to hammer out the loose and pasty mass into a compact body of Wrought Iron, by the removal of any slag sticking to it. After hammering, we roll the mass out into flat bars, known as puddled bars. This constitutes the early stage of the process, and with this only, the Moss Side Works deals. But puddled bar is only a material of which Merchant Iron can be manufactured. We shear the puddled bar into lengths, pile a number together, and being fastened, reheat them; then hammer and roll into bars, and rods, and wire, and plates, and sheets, and hoops.

This production of Merchant Wrought Iron is carried on at Albion Works, Aspull; the Rolling Mills, Ince; and the Rolling Mills, Wigan. But Steel is now so much used that all these works receive Steel Billets, already referred to, which they reheat, and hammer, and roll into forms and shapes similar to Merchant Wrought Iron. Such describes, briefly, the Iron and Steel Industries at Wigan as we know them now, and no doubt in these special industries we may look for considerable extension. The district is rich in Coal, and produces the raw Pig Iron very largely. The finished Iron and Steel Manufactures have every scope. A kindred industry, which no doubt will follow, is that of Steel Castings, which bears the same relation to the Steel we have described as Foundry Castings do to Wrought Iron. Steel is rapidly pushing Wrought Iron out of the way; Steel Castings will do likewise eventually to Cast Iron.

Now we proceed to occupations in close connection with those already described. In a busy industrial centre like Wigan, with its Iron Works and

Steel Works, and Collieries, and Cotton Mills, although many of such establishments do more or less of their own engineering, and although special machinery, especially in connection with Cotton Mills, is obtained from special works in other towns, still it is in the very nature of things that we should have Engineering works of more or less importance, at which some of our mechanical requirements can be met with in the shape of engines and boilers, and general machinery.

For a very long time in Wigan one firm had the predominence in Engineering matters, had an excellent reputation, and of course did an extensive business. This firm, was known far and wide as the Haigh Foundry Company, and had its works in the township of Haigh, and on the very borders of Wigan.

Strangely enough, during the whole time when it was practically without railway communication, and being in a hole made getting in and out difficult, Haigh Foundry flourished, and not only did work for our own immediate locality, but sent its Forgings and its Locomotives and other Machinery far and wide, at home and abroad. When the formation of the Lancashire Union Railway brought the railway into its very workshops the greatness of Haigh Foundry diminished, then passed away, leaving nothing but a memory behind. But other engineering firms stepped in, and have made for themselves a name which enables them to compete successfully elsewhere, and has made it difficult for other firms to compete here. It is difficult to put them exactly in order of seniority, and would be harshly invidious to attempt to put them in any order of merit. Messrs. Walker Brothers have a very extensive establishment as Engineers and Boilermakers at Pagefield Iron Works, Wigan, and have a large business in all Machinery connected with Iron Works, Steel Works, and Collieries. Amongst their specialities we may mention their Compressing Engines for Collieries and Blowing Engines for Steel Works, powerful Colliery Winding Engines, and Ventilating Fans, of the most approved types. These Ventilating Fans are not confined to Collieries, although principally used there; the Mersey Tunnel and the Severn Tunnel both being effectively ventilated by these powerful fans. Some years ago Messrs. Walker Brothers made and sent to a colliery firm in Canada a pair of Compound Hauling Engines, fitted with patent clutch gear, and to work with a steam pressure of 150 pounds. Messrs. John Wood and Co., for many years at Water Heyes Foundry, are just removing to more convenient and much more extensive works at Frog Lane, Wigan, comprising well appointed shops and offices. This firm do an extensive Engineering business with the local

Collieries and Iron Works, and Cotton Mills; and also in Colliery Appliances generally, for winding and pumping, and hauling and screening, and picking, and coal washing, go a good deal further afield. During the last year or two they have fitted several Iron Mines in Ireland with machinery for hauling and winding, and pumping. Amongst the Engineering firms occupying a prominent position there are the Worsley Mesnes Iron Company and Messrs. W. Wilkinson and Company, both doing an extensive business with local works, and works elsewhere; in addition to which the latter firm have been distinguished for steam barge machinery for inland navigation, and steam trams. The specialities of the Worsley Mesnes Company are heavy Winding, Pumping, and Rolling Plant; Iron Works Machinery, Steam Hammers, and Gold Mining Plant. The Patent Steam Tram of Mr. William Wilkinson exclusively works the Wigan and District Tramways, and is also at work upon many other tramways in the United Kingdom and on the Continent of Europe. We have only space to mention Douglas Forge, Messrs. W. Park and Company's Wigan Forge, at present worked by Mr. Alderman Henry Park, Mayor of Wigan from 1884-88, and for 100 years has been worked by his family; Clarington Brook Forge, probably the oldest Spade-making establishment in the district; Messrs. Tickle Brothers, Messrs. Swift Brothers, and Messrs. Hough, of Newtown, Boiler Makers. The Ince Forge Company, at Ince, was founded in 1856, by Messrs. William Melling, sen., William Melling, jun., and James Burrows; and is now carried on by the sons of Mr. Melling, jun. The Works took up and carried on the Forge business of the old Haigh Foundry Company. They are conducted with much ability and enterprise, and produce Forgings in Iron and Steel up to 25 tons in weight. Almost their latest work has been a couple of Connecting Rods each weighing 15 tons.

