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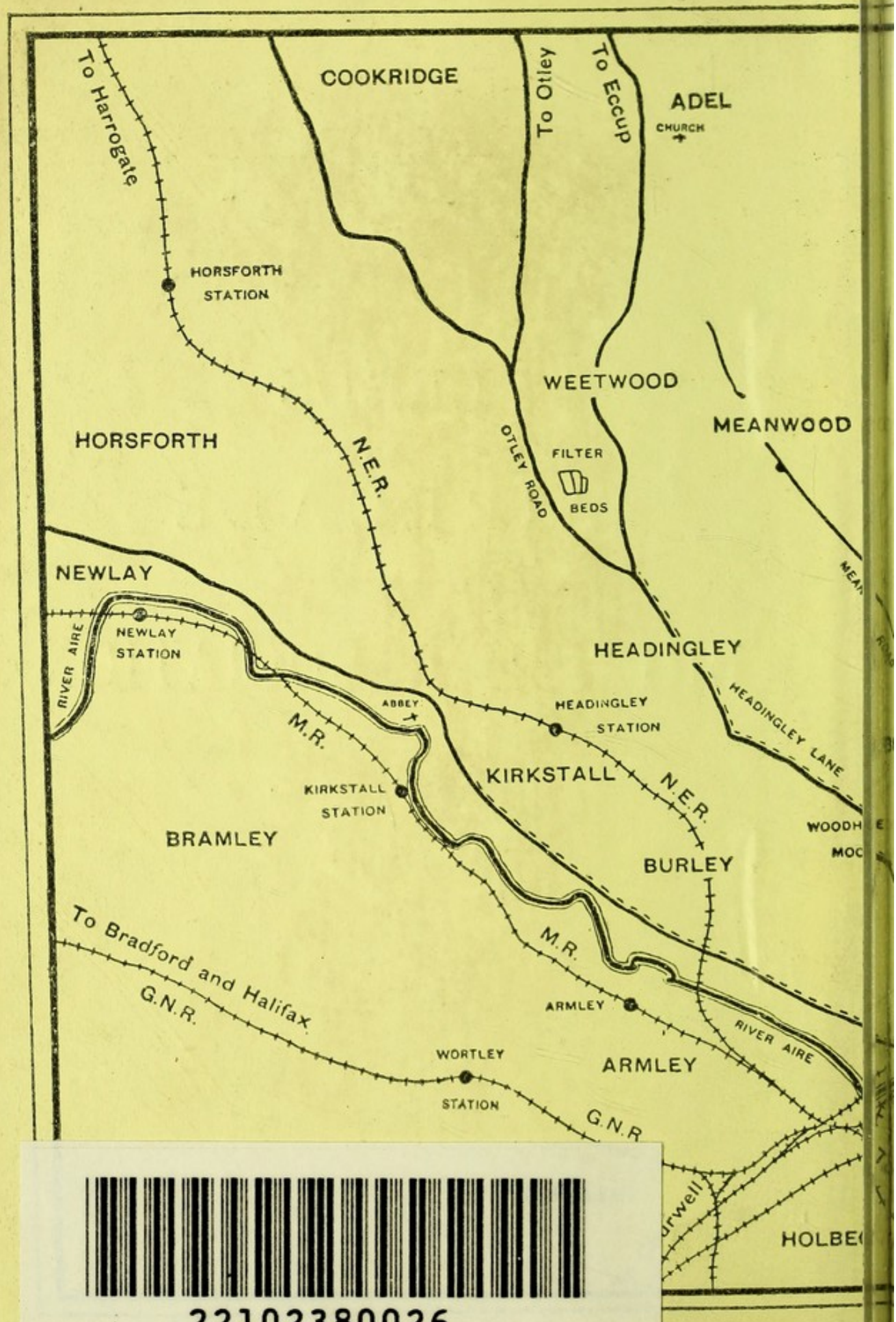