Brass work of all kinds to suit, practically, all possible requirements is provided by the Pepper Mill Brass Foundry Co., Darlington Street, and Messrs. Roger Bolton and Sons, Standishgate. In Waggon Building a good deal is done at the respective works of the various Collieries, many of whom have hundreds of their own waggons constantly at work, and there are two important firms, namely, the Ince Waggon Co. and the Wigan Waggon Co., both located at Ince, which do a large business in Waggon Building and Waggon Repairs. There is no better waggon running upon any railway than the average Lancashire Colliery Waggon, weighing when empty about 5 tons, and capable of carrying a load of from 6 to 10 tons. A busy and populous district finds, as will be expected, continuous occupation for a good many firms of Masons and Joiners and Builders in the erection of dwelling-

houses and public buildings. The most prominent of the latter that have come into existence during the present generation are the Wigan Municipal Buildings; the Royal Albert Edward Infirmary, opened by their Royal Highnesses the Prince and Princess of Wales in 1873; the Market; the Free Public Library, the gift, as regards the building, of Mr. Thomas Taylor, and, as regards the books, of Mr. J. T. Winnard; the Baths; the Gas Works; the Post Office; the County Police Courts; and the Sanitorium. The new places of public worship built during the same period comprise St. James's Church, Poolstock; St. Michael and All Angels' Church, Wigan; St. Andrew's Church, Wigan; St. Elizabeth's Church, Aspull; St. Peter's Church, Hindley; Christ Church and St. Mary's Church, Ince; St. Patrick's Roman Catholic and St. Joseph's Roman Catholic, Wigan; the Roman Catholic College at Upholland; St. Marie's Roman Catholic Church at Standish; St. Benedict's Roman Catholic Church at Hindley; the Presbyterian Church at Wigan; the Methodist Free Church at Wigan; the Hope Chapel Independent at Wigan; in addition to very many schools connected with the various denominations. We have also had recently erected a large Drill Hall for our local Volunteers, and as a place of entertainment the Royal Court Theatre is well appointed and seats 2,500 people. The entertainments provided are excellent.

It would be a long task to enumerate all the firms engaged in building operations, but amongst the most prominent are Mr. Joseph Wilson and Mr. C. B. Holmes, and Mr. John Johnson, in Caroline Street; Mr. John Preston in Church Street; Mr. W. Winnard in Wallgate; Mr. Alex. Wigan in Ince; Messrs. France and Smith in Pemberton; Mr. Ablett in Darlington Street; Mr. Thomas Berry in Cambridge Street; Mr. Alfred Millington in King Street; to all of whom and to their successors, in concluding our article, we wish substantial and increasing prosperity.

COTTON AND OTHER INDUSTRIES.

BY C. M. PERCY.

IT would be impossible, and not only impossible, but very wrong, in any series of articles on Wigan Industries not to give a prominent position to Cotton, which has not only for a long period been amongst our leading Local Manufactures, but at the present time is rapidly becoming even more important. The industries which are dealt with elsewhere, namely, Coal Mining, Iron Manufacture, Steel Manufacture, and Engineering and Building, employ almost exclusively male labour; even Mining, in which, in spite of strenuous endeavours by well-meaning philanthropists to the contrary, females are employed upon the surface, the female labour only represents between one and two per cent. of the total persons employed, being about 10,000 in 600,000. But in the Cotton Industry the great bulk of the people employed are females, and it is well for a district like ours there should be side by side with industries for men means of occupation for women. In a very able Paper on Cotton Machinery (and the Cotton Industry is widely different from Iron and Steel Manufacture and Mining in respect to the amount of machinery employed; in Cotton practically everything is done by mechanical appliances; the hands employed become mere supervisors of the work that is being done) by an eminent Lancashire man, Mr. John Platt, of Oldham, he gives some remarkable figures showing the progress made in Cotton Manufacture during the century commencing 1760. In that year the total value of Cotton Yarn produced was £200,000, as against £85,000,000 a hundred years later. In 1760 the total weight of Cotton imported was 3,870,000 pounds, as against 1,083,000,000 pounds in 1860. The value of one pound of No. 42 yarn in 1760 was ten shillings and eleven pence, as against eleven pence a hundred years after. The value of one pound of No. 100 yarn in 1760 was thirty-eight shillings, as against two shillings and sixpence in 1860. In a century the value of yarn produced per year increased 425 times, the weight of Cotton imported per year increased 285 times, and the selling price per pound of yarn was reduced from 12 to 15 times. The total number of spindles employed in the Cotton

Manufacture of Great Britain was given in the latter year as 36,000,000, increased at the present time, 1889, to about 42,000,000 spindles; and taking them as spinning on the average No. 32 yarn, when each spindle produces 33 hanks of 840 yards each, this would represent a regular production of 660,000,000 miles per week of 56 hours when in full work, or a length of thread equal to near upon eight times round the earth every minute. In this we are making allowance for the increased development up to the present year, 1889. There are towns, Lancashire towns, no doubt, in which the manufacture of Cotton plays an important part, and finds employment for a great many more people than in Wigan, even including its surroundings; nevertheless, in the number and magnitude of establishments and the number of persons employed, it is second to no industry in Wigan and district. We employ in the United Kingdom, in the Cotton Industry, over 500,000 people, which is within measurable distance of the 600,000 persons employed in mining. We have spindles nearly equal to all the rest of the world combined. We have in the United Kingdom over 42,000,000, as against 23,000,000 on the Continent of Europe, and 23,000,000 in America. Amongst the most important firms are Messrs. Rylands and Sons, Messrs. James Eckersley and Sons, Messrs. ffarington Eckersley and Company, Messrs. William Brown and Nephews, Messrs. Thomas Taylor and Brother, and Messrs. William Woods and Son, all in the town of Wigan, and a good many others in adjoining townships. The writer of this sketch has neither the knowledge of this subject nor the ability to deal with it at all thoroughly (and only undertook the task because more able pens were unwilling, and sometimes mortals have to step in where angels fear to tread), and he will only attempt, very briefly, to mention some of the processes in Wigan Cotton Manufacture.