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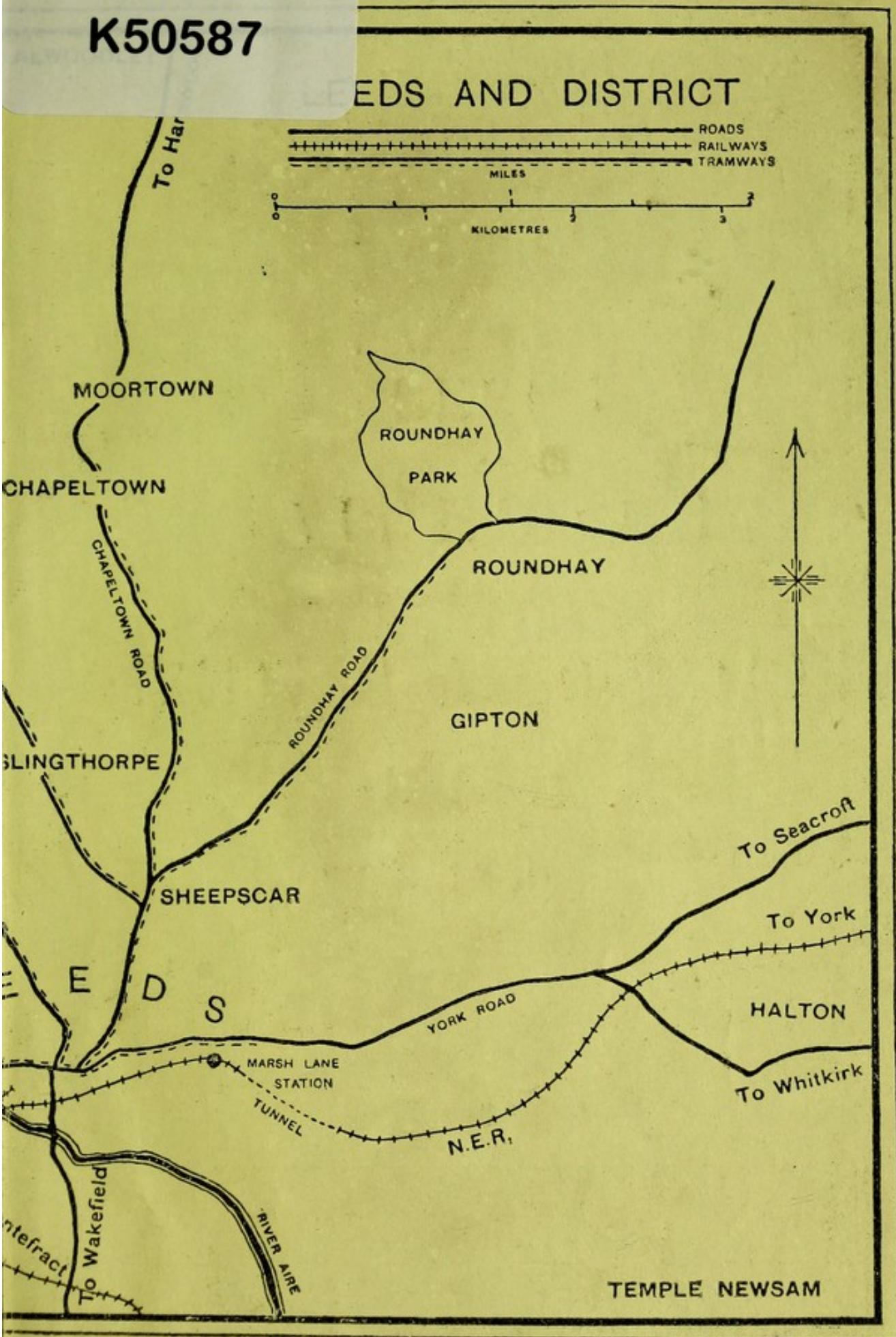
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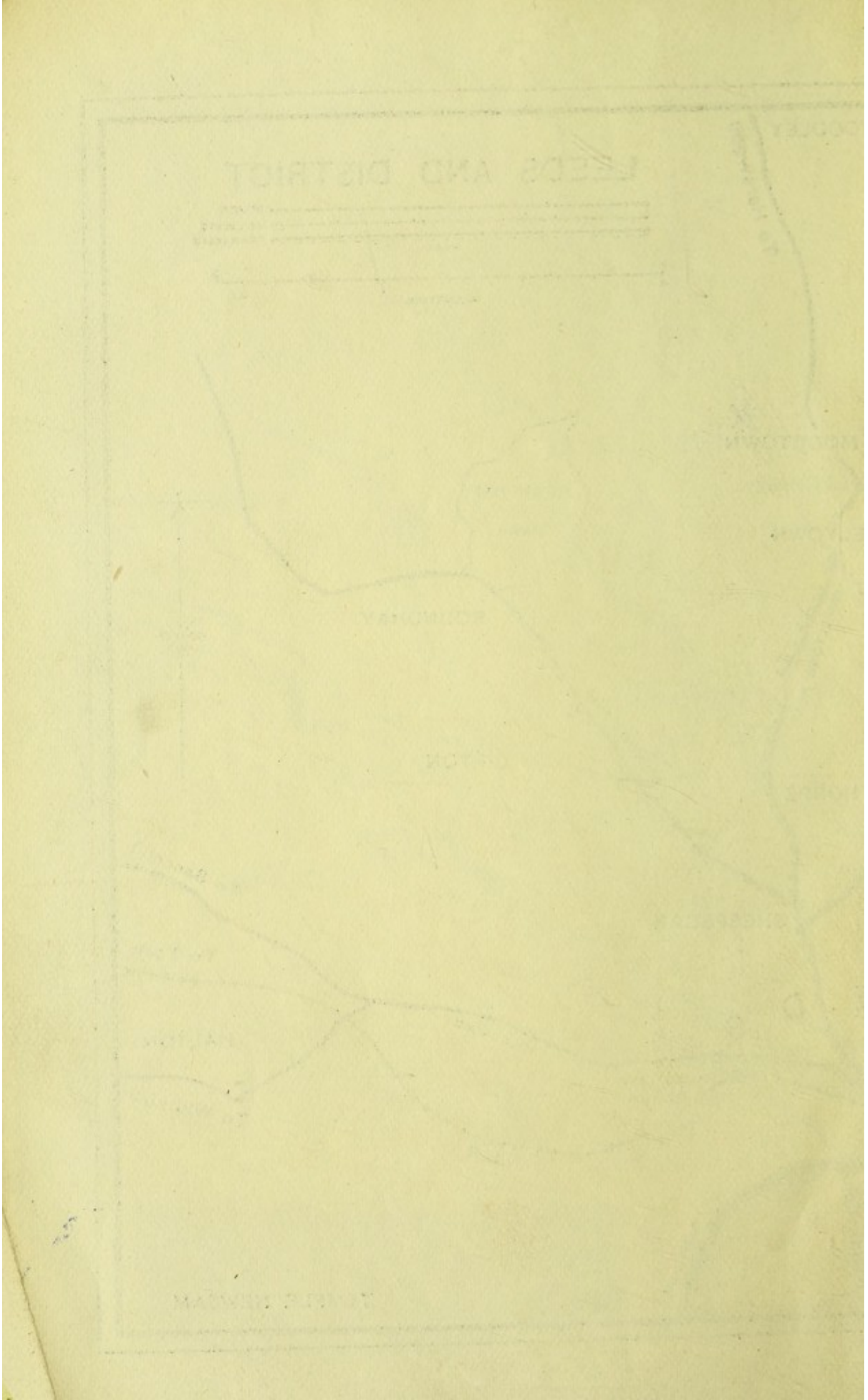

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HANDBOOK

FOR

LEEDS AND AIREDALE.

PREPARED FOR THE USE OF THE

BRITISH ASSOCIATION,

LEEDS, 1890.

EDITED BY

PROF. L. C. MIALL.

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PREFACE.

THE following pages have been prepared by the writers whose names are prefixed to their respective sections. In the chapter on the Industries of Leeds, the urgent necessity of keeping the book so small as to be readily carried in the pocket, has called for an abridgment of some of the articles. We have therefore to explain, in justice to the contributors, that what is now printed does not always give the words or the expressions originally used. In the course of editorial revision and of a condensation, which aimed rather at brevity than at elegance, changes have been made for which the authors cannot be held responsible.

The thanks of the local Committee are due to many gentlemen, whose time is very precious, for the pains which they have taken to supply full and interesting information on the subjects which they have treated.

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CONTENTS.

AIREDALE;

Its Scenery, Historic Sites, Geology, and Natural History.

By Prof. L. C. Miall.

SOURCES OF THE AIRE.