The raw cotton comes to us directly from the United States of America, the crop of which probably exceeds that of all other countries put together. The cultivation of the cotton plant in America has attained its present magnitude in less than a hundred years, and is at the present time expanding very rapidly; the area of land now under cultivation being near upon 20,000,000 acres. In a favourable season this would represent a crop of 10,000,000 bales, and in an unfavourable season 5,000,000 bales. Cotton cultivation in America has not attained its present great position without passing through numerous trials which, in the hands of a less enterprising people, would have destroyed it. The great crisis came during the American Civil War of 1861-65, when the soil of the great Republic was deluged with blood, hundreds of thousands of lives were sacrificed, and our own town of

Wigan and district of Lancashire experienced a terrible period of industrial adversity. The Lancashire cotton operatives passed through the ordeal with exemplary patience, and the rich and well-to-do were generous to a degree. That memorable struggle had far reaching results; slavery, that foul blot for so long upon the fair fame of America, was abolished; free and, consequently, more intelligent labour is now employed; cotton planters, met by the energetic competition of Northern immigrants, who have settled in great numbers upon the cotton lands of the South-Western States, have put forth new energy. Better systems of cultivation have been introduced, fertilisers are extensively employed, and the production of lint per acre, which had fallen to an average of 150 pounds, has steadily risen until it has now reached 200 pounds. The processes which cotton undergoes in the place of its growth are—*First.* "Ginning," which separates the fibre from the seed of the plant, and partly cleanses the fibre from foreign matter. *Second.* "Packing" or "Baling;" after "Ginning" the fibre or lint is in a loose state and unfit for convenient transport to distant markets; hence it is necessary to compress it into less space, which is ordinarily performed by means of hydraulic presses. The package leaves the press in the well known form technically called a bale, in which state it passes through the markets to the hands of the spinners. *Third* (and now we come to the actual operations of the Cotton Mill), "Mixing," which is the blending of different varieties of raw cotton in order to secure economical production, uniform quality, and colour, and an even thread in any desired degree. Even when using only one class or variety of cotton, mixing is, in a measure, imperatively necessary in order to neutralise the irregularities of growth and imperfect classification found more or less in all grades of cotton. *Fourth.* "Willowing," which is a process of opening and cleaning, although not very general in modern mills, is retained chiefly for opening and cleansing low cottons. *Fifth.* "Opening." In consequence of the heavy pressure to which cotton is subjected in packing the fibres become strongly matted together; the opening process is to loosen them, and to remove the heavier portion of the foreign substances that may be intermixed. *Sixth.* "Scutching" has a twofold object, namely, the further extraction of impurities and the formation of a "lap," which is a web or sheet of cotton formed in the machine and wound upon a small roller. In this web the fibres lie in all directions. All the operations hitherto named deal with cotton in the bulk. *Seventh.* "Carding," in which the process of opening is continued, but the material is treated in its individual fibres, which are taken from the lap, further cleansed, and laid in a position approximately parallel to each other, forming a thin film, which is afterwards condensed into a sliver—a round, soft, an

untwisted strand of cotton. In this process all short, broken, and immature fibre is, as far as possible, removed. *Eighth.* "Combing" is used for the production of fine yarns or those of high quality; the object is to obtain uniformity in the length of the fibres undergoing preparation. To accomplish this all those shorter than the required standard are combed away and rejected. *Ninth.* "Drawing," in which operation several slivers—the product of the carding process—are combined, and attenuated to the dimensions of one of the component parts. The objects are to render the new sliver more uniform in thickness, and to place the fibres more perfectly in parallel order. *Tenth.* "Slubbing" is a process by which the drawing or attenuation of the strand is now carried so far that it becomes necessary to twist it slightly in order to preserve its cohesion and rounded form. *Eleventh.* "Intermediate" or "second slubbing" is in all respects a repetition of the above, necessary in cases where the most even and clean form is required. *Twelfth.* "Roving" is a continuation of the preceding, its principal object being to attenuate the sliver still further. At this point also the latter receives additional twist, to enable it to bear the slight strain necessary to draw it from the spool or bobbin without the formation of uneven places. *Thirteenth.* "Spinning," which is the concluding process of the series. The sliver is here attenuated to the required fineness, and is given the twist by which the thread is completely formed. *Fourteenth.* "Doubling" is sometimes a separate business, but more often an adjunct to the preceding, and is a method of combining two or more threads to form a single cord, and is adopted in the production of many varieties of yarn which are used for widely different purposes.

The processes which we have thus briefly recommended constitute the operation of Cotton Spinning. In the Paper already referred to by Mr. John Platt, of Oldham, (and few men were better qualified to speak upon the subject, his firm and family are largely identified with Cotton Machinery now, and their connection with the Cotton Industry is historic), he divided Cotton Spinning into three distinct operations, namely, *First,* "Drawing," in which the fibres of the raw materials are drawn out longitudinally so as to lay them all parallel with one another, and overlapping at the ends; as was done by the fingers of the hand spinner for forming a continuous sliver out of the short fibres lying irrregularly in the bundle that is tied upon the distaff.

Second. "Twisting," in which the sliver previously formed is twisted into a roving or thread, for giving it longitudinal tenacity by increasing the

lateral friction between the fibres; as was done by the hand spinner by twisting the bobbin on which the portion of the thread already twisted has been wound.

Third. "Winding," in which each portion of the thread, after it has been sufficiently twisted, is wound upon the bobbin.

In the application of machinery to the performance of these three operations, the great difficulties experienced have arisen from the irregular character of the Cotton fibre on the one hand, and on the other from the unyielding action of the machinery, which has had to take the place of the delicate feeling of the fingers in hand spinning, whereby the spinner was enabled to accommodate the action continually to the variations in the material. It is a point of special mechanical interest, however, to note at how early a period in the application of machinery correct ideas were developed as to the principle in the important successive steps, so correct indeed that they have remained unaltered in principle up to the time Mr. Platt was speaking in 1866, and his statement will probably be equally true now in 1889, although many highly ingenious improvements in detail have subsequently been effected. The credit of the first invention of the Spinning Machine is given to Lewis Paul, for his invention in 1738; all Spinning having previously been done by hand. In this machine the raw cotton was passed through a succession of rollers, each pair running faster than the preceding, so as to draw out the sliver of cotton longitudinally to any degree of fineness required. The drawing only was accomplished, the sliver had to be formed, to be twisted and wound afterwards by hand. The mode of drawing in this invention has been adhered to ever since the fundamental principle in the preparation of fibrous materials for spinning. In 1748 Paul further invented a Carding Machine, for carding or combining the raw cotton in preparation for the drawing rollers. In 1758 Paul improved his original machine by rendering it capable of performing the two other processes of twisting and winding requisite to complete the operation of spinning by machinery; and he constructed a spinning machine, having a circular frame containing 50 spindles. Although the two mechanical principles which have formed the basis of all subsequent spinning machinery, namely, the drawing rollers running at different speeds and the differential motion of the flier and bobbin, were originated by Paul, his machines were never practically successful. Arkwright's Spinning Machine in 1769 has the merit of being the first to be brought into successful operation, although really only an improvement in detail upon Paul's machine. Probably Arkwright succeeded where Paul did not, because his machine had the advantage of better materials and better workmanship.