The Aire, says Camden, springs from the roots of Penighent. This is not literally true, for all the water that flows down the sides of Penighent makes its way either into the Ribble or the Wharfe. But the same high floor which underlies the dome of Penighent forms also the base of Fountains Fell, and the streams which rise on the southern slopes of Fountains Fell are the head waters of the Aire. Fountains Fell takes its name from the distant Abbey on the Skell. The Conqueror had given the Manor of Malham to William de Percy. A descendant of this William founded Sawley Abbey, and also granted Malham Water to the monks of Fountains. To this gift his daughter, the Countess of Warwick, and her husband added some surrounding pasture land. In the end the monks acquired the Manor of Malham and all the wide sheep-walks of Malham Moor. Their possessions came to extend across Wharfedale, and over Grassington Moor to Nidderdale; thence to the lower and more fertile land of the Vale of York. In the pleasantest spot within their wide estates rose the Abbey itself, at first the desolate retreat of men impatient of the relaxed rule of St. Mary's at York; in the end the palace and church of a lordly abbot, whose magnificence broke all Cistercian rules.

MALHAM TARN.

Malham Water, or Malham Tarn, owes its existence to a geological accident. The fissured limestone rocks of Malham Moor hold, as a rule, no water, and even important streams disappear into "secret sluices," to emerge again into daylight at

a considerable distance and at a far lower level. But across Malham Moor runs the great disturbance known as the North Craven Fault, and this brings up the base of the limestone to a height of 1,250 feet above the sea-level. At the foot of Malham Cove, which is a mile and a half distant and 500 feet lower, the base of the limestone is still about 200 feet below the ground. The wasting of the limestone in the neighbourhood of the Tarn has at length exposed the underlying rocks, and these are of slate and conglomerate, not fissured, and not capable of penetration by water. Upon this impervious surface a shallow lake has formed, but the overflow waters escaping to the south at once encounter the vast thickness of fissured limestone beyond the fault, and are lost to sight in a "swallow hole." Other streams collect near the old Smelt Mills, and disappear in the same way.

It has been shown by actual and repeated trial that if the waters of the Tarn are dammed up for some hours and then suddenly discharged, the flood affects two lower outlets, that at Aire Head and that at Malham Cove.* Of these, Malham Cove is a mile and a quarter nearer to the Tarn, but it is not affected till more than half an hour after the other. The underground channels are altogether inaccessible, and we are left to conjecture what the cause of the unexpected difference may be. It seems probable that a great part of the passage to the Cove is formed by a horizontal fissure, such as would be created by the enlargement of a parting between two beds of limestone. Here the friction of the bed, and possibly of the roof of the stream, will be at a maximum; the stream will be checked, so that it can only very slowly wear down its channel to one more favourable to rapid delivery. The passage to Aire Head may be a vertical fissure, such as would be due to enlargement of a joint cutting across the beds. In this case the friction will be less, and, what is especially important, the stream will be able rapidly to wear away its channel and reduce its course to a uniform slope.

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* An interesting and valuable paper, by Mr. T. Tate, on the sources of the River Aire, is to be found in the proceedings of the Yorkshire Geological Society for 1879.

A vertical fissure is easily enlarged and easily choked. If we suppose that the water-course to Malham Cove accomplishes most of its fall in one or more vertical descents, and most of its longitudinal distance in a wide, shallow, and almost horizontal fissure, while the passage to Aire Head is effected by a moderately continuous descent along a vertical fissure, the difference in speed can be explained.

Measurement of the issuing streams shows that the Cove discharges more than half of the water which issues from the Tarn.

Malham Tarn is a broad sheet of water about a mile across. Its depth is trifling, nowhere exceeding fourteen feet, and of this amount one-third is due to an embankment. The scenery of the Tarn is not beautiful. Grey limestone peeps everywhere through the turf, and gives the desolate appearance of patches of half-melted snow. The house and plantation add a touch of human interest, but they are unable to warm a prospect so vast and so cold. Wide landscapes in a mountain limestone country are often rather dreary. The hill profiles are seldom beautiful where the rocks are well-bedded and well-jointed. We miss the subtle curves and varied summits seen amongst the metamorphic rocks ; and the rounded knolls and white cliffs of Craven are a poor exchange for the noble forms of the Highlands or the Lake country. The beauty of Craven lies in its detail. A rugged gorge with ash and birch, and a clear stream murmuring among great mossy stones ; a smooth greensward overhung with trees at the foot of a white cliff ; a flat strath, with its winding stream shut in by steep rocks ; a waterfall, where the peaty water, fresh from the moors, tumbles into a shady pool—these are the scenes to which pleasant memories cling, and not the cold expanse of Malham Moor. Gray is not too disparaging when he says, " Craven, after all, is an unpleasing country when seen from a height."

Malham Tarn abounds in fish. The common trout is abundant, as in the upper waters of the Aire. Another variety, probably the same as the Loch Leven trout, and called at Malham the " Silver Trout," is less common. Perch also occur.

Both varieties of trout are liable to an unusual defect. The operculum, or gill-cover, is deficient in from one-thirteenth to one-twentieth of the fish. No satisfactory explanation of this strange peculiarity has been given, but similar deformities have often been observed where fishes or other animals have been kept for many years in a small area without the possibility of a new strain of blood. Gold fishes and carp yield plenty of instances. The trout of Malham Tarn were probably introduced by the monks of Fountains. Fish-ponds were a valuable resource in Lent, and at the time of the Dissolution the fishing in Malham Tarn was let for £6 18s. a year, a sum which happens to be as nearly as possible twice the annual value of the farm then tilled by Hugh Latimer's father, and slightly more than the pensions upon which the canons of Bolton managed to subsist after they were turned out of their goodly priory.

MALHAM COVE.

MALHAM COVE is the finest inland cliff in Yorkshire. It faces the Mid-Craven Fault, which runs nearly half a mile to the south. In attempting to account for this stupendous precipice, 285 feet high, many persons, impressed with the geological views of the last generation, will be inclined to suppose that the sea once rolled at its base. There is independent proof that once, or more than once, in comparatively recent times, Craven has been covered by the sea; and yet we hesitate to attribute Malham Cove to the wasting power of the sea. If this particular case demands such explanation, the many other limestone precipices of Craven demand it also. This implies that marine denudation acted long and steadily at a great variety of levels, and without leaving behind it any raised beaches, parallel roads, or other unmistakeable proofs of an ancient shore-line, subsisting long at a level much higher than at present. Slow atmospheric waste is rather the agent which we should now invoke to explain Malham Cove, Kilnsey Crag, and all the countless limestone cliffs of Craven. The river at the Cove is concerned, inasmuch as it is a solvent for the loose stuff which would otherwise

encumber its base. Possibly the Mid-Craven Fault may be a more remote cause. By opposing a face of hard limestone to more perishable rocks, it perhaps determined the vertical cliff, which has now weathered back several hundred yards.

The old Malham schoolmaster, Hurtley, is our authority for the statement that in times of flood the sinks on Malham Moor have been known to become choked with water, and that a stream then pours down the ravine which leads to the top of the Cove, forming a cascade of imposing height, though probably of inadequate volume. This spectacle has never been witnessed by living men.

Both Malham Cove and Gordale have left their mark upon our literature. Kingsley's description of Vendale in the "Water-babies" is a very lively picture, which bears evidence of having been written under the inspiration of the scenery of Malham. Wordsworth's two sonnets are well-known.

GORDALE.

GORDALE is essentially a water-worn ravine, with a rapid stream wearing down the soluble limestones. The vertical sides of the narrow gorge below the fall suggest that an underground stream formed first of all a cavern, which was converted into an open ravine by the falling in of the roof. This explanation was applied by Prof. T. Mc. K. Hughes to the similar gorge of Trow Gill, near Clapham. Of all descriptions of Gordale the most spirited is that by the poet Thomas Gray, who visited the north of England in 1769, and wrote an account of what he saw to his friend Dr. Walton. We have no really interesting and appreciative description of the scenery of Yorkshire, Cumberland, or Westmoreland earlier than this delightful diary. To understand how new a thing it was in 1769 to feel the sentiment of hills, we must remember that fifteen years earlier a great English writer—no other than Oliver Goldsmith—had found it possible to compare the scenery of Scotland and Holland, to the disadvantage of Scotland.*

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* See the well-known passage in Macaulay's History of England.

Gray's description of Gordale runs as follows :—

"October 13th, to visit Gordale-scar. Wind N.E., day gloomy and cold. It lay but six miles from Settle ; but that way was directly over a fell, and it might rain, so I went round in a chaise, the only way one could get near it in a carriage, and made it full thirteen miles, and half of it such a road ! But I got safe over, so there's an end of it, and came to Malham (pronounced Maum), a village in the bosom of the mountains, seated in a wild and dreary valley ; from thence I was to walk over very rough ground, a torrent rattling along on the left hand. On the cliffs above hung a few goats ; one of them danced and scratched an ear with its hind-foot in a place where I would not have stood stock-still for all beneath the moon. As I advanced, the crags seemed to close in, but discovered a narrow entrance turning to the left between them. I followed my guide a few paces, and lo ! the hills opened again into no large space, and then all farther way is barred by a stream that at the height of above 50 ft. gushes from a hole in the rock, and spreading in large sheets over its broken front, dashes from steep to steep, and then rattles away in a torrent down the valley. The rock on the left rises perpendicular, with stubbed yew trees and shrubs staring from its side to the height of at least 300 ft. ; but those are not the thing. It is that to the right under which you stand to see the fall that forms the principal horror of the place. From its very base it begins to slope forwards over you in one block or solid mass, without any crevice in its surface, and overshadows half the area below with its dreadful canopy. When I stood at (I believe) full four yards' distance from its foot, the drops which perpetually distil from its brow fell on my head, and in one part of the top more exposed to the weather there are loose stones that hang in air, and threaten visibly some idle spectator with instant destruction. It is safer to shelter yourself close to its bottom, and trust to the mercy of that enormous mass, which nothing but an earthquake can stir. The gloomy, uncomfortable day well suited the savage aspect of the place, and made it still more formidable."

CONTRASTS OF VEGETATION IN CRAVEN.

MALHAM abounds in rare plants, and has been a favourite collecting-ground for two hundred years. The effect of soil upon vegetation is nowhere better seen than between Settle and Malham. Here the Mid-Craven fault brings shales and sandstones against the mountain limestone. On the north are the grey limestones, scantily clothed with bright green turf, which is closely cropped by sheep. The mountain pansy, the purple primrose, the cistus, thyme, and many small and dainty ferns star the slopes, or nestle in the crevices of the rock. To the south are sombre fells, covered with heather and long grasses—sure token of sandstones and shales—soaked with sour moorland water. Sometimes, when the sun is low, the contrast can be made out at a distance of several miles.

THE FOUNDATIONS OF YORKSHIRE.

THE lowest rocks visible in any part of Yorkshire are Silurian slates. Under Ingleborough the Coniston flags, grits, and limestone, with characteristic fossils, and the Lower Silurian slates are well seen. These old rocks have been contorted, and thrown into ridges and folds, which do not affect the rocks above them. Then they were raised into a land-surface, which remained long above the sea, and was worn into hill and valley. Upon this base the Carboniferous rocks now rest unconformably, the slope of the beds bearing no constant relation to that of the slates beneath. The very lowest bed of the Carboniferous is an irregular layer of conglomerate, not always present, but sometimes of considerable depth. To this succeeds the great mass of Mountain Limestone, which in Airedale is almost undivided. Above the Mountain Limestone come shales with thin limestones, then bed after bed of coarse sandstone with shales and flagstones (Millstone Grit). The Millstone Grit occupies most of the valley between Skipton and Shipley. In the neighbourhood of Shipley the Lower Coal Measures appear on the hill tops, sinking steadily as we pass to the south-east, but so gently,

that at Kirkstall they are still above the level of the river. The coal seams, shales, and sandstones now come on, one after another. The flagstones of Woodhouse, Idle, and Elland, the Low Moor coals and iron-stones, the coals of Beeston and Hunslet, and the Middleton Main coal of Garforth, Middleton, Rothwell Haigh, and Ardsley are the principal beds exposed in Airedale. At Garforth and Parlington a newer deposit, the Magnesian Limestone, overlies the Coal Measures unconformably, and pits have been sunk through it to reach the coal. Here the Halifax Hard Bed, one of the lower coals mentioned above, is about 400 yards below ground. Upon the Magnesian Limestone lies the New Red Sandstone, and this, thickly covered in most places by river deposits, extends as far as the junction of the Aire with the Ouse.

KIRKBY MALHAM.