In 1770 came Hargreaves's invention of the Spinning Jenny, the principle of which, said Mr. Platt in 1866, was identical with that of the present Spinning Machinery, and it presents a remarkable instance of a correct perception respecting the best mode of working having been attained at so early a stage in the application of machinery to a new purpose. Further improvements in the preparatory processes of carding and roving were introduced by Arkwright in 1775, which may be said to include the principal features contained in the carding and roving machines still used.

The result of Arkwright's later inventions, whereby he introduced special machines for each process in the preparation of the material for spinning, whereby he effected a most important division of labour, was that the factory system became rapidly extended. In the practical working of Arkwright's Spinning Machine and Hargreaves's Spinning Jenny it was found that the rovings and threads produced were coarse and uneven, and a great improvement was effected in this respect in 1779 by Samuel Crompton's Spinning Machine or Mule, which was a combination of Paul's or Arkwright's Spinning Machine and Hargreaves's Jenny, combining the drawing roller in the former with a modification of the sliding cross bar and spinning spindles in the latter. Crompton's first mule had 30 spindles, and the threads spun by it were far superior in regularity, strength, and fineness to any ever spun before, and they obtained a double price.

In 1811 there were 600 mills, containing 4,209,000 spindles, working on Crompton's plan; 310,500 spindles on Arkwright's plan, and 155,900 spindles on the Spinning Jenny plan. Many of the principal movements in the working of Crompton's mule had still to be performed by hand by the spinner, and in 1818 the entire operation of winding up the spun threads into cops on the spindles was rendered altogether self-acting by William Eaton, which involved a self-acting method of performing what is called backing off, and a self-acting arrangement for guiding the threads regularly upon the cops during the winding, and a self-acting contrivance for regulating the speed of the spindles according to the increasing size of the cops.

It was in 1825 that the Self-acting Mule of Richard Roberts was brought out, and with the introduction by himself and others of subsequent improvements, says Mr. Platt, speaking in 1866, it is the form of self-acting mule almost universally employed at the present time for spinning cotton. The number of spindles in the self-acting mules had been gradually increased until at that time many mules contained 1,000 spindles each. One pair required only the attendance of one man and two boys for cleaning, setting

rovings, attaching broken threads, taking off cops, and re-starting machines. In spinning No. 32 yarn (in which the weight of 32 hanks, each containing 840 yards, is one pound), the production of a pair of mules per week of 60 hours is 45,000 hanks, or 21,477 miles per week, weighing 1,406 pounds. The floor space for a mule containing 1,000 spindles will be 116 feet by 10 feet. The cost of a modern cotton mill for spinning No. 32 yarn, including building, machinery, and accessories, steam engine and shafting, with fire-proof floors in the scutching and carding rooms, and timber floors in the spinning rooms, was put at 18 shillings a spindle. The amount of thread which a self-acting mule could spin was as much as could be produced by 3,000 hand spinners.

Now just a word or two about the processes which follow Spinning, which may or may not be carried on at the same establishment, namely Weaving, under which the yarn which has been spun is converted into cloth, and which further processes represent Weaving. Unlike the Spinning, which is carried on in a building several storeys high, Weaving takes place in a shed, as much of the work as is possible being carried on on the ground floor. The weft yarn, or that which is laid transversely in the cloth, leaves the mule in the condition in which it is required at the weavers' loom, but the twist or warp yarn passes through several preparatory processes to fit it for the operation in the weaving.

First. Winding, to take the yarn from the cop and throstle bobbin and place it on the warpers' bobbin.

Second. Warping or Beaming, to wind the yarn from 400 to 500 bobbins on to one large beam.

Third. Sizing, which is covering the warp with an adhesive preparation to fit it for standing the strains in weaving. No process is more important in the Weaving Mill, and on it depends the quality and quantity of the work turned off, and probably the success of the concern. In sizing the objects are to press into the thread a mixture of suitable ingredients, so as to strengthen the yarn, smoothen it, and lay the fibres which project from the surface of the thread, thus increasing the strength, and at the same time reducing the amount of fluff at weaving; and to give the yarn and cloth the requisite appearance of toughnes, strength in body, known technically as the "feel." It is in the sizing that the "boardy," "leathery," "clothy" feels or grips are produced. The percentage of size put on cotton goods is calculated according to the increase of weight in the warp only. Thus if the warp in

a piece of cloth be composed of 10 pounds of cotton covered with 4 pounds of size, the warp will have been sized to the extent of 40 per cent. The amount of size on cotton warps varies from 3 to 200 per cent.

Fourth. Attaching the healds and reeds to the warp, called looming or drawing in.

Fifth. Weaving, and about this we will only say that it is the last process in the manufacture of cotton goods, and the one in which all the previous ones culminate. It has for its object the combination of the warp and weft yarns, interlacing one with the other in such manner as to produce a firm texture, fitted for the varying uses to which cotton cloth is adapted—for warmth, for ornament, for trade purposes, for sale.