"THE church is a noble example of North Country Perpendicular. The pillars have saints' niches on their western faces, said by Whitaker to characterise churches built by the great Craven family of the Tempests. It contains a very ancient, and very curious, probably unique font, and some monuments of the Lambert family, and of an unknown prior. The register has entries of marriages celebrated by Oliver Cromwell; in one case the bridegroom was a certain Martin Knowles, who lived at Middle House, about a mile north-east of Malham Tarn. This house is the highest house in England, being 1,500 ft. above sea-level, or 24 ft. higher than the house in the Kirkstone Pass." (From Notes by Mr. Walter Morrison, appended to Malham Tarn Fishery Ticket.)

CALTON AND GENERAL LAMBERT.

HALF-WAY between Malham and Bell Busk lie the two villages of Airton and Calton, one on each side of the river. Calton is memorable as the birthplace and home of Major-General Lambert, the well-known leader of the armies of the Parliament against the Royalists. A conspicuous white house, east of the river, marks the site of his house. Lambert fought at Marston

Moor, Preston, Dunbar, and Worcester; and was in chief command, alone or with others, at the taking of York, Pontefract, Oxford, and Newark. His great-grandfather was a statesman or small yeoman of Skipton, heir to a property of £10 a year. He took to the law, and rendered useful service to the commissioners for the dissolution of the religious houses. They repaid him by grants of the forfeited lands, and when he died he was chief owner of the parish of Kirby Malham, and possessed a landed estate worth £225 a year, equal, perhaps, to £2,000 a year in our day. John Lambert, afterwards Major-General, succeeded to the estate in 1632, when a boy of thirteen. At twenty he married a daughter of Sir William Lister, of Thornton-in-Craven, another family which held stoutly for the Parliament. Young Lambert threw himself heartily into the quarrel, and joined the Fairfaxes, Listers, and Stapyltons in the petition presented to the King at York, June 3rd, 1642. The petition, mild enough in its language, was circulated with a protest and declaration against "raising and continuing together in a body such forces of horse and foot in this county as have been proposed without consent and authority of Parliament." The petitioners further declared that they would allow no troops or money to be levied in the county nor any foreign force brought in, and if such attempts should be made they pledged themselves to resist and suppress them. Charles was daunted by this opposition, and left Yorkshire to raise his standard at Nottingham, about six o'clock in the evening of a very stormy and tempestuous day, as was noted by believers in portents. A month later Fairfax was appointed Commander-in-Chief of the Parliamentary forces in the Northern District. As subordinate to Fairfax, and afterwards to Cromwell, Lambert soon came to the front, and was in every particularly hot thing which went on during the next ten years, becoming in the end one of ten Major-Generals to whom the care of the peace was intrusted by the Protector. Lambert, now the Lord Lambert, held Yorkshire, Durham, Cumberland, Westmoreland, and Northumberland. This was Lambert's highest promotion, and it did not last. Opposing too keenly the proposal to make

Oliver King, he was dismissed from all his offices and employments (Major-Generals had been abolished earlier). Lambert retired to Wimbledon, and grew flowers. After Oliver's death he came to the front again, nominally supporting Richard Cromwell as Protector for a time, shutting out the members of the House of Commons at a later crisis, then serving on a committee of safety which replaced the Rump for a few weeks. When Monk with the English troops in Scotland threatened to march southward, Lambert set out to meet him, but could not succeed in drawing his sword. The appearance of Lord Fairfax in arms at Marston Moor broke up his army, and Monk marched on to London without resistance. One last outbreak showed Lambert's determination not to be effaced without a struggle. He escaped from the Tower, where he had been sent by the recalled Presbyterian Rump, and declared for a free Commonwealth. But the effort was in vain. Lambert's insurrection was quelled by Monk, and its leader was shut up in the Tower once more. He never regained his freedom. When banished by the restored Royalists to Guernsey,* he amused himself for more than twenty years with his garden and pictures. We may say of him, as of Fairfax, that he was a man of great powers and energy, whose spirit was broken by the dominance of Cromwell.

RILSTON AND THE NORTONS.

At Rilston, near the top of the low pass which leads from Gargrave in Airedale, to Burnsall on the Wharfe, the Nortons were once settled in the midst of lands belonging to the Cliffords, of Skipton Castle. Richard Norton, who held Rilston in the days of Queen Elizabeth, had an ingenious plan for capturing the deer which roamed over his neighbour's wide estate. In steep and broken ground, on the edge of the moor which looks down upon the distant Aire, he made a sunk wall, down which the deer could easily leap, but which effectually imprisoned them when once they had ventured into the pastures

* Lambert was afterwards removed to Plymouth, possibly because a son of the governor of Guernsey had married his daughter.

below. Hard by, Norton built a square tower, small but strong, the ruins of which are a conspicuous object from the road which leads past Rilston. He also fenced land over which the Cliffords claimed the right to drive their deer. Norton held strongly to the old faith, while the Cliffords were Protestants and supported the politics and religion of Henry VIII. and Queen Elizabeth. There was no good will between the two families, therefore, and no doubt the Lord of Skipton often longed to join the land of his cunning neighbour to his own wide domains. The Nortons ceased to vex the Cliffords after the "Rising of the North" in 1569. In that year the Earls of Northumberland and Westmoreland, with the chief Catholic gentry of Northumberland, Durham, and Yorkshire, took the field in the hope of rescuing Mary, Queen of Scots, then in captivity at Tutbury, and of restoring the old religion. They marched to Clifford Moor, near Tadcaster, where they found themselves enclosed by the Queen's troops, and retreated northwards to Raby Castle. After this they made no effectual stand; some of their leaders escaped to the Scotch Border, or to the Netherlands, while many fell into the hands of the Queen's officers. The Nortons were amongst those who joined the revolt, and Richard Norton was appointed to bear the banner on which the five wounds of Christ were displayed. An old ballad tells how he and his eight good sons were doomed to die. In reality, Richard Norton escaped to Flanders. His brother Thomas and his son Christopher were actually executed at Tyburn. Two other sons were pardoned, and one seems to have found his way with his father to Flanders. The rest of the eleven sons and eight daughters were not concerned in the rebellion. The estates were forfeited to the Crown, and came at length into the hands of the Cliffords. It was believed in Craven that long after the Nortons had disappeared from Rilston, a white doe, which dwelt in their park, used to cross the moors to Bolton on Sundays, and might be found in the churchyard during service. This tradition suggested to Wordsworth his poem of "The White Doe of Rylstone."

ESHTON AND GARGRAVE.

ESHTON HALL, the seat of Sir Mathew Wilson, is a modern building, standing on the banks of the Winterburn Beck. The library contains important MSS. and a fine collection of books made by Miss Currer. Here are also some interesting portraits of Cromwell, Fairfax, and General Lambert.

Gargrave, says Whitaker, may be considered the central parish of Craven, as well as one of the warmest and most fertile. The village is beautifully situated in a wide and rich valley, overshadowed by the moorlands of Flasby Fell, and full in view of the hills of North Craven. It has had its monuments of ancient days—a fine Roman villa, a church originally built by the monks of Sawley, and re-built in the time of Henry VIII. These links with the old time have disappeared wholly or in great part. The old church has gone, and of the second church built on the same site nothing remains but the tower. The Roman villa at Kirk Sink, half a mile below the village by the river side, was destroyed long ago ; its foundations were dug up for building stones, and a tesselated pavement found on the spot 150 years ago has perished utterly.

SKIPTON AND THE CLIFFORDS.

THE Cliffords of Skipton Castle lasted for something over 300 years, and were during those centuries a valiant race, such as the rough times required. They held their own through the long wars with Scotland and the hundred years' war with France and the yet more deadly wars of the Roses. Twice the inheritance of the Cliffords fell into other hands in consequence of troubles and civil war, but each time the interval was short, In the end the lordship of Skipton descended by peaceful title to remote heirs.*

The family history begins with Robert de Clifford, who received the grant of the Skipton estate from our luckless

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* De Clifford was the title of the barony. On the death of Anne Clifford, Countess of Dorset, Pembroke, and Montgomery, it descended to her daughter, Lady Margaret Sackville, and so to her son Thomas, sixth Earl of Thanet. As he left only daughters the title fell into abeyance.

Edward II., and fell a few years after at Bannockburn. He built the older parts of Skipton Castle, much of which still stands. Robert Clifford's father had acquired by marriage the estates of Appleby and Brougham, and was hereditary sheriff of Westmoreland. The fourth Lord of Skipton, a grandson of Robert de Clifford, fought at Cressy. The fifth lord went twice to France with Edward III. The seventh Lord served under Henry V. The ninth lord, known as the "Blackfaced Clifford," or "the butcher," took the Lancastrian side in the wars of the Roses. He slew the young Earl of Rutland at Wakefield, and was himself killed just before the battle of Towton. Having loosed his gorget, he was hit in the throat by a headless arrow shot out of a bush. For twenty-four years after the murderous day of Towton the lands of the Cliffords were held by their enemies, and the heir, Henry de Clifford, called "the Shepherd Lord," dwelt in retirement, first on the estates of the Cliffords at Londesborough, afterwards in greater seclusion at Threlkeld, in Cumberland.

> Love had he found in huts where poor men lie,
> His daily teachers had been woods and rills,
> The silence that is in the starry sky,
> The sleep that is among the lonely hills.

When Henry VII. came to the throne he restored the Cliffords to their lands and honours. "The Shepherd Lord" lived to hold a chief command at Flodden Field in 1513. All his charters are dated from Barden Tower, which he built, and where he constantly resided.

The eleventh lord of Skipton was created Earl of Cumberland by Henry VIII. By marriage with the Lady Margaret Percy he came into possession of the Percy Fee, which covered half Craven. He was allowed to marry his eldest son, Lord Clifford, afterwards second Earl, to Eleanor Brandon, daughter of the Duke of Suffolk, and granddaughter of Henry VII. The Cliffords stood by Henry VIII., as they afterwards did by Queen Elizabeth, in all the troubles which sprung from the breach with Rome. Indeed, during these reigns they are to be reckoned as the chief Protestant and loyal house of Yorkshire, whose great

families mostly sided with the partisans of the old faith. The first Earl held Skipton Castle against the revolt known as the Pilgrimage of Grace. Later on he shared in the dissolved monasteries, buying at a nominal price much of the lands of Bolton Priory. He built the eastern wing of Skipton Castle, including the Octagon Tower, to receive his son's high-born bride.

The Pilgrimage of Grace was a popular rising against Henry VIII., in which the clergy and gentry of the north came forward as leaders. It had strong and wide-spread feeling behind it, for the peasants, the Church, and the great families had all deep injuries to resent; it mustered thousands of resolute men, and shook the throne. But there was no guiding hand strong enough to use the gathered forces. The revolt took an uncertain course, acquiesced in its own defeat, and ended on the scaffold and in wide confiscation.

The grounds of the northern rebellion were manifold. In 1535, Thomas Cromwell, the King's chief adviser, had carried out a general visitation of the religious houses. The report was laid on the table of the House of Commons, and all the smaller monasteries, with incomes under £200 a year, were closed, and their lands given to the King. It was not doubted that the great monasteries were reserved for a somewhat later doom. Besides this chief grievance, the recent Statute of Uses had practically, though unintentionally, forbidden a landed gentleman to provide for any of his children except the eldest son, or to raise money on his land. Further, a heavy subsidy was being levied for the war in Ireland; and this pressed hard on the gentry. To these complaints of the ecclesiastics and landowners were added the long-standing wrongs of the peasantry. The high profits of sheep-farming had encouraged the enclosure of common and waste lands, and the conversion of arable land into pasture. Hence thousands of people found themselves turned out of their little farms, or prevented from grazing their cattle on what had been open land. A petition to the Crown complains that the dwelling-houses were decayed, the ploughs and all the people clean gone, and that in many parishes only a

neat-herd and a shepherd were to be found where there had formerly dwelt three or four score persons. It was the injury done to religion which first fired the dry tinder. On October 2nd, 1536, the visitor appointed by the Clerical Commission was attacked at Louth; on the 3rd, a rising took place at Horncastle, and the Chancellor of Lincoln was slain by a mob urged on by the clergy. Sixty thousand men soon mustered at Lincoln, plundered the Bishop's Palace, and occupied the city. But there was no plan and no command among the insurgents. The Duke of Suffolk, who had hastily raised troops, was allowed to march unopposed into Lincoln, and in less than a fortnight the Lincolnshire revolt had subsided.