In the matter of spinning four sorts of machines are used for completing the attenuation of the thread, namely, the self-actor mule, the ring frame, the hand mule, and the throstle frame. The hand mule and throstle frame are fast disappearing in consequence of the great improvements over the hand mule which have been made in the self-actor mule, so as to spin fine counts up to 300's, and in the increased output of the ring over the throstle frame. The mule is automatic in all its movements for spinning the yarn and winding it on the spindle in the form of a cop, which is a cylindrical coil of yarn, cone-shaped at each end. In this machine the spinning is intermittent, that is for a few seconds the different portions of the machines are engaged in drawing out the rovings to the required fineness until about 64 inches have been spun, then a few seconds are employed in drawing back the carriage and winding the yarn on the spindles. The ring frame is a constant spinner, and as fast as the yarn is spun it is wound on a bobbin, while the necessary twist is put in it by a traveller shaped ⊂ revolving round a ring. The ring frame is suited for both warp and weft yarns, but in the case of the latter paper tubes are used instead of the bobbins. The ring frame is suitable for all yarns. The mule will spin both weft and twist. Throstle twist is the evenest and roundest thread, ring twist next best, and mule yarn inferior to both. Mule yarn, however, has an elasticity which the others have not.

It does not fall within the scope of this short article to deal with that supplementary and important branch of cotton manufacture, namely, weaving, more than the immediately preceding notes have touched upon, nor, at any length, the various mechanical appliances by which the various operations are performed. All we have endeavoured to do is to describe in very general terms the Cotton Industry of Wigan.

The Bobbin has been a good deal referred to, and is used in hundreds of thousands in Wigan and district; Messrs. John Riddlesworth and Son, of Wigan and Hindley, are extensive bobbin manufacturers.

During the present generation an industry, which fitly follows in our notes, that of Cotton, has found a home in our midst, and is responsible for a good deal of female employment. We refer to the manufacture of Clothing upon a very considerable scale, for which we are indebted chiefly to the ability and enterprise of Messrs. Coop and Co., who made, and still hold, the business, and have this year made considerable additions to their already extensive and well appointed works in Dorning Street. Another firm is making arrangements to join in the industry at a works in Chapel Lane, and for many years Messrs. Crossley and Brown have modestly and successfully been working on similar lines. The establishments we have mentioned, and especially that of Messrs. Coop and Co., have availed themselves very largely of the excellent machines produced and sold so extensively by the Singer Manufacturing Company. More power to our Clothing Industry.

The writer heard with some surprise, whilst preparing these articles, that several hundred persons were employed in and round Wigan in the useful occupation of Nail making. Compared with the Black Country, where many thousands are so employed in the production of nails and chains, the few hundreds with us do not count for much; still such an occupation is not to be despised, because it is in many cases the lesser industries which provide work collectively for a considerable number of those for whom the greater industries do nothing; and it is pleasant to know that nail making in Wigan is an occupation followed properly by men and not, as elsewhere unfittingly, by women.

Hinge making is also an important industry in and around Ashton, and one firm, that of Messrs. Whitley and Co., have been engaged in the business for a century.

CONCLUSION.

So ends our notes on the past and present Industries of Wigan. What we have said will suffice to show that even now those Industries are important and varied and numerous. We can hardly make them more important; they ought to be and might well be made more varied and more numerous. Wigan, naturally, has great and valuable resources,

and, geographically, is well situated. Within itself and immediate surroundings it has intercommunication by means of an excellent service of trams. We have an inland water communication with many towns of Lancashire and Yorkshire by means of the Leeds and Liverpool Canal, which no doubt will eventually be enlarged and made capable of dealing with vessels of several hundreds of tons burthen. We are served in the matter of railways by three important railway companies—namely, the London and North-Western, the main line of which, between London and Scotland, passes through our midst; the Lancashire and Yorkshire, which gives us connection with every town and city of the two counties; the Manchester, Sheffield, and Lincolnshire, opening out to us its entire system, and giving us a new route to Preston and Blackpool. The motto of the Industrial Metropolis of Scotland is—"Let Glasgow Flourish;" that of the Lancashire Mining Capital should be—"Let Wigan Progress.'

C. M. Percy.

Wigan, July, 1889

OPENING OF THE EXHIBITION.

IT is not the custom of the Royal Manchester, Liverpool, and North Lancashire Agricultural Society to open their shows with any ceremony, but a number of gentlemen on the Local Committee thought the opening of the Local Exhibition should not pass unnoticed; and, accordingly, by invitation of the Mayor, representatives of the Corporation and of the Council of the Society, as well as other gentlemen, attended in the Council Chamber, Rodney-street, for the purpose of forming a procession to the show ground. The following is a list of those present:—The Mayor, the Earl of Crawford and Balcarres, Mr. F. S. Powell, M.P., Mr. T. Stuart, Mr. H. Ackerley, Mr. J. Smith, Mr. H. Park, Mr. S. Alker, Mr. R. F. Hopwood, Mr. C. M. Percy, Mr. R. Johnson (Ince), Mr. J. Wilson, Mr. R. Richards, Mr. J. Jackson, Mr. R. E. Kellett, Mr. J. Harrison, Mr. W. Roger, Mr. W. Millington, Mr. R. Halliwell, Mr. W. J. Lamb, Mr. J. Hilton, Mr. L. Booth, Mr. J. Gee, Mr. D. Dix, Mr. R. Layland, the Rev. C. Bluett (Coppull), and Rev. E. Franks (Wigan), Mr. County Alderman Barrett, Mr. County Alderman Gaskell, Mr. A. C. Smethurst, Mr. J. W. Fair, Mr. T. Heald, Mr. Drury (agent to the Duke of Devonshire), Mr. Nevitt (Preston), Mr. W. Tomlinson, Mr. W. Simpson, Mr. W. Kellett, Mr. C. Appleton, Mr. L. R. Rowbottom, Mr. W. B. Johnson, Mr. C. Wall, Mr. J. Pendlebury, Mr. J. Wood, Mr. W. H. Harbottle, Mr. R. Catterall (Kirkham), Mr. J. Marsden, Mr. R. B. Seddon, Mr. W. Crompton, Mr. C. Fairclough, Mr. J. Seddon, Mr. G. Gilroy, Mr. ffarington Eckersley, Mr. Carter, Mr. T. Stone, Mr. H. Flint, Mr. W. Partington, Mr. J. Wright, Mr. J. Gerrard, Mr. J. McClure, Mr. W. Bryham, jun., Mr. J. Harris, Mr. Hardcastle (Kirkham), Mr. W. Winnard, Mr. J. T. Gee, Mr. T. H. Cowburn, Mr. H. T. Folkard, Mr. W. Bolton, Mr. J. Yates, Mr. Hughes, Mr. Timmins, and Mr. W. Grime. On Lord Crawford arriving, about twenty minutes to eleven, he was greeted warmly, and then the Mayor addressed a few words to the company. He said: Gentlemen, to-day is a red letter day in the history of Wigan. The Royal Manchester, Liverpool, and North Lancashire Agricultural Society having selected Wigan as the place for holding their annual show this year,