Meanwhile the West Riding had risen, and had found a leader in Robert Aske. He and his brother Christopher were cousins of the Earl of Cumberland, Lord of Skipton, and came of a family settled near Selby, in the East Riding. Robert Aske was a lawyer in the Temple. A proclamation sent out by him, or in his name, roused the northern counties, and the rebellion grew daily in Yorkshire and Northumberland. York, Hull, and Pomfret Castle fell into the hands of Aske and his friends. In a few days only one stronghold in the West Riding was held for the King. This was Skipton Castle. The nobles and gentlemen of the north were now gathering fast to the banner of the Catholic Lords. Near 50,000 men marched upon Doncaster, where a conference was held; the demands of the insurgents were sent to the King, and both parties waited for the result. The Earl of Cumberland still held out in Skipton Castle. Robert Aske's two brothers, Christopher and John, were with him. Nearly all the Earl's gentlemen had ridden off to join the insurgents, and only eighty men, chiefly servants, could be found to man the Castle. The town was filled with a furious mob, who soon discovered that Lord Clifford's young wife, with three little children and several ladies, were not in the Castle, but six miles off, at Bolton Abbey. On the third day of the siege word was sent to the Earl that the ladies should be held as hostages for his submission, and brutal threats were offered if he should prove himself obstinate. But Christopher

Aske, with the Vicar of Skipton, rode off by night to Bolton, and brought the ladies back, as Christopher Aske himself says, "so close and clean, that the same was never mistrusted nor perceived till they were within the Castle." A few days later he sallied forth, in full armour, with his train, and read the King's proclamation in Skipton market place, "with leisure enough, and that done, he returned to the Castle."

The opportunity of the insurgents passed while they were holding conferences with the King's servants. Aske was afraid to move, and repeated discussions took place. The leaders strove more and more to give to what was really a revolt the character of a petition for the King's grace. They professed to be pilgrims, and wore the five wounds of Christ as a badge upon their breasts. The King, on his side, made some concessions of no great moment, and also some promises which were never fulfilled. Aske was invited to speak with the King in person, as being once more his faithful subject. He went, saw the King, and returned in safety. But new disorders broke out, headed by those who, not without grounds, cried out that they were being fooled by the great gentlemen. The King's officers had by this time recovered from their surprise, and forces had been raised. They began to treat the pilgrims no longer as mistaken friends, but as rebels fit for the gallows. Many were captured, hanged, or sent to London in chains. Aske and his chief comrades were taken April, 1537. After this the Pilgrimage of Grace was at an end, but the trial and execution of its chief instigators lasted till July, when Aske was drawn through the streets of York on a hurdle, and hanged from the top of a tower.

The thirteenth Lord of Skipton served in the English fleet against the Armada, and led nine expeditions against the Spaniards, chiefly to the West Indies. His only daughter, Anne Clifford, was born in Skipton Castle. On her father's death, her uncle, and afterwards her cousin, succeeded to the estates. Her cousin, the last Earl of Cumberland, took the King's side in the civil wars, and attempted to raise troops for the King in Yorkshire (June, 1642), but was resisted by Sir

Thomas Fairfax. Soon afterwards Skipton Castle was besieged by the Parliamentary forces. The siege lasted three years, and must have been languidly pressed, though some lives were lost, and part of the Castle was battered by cannon placed on the rising ground where the road to Rilston now leaves the road to Gargrave. The Earl of Cumberland died of a fever at York early in the siege. Anne Clifford, who was thrice married, first to the Earl of Dorset, and secondly to the Earl of Pembroke and Montgomery, succeeded to the estates, but was not able to obtain possession for some years, owing to the troubles occasioned by the war. In 1648, at the time of the Duke of Hamilton's invasion of England with a Scotch army, Skipton Castle was again held by a Royalist force; and when recovered, the Parliament gave orders that it should be "slighted" or demolished. This was done, but not effectually, and the workmen desisted when the immensely solid foundations were approached. The eastern buildings appear to have been left untouched. In the summer of 1649, the Countess visited Skipton, and stayed ten days. The whole of the next year she spent upon repairs, but did not venture to rebuild the old castle till 1656, the very year in which the Major-Generals were suppressed. The Lord Lambert, Major-General of the northern district, though he had, no doubt, a due sense of the importance of Skipton Castle, was little inclined to provoke fresh unpopularity at that moment. Accordingly the Countess was suffered to go on. In her own words, "On 25th May, 1656, she began to repair Skipton Castle, and about Michaelmas following there were thirteen rooms finished, seven whereof were upper rooms, in one of which she was born, and her uncle Thomas, Earl of Cumberland, dy'd, and the Conduit Hall was cleaned of the rubbish, and the rooms were covered with slate and the gutters with lead. But she was not suffered to cover the rooms with lead" (lest cannon should be planted on the roof). The Castle, when rebuilt, was occupied by a garrison of Parliamentary troops. Over the new gateway the Countess set an open parapet formed into an incription, and bearing the ancient motto of the family, "Désormais." The stout old lady had yet

other work to do in this world. Appleby, Brougham, Brough, Pendragon and Barden lay in ruins, and all these she repaired. Among the letters in the Countess's hand is one which agrees very well with her portrait, of which Whitaker says that it is more expressive of firmness than benignity, and that no one who saw the picture of Lady Pembroke, without knowing whom it represented, would suppose that it was meant for a beneficent and amiable woman. Sir Joseph Williamson, Secretary of State to Charles II., had written to name a candidate for Appleby, which was a pocket borough belonging to the Countess. She replied :—

"Sir, I have been bullied by an usurper; I have been neglected by a Court, but I will not be dictated to by a subject. Your man shan't stand.

Anne Dorset, Pembroke, and Montgomery."

It was our Countess who set up the monument to Edmund Spenser in Westminster Abbey. Her tutor was the poet and historian, Samuel Daniel. Sir Matthew Hale was her friend and secretary. Bishop Rainbow said of her in his funeral sermon, "That she could discourse well on all subjects, from predestination to slea silk" (i.e., carded unspun silk).*

Some parts of Skipton Church date from the Plantagenets, but most of it is comparatively modern. The Countess rebuilt the tower in 1655. Beneath the altar is the family vault of the Cliffords, and tombs around commemorate their names with all "the boast of heraldry, the pomp of power."

GEOLOGY OF SKIPTON.