I desire to give them a very hearty welcome, and although the weather at the present time is not what we desire, yet I hope to be able to congratulate the Society on having a very satisfactory show. (Hear, hear.) I shall be pleased now if you will accompany me to the show. (Applause.)

A procession was then formed in the following order:—First came the Wigan Old Borough Band, then a detachment of police under the command of Mr. Webb (chief-constable), and following were the gentlemen whose names are given above. The route taken was up King-street, straight up Wigan-lane to the show. A sharp shower of rain fell while the procession proceeded, but there was no falling out of the ranks, though the march was anything but a congenial one. The streets were lined with thousands of interested spectators, and many faces could be seen in the various windows along the route. On arriving at the entrance to the show the procession disbanded, but the gentlemen kept together on gaining admittance, and a visit was paid to the local industrial exhibits, which it had been arranged should be opened by the Mayor.

On arriving at the section, the party were met by Mr. T. Brown, who said: Mr. Mayor, Lord Crawford, and gentlemen,—As Chairman of the Local Industrial Exhibition, I have very great pleasure in welcoming you here this morning. In passing through the section, you will find that the exhibits are interesting and varied, and I think reflect great credit upon Wigan and the district. (Hear, hear.) I must admit that some months ago, when it was first broached, that I did not think this section would meet with the success it has, but it is all owing to our secretary, our indefatigable secretary (Mr. Percy). (Hear, hear.) But this success will not be complete till your worship has done us, the committee, the honour, and also the exhibitors, of declaring it open. I have very great pleasure in asking your worship to perform the ceremony of opening this exhibition. (Applause.)

Mr. Percy (after presenting the Mayor and Lord Crawford with a copy of the Local Catalogue) said: I wish to supplement what Mr. Brown has so well remarked, and to observe that there is no necessity for a long speech to-day, because in that little work (the catalogue) there is all we wish to say with regard to the exhibits of the industries of the district. We make no apology for attaching this section to the Agricultural Show, because agriculture in itself is the largest industry in the world, and in this district at any rate it is closely allied with the other occupations whereby the masses of the people have to obtain their livelihood. I am glad to see the Chief

Magistrate of the borough present on this occasion, and I take the opportunity of saying, on behalf of the Committee and friends here, that you have during the period you have held office maintained all its best traditions—(hear, hear) —and are setting a brilliant example which will be difficult to follow. (Hear, hear.) Many things have happened during your mayoralty, and many more will probably happen, but I hope that amongst others a new and a prosperous era will commence in this district. I am very glad to see you present. (Applause.)

The MAYOR, who was well received, said: My lord and gentlemen,—I can scarcely find words sufficient to thank you, and I do thank you most heartily, for the honour you have done me by receiving me here to-day, and also by associating and dedicating to me this most valuable work. The Industrial Exhibition of this show will soon be a thing of the past, but this pamphlet will live for generations to come—(applause)—and if possible will increase in value. You have been good enough to ask me to open this Exhibition, and it gives me very great pleasure to do so, in fact, greater pleasure than anything I have done during the time I have had the honour of holding the position I now hold in Wigan. And for this reason, because I think it will be the means of increasing and developing the trade of the district. Before declaring the Exhibition open, I should like to thank the Committee for what they have done with regard to the show, and particularly my friend Mr. Percy, for the energy and zeal he has displayed in everything he has undertaken. (Hear, hear.) In fact, I think the Committee will agree with me when I say it is mainly, if not altogether, due to him that this Industrial Exhibition has been crowned with success. I have great pleasure in declaring the Industrial Exhibition open. (Applause.)

Cheers were then given for the Mayor, and the party, under the guidance of Mr. Percy, inspected the stands, and were much pleased with the various exhibits.

At the conclusion of the inspection of these exhibits, Lord CRAWFORD expressed his indebtedness to the committee for the pleasure they had afforded him that morning. He not only did not claim, but, as was well known, possessed no special knowledge in matters of agriculture, but he did claim to have great interest in all matters of an industrial character. The exhibits that he had inspected were most interesting, and what struck him very forcibly was that Wigan appeared to be capable of producing anything of an industrial character that could possibly be required.

REFERENCES AT THE LUNCHEON.

At the public luncheon, which was afterwards held in the large pavilion on the ground, the Earl of CRAWFORD and BALCARRES, President of the Society for the year, who ably filled the chair, in giving the toast of "The Society; long life and prosperity thereto," said: On the occasion of this year's show rather a new departure had been entered into in making an exhibition of the industries of the town—(hear, hear)—and he could not help feeling that Mr. Rigby, the secretary, was to be congratulated on the display they had been able to get together of the different industries which are practised in Wigan and the surrounding district. His friend the Mayor was good enough to open that industrial portion of the show, and in passing round the long list of exhibits there shown he felt there were very few things of manufacture belonging to the necessaries of life which they could not produce in their own district. Of course, a show of that description was necessarily dependent upon the gate money, which varied according to the state of the weather, and from the crowds he saw in the yard that day he hoped the takings of the society would be such as to satisfy them, and lead them to desire to come to Wigan again. (Applause.)

Mr. F. S. POWELL, M.P., who gave "The Health of the Earl of Crawford," said he felt that there was a special reason why Lord Crawford should not only be present that day, but that he should be heartily welcomed by everyone under that tent. Lord Crawford made some reference to the industrial exhibition—of which every person connected with Wigan was justly and rightly proud, and also to the agricultural show. Lord Crawford had taken a leading part, not as a spectator, but as an actor—having both knowledge and skill—in the industrial development of this great district, and he had also, as he (Mr. Powell) was informed by those around him, found time among his many avocations to be a breeder and be successful in the show of that day. His Lordship, therefore, was not only a leader by station, but he was also a practical leader by success in the noble and real competition. (Applause.)

The *Wigan Observer*, referring to the meeting of the Society in its leading columns, remarked:—Locally the present gathering has greater claims on our attention. By a happy suggestion, Mr. C. M. Percy—and to him the credit of the success of this department must assuredly be given—submitted to the Committee that the visit of the Society to Wigan might be availed of

to show the many strangers attending the yearly event what the district is capable of. We are not particularly strong in agriculture—we are a manufacturing centre, but whilst extending the hand of fellowship to our farmer friends and the admirers of stock and produce, we are striving to promote the trade of the country, and our interests are, after all, not vastly different. Mr. Percy proposed that in connection with the show there should also be an exhibition of Local Industries, an idea which was unanimously adopted. The matter was left practically in his hands, and he has succeeded in getting together a collection which does honour to the town, and cannot fail to prove a most valuable feature in this year's exhibition. As Lord Crawford, who is President of the Society for this year, and who, as might have been expected, did not neglect this portion of the show ground, stated, after a careful inspection, the wonderful display, gathered together at so short a notice and for so brief a period, showed that Wigan, in the way of manufactures, could practically produce anything the world wanted. Anyone visiting this department cannot fail to be struck with the many and varied articles which the district produces, and the exhibition must result in benefit to the trade of the neighbourhood, and we shall be surprised if the additional attraction which it offers does not also tend to procure increased help for the Society, which has our hearty good wishes, and which we all trust may reap the reward this year which it assuredly deserves.

The *Wigan Examiner*:—Just a word as to the Local Industrial Exhibition. As we have all along predicted, this section of the show has proved of more than ordinary interest, illustrating, as it does, the industries and manufactures carried on in the Wigan district. These are much more extensive than many people imagine, and eloquently testify to the enterprise of our manufacturers. Some good, we hope, will come of the exhibition in the direction of stimulating and developing our local industries.

CATALOGUE

OF

INDUSTRIAL EXHIBITS.

COMPILED BY C. M. PERCY.

THE INCE FORGE COMPANY.

No.

1.—Crank Shafts; Three-throw Crank, Connecting Rod, Marine Type, made of Ingot Steel.

THE WORSLEY MESNES IRON CO.

2.—Horizontal Steam Engine, with Patent Governor and Cut-off.

JOHN WOOD AND CO.

3.—Self-contained Hauling Engines; Model of Endless Haulage Arrangement.

JOHN WILLIAMS.

3A.—Carriages.

WALKER BROTHERS, WIGAN.

4.—Two Model Ventilating Fans, illustrating action of Walkers' Patent Anti-vibration Shutter; Cover of Air Compressing Cylinder, showing Walkers' Patent Inlet and Outlet Valves, and their respective controlling gear.

5.—Photographs of Mining and other Machinery during construction; View of the Ventilating Machinery and Buildings at Liverpool and Birkenhead of the Mersey Tunnel.

WALKER, OLIVER, AND CO.

No.
6.—Electrical Appliances, including—
Dynamos,
Incandescent Lamps,
Electric Signals,
Electric Blasting Apparatus,
Lamp Fittings,
House Bells, &c., &c.

THE WIGAN COAL AND IRON CO.

7.—Samples of Cannel (Standish).
„ Arley (Hewlett Pit).
„ Yard (Hindley).
„ Pressed Bricks.
Safety Lamps for Firemen and Colliers.
Photographs of Crawford, Hewlett, and Alexandra Pits.
Model of Locomotive Engine.
Samples of Coke.
„ Limestone.
„ Pig Iron.
„ Spiegelisen.
„ Ferro-Manganese.
„ Steel.
Photographs of Ironworks.

W. S. SHREEVE.

7A.—Model of the "Emperor" Mining Wedge.

EVENCE COPPÉE, AND CO.

7B.—Model of Coppée Coke Ovens; Samples of Coke and Washed and Unwashed Coal; Drawings of Coke Ovens and Coal-washing Machinery.

WILLIAM WHITWELL.

7C.—Model of Whitwell's Patent Regenerative Hot Blast Stove, for obtaining high temperature in Blast Furnaces.

HEYWOOD BROTHERS.

7D.—Tin Plates made from Steel.

JOHN HALL AND CO.

No.

7E.—Fire-Brick Specialities.

BLUNDELL AND SON.

8.—Model of Coal Washing Arrangement; Samples of Washed Nuts and Slack, and Coke made from Washed Slack; and Cannel.

DOUGLAS BANK COLLIERIES.

8A.—Bryham's Disconnecting Hooks; Locked Coil Wire Rope; Wigan Cannel and Deep Arley Coal.

THE NORLEY COAL AND CANNEL CO.

8B.—Samples of Cannel.

CROSS, TETLEY, AND CO.

8C.—Boring Tools and Cores, from recent borings.

THE GARSWOOD COAL AND IRON CO.

8D.—Samples of Coal—Ince 4 feet, Ince 7 feet, Wigan 4 feet, Wigan 6 feet, Orrell 5 feet, and Orrell 4 feet; Samples of Slack unwashed, washed, Refuse from Slack, Slack after crushing, and Coke.

THE ORRELL COAL AND CANNEL CO.

9.—Samples of Hard Coke, Arley Coal, Yard Coal, Bagging Nuts, Quick-burning Slack, and Cannel.

W. WILKINSON AND CO.

10.—Inverted Vertical Marine Engines, for high speeds; will run to 450 revolutions per minute; suitable for Steam Yacht, Electric Dynamos, &c., &c.; also, on M. Mercier's Stand, an Air Compressing Engine, for providing Air for Lucigen and other Lights.

PEAK AND CO., BRIDGEWATER CHEMICAL WORKS, WIGAN.

11.—Artificial Manures; Condimental Foods; Coal Tar Products.

THE ST. JOHN AMBULANCE.

No.

12.—Appliances for Relief of Injured, comprising an "Ashford" Litter, a T Stretcher a Police Stretcher, a Lowmoor Jacket for use in Pits, with Dummy; a Hamper fitted for use at Railways and in Pits; a small Hamper with First Aid Appliances; Ice Ball.

J. H. PECK.

12A.—Stretcher; Horse Cloth and Brattice Cloth.

ALEXANDER BERTRAM.

13.—The "Visor" Appliance for the prevention of Accidents by Overwinding at Collieries.

THE ACCIDENTS PREVENTION CO.

13A.—The "Detector" Appliance for the prevention of Accidents by Overwinding.

EDWARD ORMEROD.

13B.—Patent Safety Cages; Patent Safety Hook; Patent Winding Engine Brake.

MILES SETTLE.

13C.—Colliery Model; Underground Workings; Appliances to prevent Overwinding; Water Cartridges.

THOMAS SMITH.

13E.—Brake Gear and Overwinding Gear.

J. H. NAYLOR.

14.—Miners' Safety Lamps and Miners' Tools.

JAMES ASHWORTH.

14A.—Miners' Safety Lamps.

WILLIAM LLOYD.

14B.—Miners' Safety Lamps and Patent Safety Scaffold for Sinking Pits.

ROGER BOLTON AND SON.

15.—Brass Castings; Miners' Safety Lamps; Beer Engines and Bar Fittings; Copper Work; and Tin Work.

THE PEPPER MILL BRASS FOUNDRY CO.

No.

16.—Winding Indicators and Signal Bells for Colliery Engines; Sight Feed Lubricator; and General Brass Fittings.

MESSRS. WILLIAM BROWN AND NEPHEWS.

17A.—Manufactured Cotton Goods and Cotton in different processes of manufacture; Photographs of Cotton Machinery.

JAMES ECKERSLEY AND SONS.

17B.—Model Throstle Spinning Frame; Windles of Cloth; Windles of Twist (Yarn): Photographs of Cotton Machinery.

JOHN DAVIS.

17C.—Fancy Cotton Trouserings; Corduroys; Partridge Bedford Cords.

R. BURLAND AND SON.

18.—Oils, Colours, and Chemicals.

A. BAXENDALE.

18A.—Model of St. James's Church.

FREDERICK RIMMER.

18B.—Wood Carving, as applied in Building and Cabinet Making.

JOHN ILLINGWORTH.

19.—Dairy Cans; Cotton Cans; Stove Pipes; Lamps; Oil Pumps; and general Tin Ware.

T. J. S. CLEPHAN.

20.—Electrical Appliances, including Bells, Signals, Medical Appliances, Gas Lighters, Alarms, Indication Coils, Electrical Wire, Insulator, and Speaking Tubes.

JOHN LAMB AND CO.

No.
21.—Resin and Tar Products; Lubricants; and Colours.

OWEN McBREEN.

21A.—Artificial Teeth.

WARRINGTON WIRE ROPE WORKS.

21B.—Samples of Rope; Hawsers; Conductors; Fencing Strands; Lightning Conductors, &c.

THE ROBURITE EXPLOSIVES CO.

21C.—Samples of Chemicals; Dummy Cartridges; Detonators; Magneto Exploder; system of Packing.

THE WIGAN WAGGON CO.

22.—Models of Coal and Tipping Waggons, and sundry Waggon Materials.

S. CUBBIN.

22A.—Public-House Furniture.

J. RUDD.

23.—Brushes.

WHITLEY AND CO.

24.—Hinges.

JAMES WHITFIELD.

24A.—Spades.

H. JOWETT.

24B.—Model of Horse.

J. TIMMINS.

No.

24c.—Coal Tar Products.

WILLIAM BOLTON.

25.—Water Appliances, &c.

JOHN RIDDLESWORTH AND SON.

26.—Bobbins for Cotton Spinning: Samples of Wood Turning; Sawn Wood; Pick and Spade Shafts.

JOHN ROTHWELL.

27.—Cocoa Machinery and samples of Goods.

DEAKIN AND HODGSON.

27A.—Preserves.

MESSRS. COOP AND CO.

28.—Machinery in operation, as used in the manufacture of Clothing.

MAUNSELL MERCIER.

29.—Wilkinson's Air Compressing Engine.
Crossley's Otto Gas Engine.
Tram Sleeper; Steel Pit Tubs.
Iron and Steel Tubes; Air Pipes.
Electrical Appliances; small Fans; Wenham Lamps; Gas Governors·
Lubricators; Rock Drills; Cast Iron Props.
Schiele Fan; Hydraulic Coal Getter; Steam Hammer; Hot Air Engine.

THE SINGER MANUFACTURING SEWING MACHINE CO.

30.—A selection of Sewing Machines at Work.

ROBERT DAGLISH AND CO.

No.

31.—Photographs of Mining and Pumping Machinery.

W. B. JOHNSON AND SON.

32.—Drawings of various Designs of Compound Locomotive Engines—W. B. and J. A. Johnson's Patents; Improvements in Elevator and other Vertical Bins; Gas Stoving Grain; Ventilating, Cooling, Mixing, and Drawing off the Grain by means of vertical and sloping tubs—W. B. and J. A. Johnson's Patents.

STANLEY BROTHERS.

33.—Patent Coal Heading Machine, similar to one now in use at the Bamfurlong Collieries of Messrs. Cross, Tetley, and Co. The Machine cuts an annular groove round the face of the heading, and leaves a core which falls off or is got off.

TAYLOR AND FARLEY.

35.—Photographs of Machinery for Iron Works and Steel Works.

DAVY BROTHERS.

37.—Photographs of Machinery.

JACKSON TYRER.

38.—Specimens of Letterpress.

THOS. WALL AND SONS, PRINTERS, WIGAN.