From Skipton a second low pass runs between Airedale and Wharfedale. Here the rocks of the district are well seen, and under circumstances of unusual interest. The slates of Malham Moor are now nearly 1,000 feet below the surface. The top of the limestone rises into the irregular boss of the Skipton rock, which has been so long quarried for road metal and iron smelting. Above the limestone, on the sides of the steep edges

* "Sleep, that knits up the ravell'd *sleave* of care."—*Macbeth.*

of Embsay and Skipton Moor, rise the Yoredale shales, and these in turn are overlaid by the Millstone Grit sandstones, which form a barren and heathery cap to all the neighbouring heights. The limestone in the floor of the valley is thrown into a number of folds, and presents one of the most striking examples of the way in which a hard rock, under great pressure of overlying strata, can be bent into sharp angles without fracture. Draughton Quarry has become classical, having been copied into many geological text books from a photograph issued by the West Riding Geological Society in 1871. Fine examples of contorted Mountain Limestone are also to be seen at Thornton-in-Craven and at Raygill-in-Lothersdale.

GEOLOGY OF THE COUNTRY BETWEEN SKIPTON AND SHIPLEY.

THE Millstone Grit series consists of several variable sandstones, sometimes of great thickness, with interposed shales, resting upon an uneven floor of Yoredale Rocks, and overlaid by the lower Coal Measures. When the continuous Millstone Grit tract of Derbyshire and Yorkshire is studied by means of a N.-S. section,* it becomes evident that the most constant features in this part of the Carboniferous Series are the *Rough Rock*, or topmost sandstone, a coarse and massive felspathic grit, about 100 feet thick, conspicuous at Baildon, Bingley Moor, the Druid's Altar, Rivock Edge, and the summit of Rombalds Moor; and the *Kinder Scout Grit*, or lowest sandstone, which varies greatly in thickness, generally increasing northwards. It is about 500 feet thick between Keighley and Skipton, and on Skipton and Embsay Moors. Though usually coarse it contains in places beds of flagstone, and is sometimes subdivided by shale.† Between these two sandstones are others of far less constancy, and considerable beds of shale.

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* Such a section is given in the Geology of the Yorkshire Coal Field, Plate 1.

† The "Yoredale Grit," regarded as belonging to the Yoredale Rocks in many publications of the Geological Survey, is now found to be incapable of separation in all cases from the Kinder Scout Grit. (Geology of the Yorkshire Coal-field, p. 65.)

About Keighley and Ilkley there are several of these intermediate sandstones, now termed *Middle Grits* by the Geological Survey, of which the Addingham Edge Grit forms conspicuous escarpments at Earl Crag, Addingham Edge, the Cow and Calf above Ilkley, and Otley Chevin.

The Millstone Grit tract of Airedale is at lower elevations grassy and often well covered with trees. At greater heights it forms wet moorlands with heath and sphagnum bogs, clear indications of an ill-drained, retentive soil. The flats along the river are tolerably fertile, and make fair wheat land. There is much glacial till, due apparently to local glaciers, as it contains no rocks foreign to the Aire valley. Many ice-scratched pebbles occur, and limestone boulders become more and more frequent as we ascend the valley and approach the district where the limestone occurs in situ.

CARLTON AND DR. MARTIN LISTER.

THE little village of Carlton, near Skipton, is connected with the name of a noteworthy Yorkshireman, Dr. Martin Lister. The Listers were an important Craven family from the middle of the sixteenth century till the beginning of the eighteenth, when the male line became extinct. The heiress, Anne Lister, married Sir John Kaye, of Woodsome, and from them have descended the Lister-Kayes, the present lords of the manor of Thornton. Dr. Martin Lister studied at Cambridge, and became a Fellow of St. John's College in 1660. He married a daughter of Thomas Parkinson, of Carlton Hall, and inherited a share of the estate. He lived at Carlton for some years, until in 1670 he removed to York. Here he busied himself with antiquities, traced the Roman wall, and made the first description of the Multangular Tower. Lister was eminent as a physician. Removing to London in 1683, he soon won Court favour, and became a fashionable physician. He accompanied the Earl of Portland to France in 1698, and was afterwards made physician to Queen Anne. He died in 1712 at the age of 74. Lister is now chiefly memorable for his work in natural history. He published an excellent sketch of the natural

history of shells. He was perhaps the first to propose a geological map, and his description of a possible map of the soils of Yorkshire marks an era in geological history.* Not a few interesting memoirs by Lister are contained in the early volumes of the Philosophical Transactions. His writings are somewhat dry, and as he grew old he developed a pompous manner well suited to the wig and gold cane of a Court physician. I do not know how it happened that a man so learned and dignified came to write, if he did actually write, one of the most touching of English epitaphs. His little daughter Jane is believed to have died soon after his removal to London, and to be buried in Westminster Abbey with this inscription—"Jane Lister, dear child. October 7th, 1688."

KILDWICK.

At Kildwick we have to remark the Lang Kirk of Craven (145 ft.), with the tomb of Sir Robert de Stiveton, or Steeton (1307); the bridge built by the monks of Bolton, to whom the manor belonged, in 1305, but since much altered; and Kildwick Hall, with its shady woods, seventeenth century gables, and terrace gardens. The village and manor of Kildwick formed part of the grant made by Cecilia de Romillé to the monks of Embsay, afterwards of Bolton, who held them till the Dissolution. In the beginning of the sixteenth century the manor was sold to Hugh Currer, with whose descendants it has ever since remained.

Farnhill Hall stands upon a green knoll which projects into the valley just above Kildwick. It commands a good view both up and down the river. The outside of the house is modern, but the shell is of such thickness as to point to its erection in times of danger from foreign enemies. Kildwick was wasted by the Scots in the thirteenth century, and this stronghold was perhaps built as a defence against similar incursions in future.

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* Lister's map was never actually made. The first published map which can be called geological is, so far as I know, the *Atlas descriptif et minéralogique de la France*, prepared by Guettard and Lavoisier, but published under the names of Guettard and Monnet (Paris, folio, 1780).

Very likely Farnhill was once a "peel," or strong tower, into which cattle could be driven, and which would stand a short siege.

Three miles from Keighley, is the little town of Haworth, well-known as the home of the Brontës. Recent changes have destroyed much of the interest of the place.

NATURAL HISTORY OF THE AIRE.

AT Keighley, the first considerable manufacturing industries of the Aire are met with, and this may be a convenient point to introduce some remarks on the past condition of the river. In the old days, the Aire below Bell Busk was a pure though somewhat sluggish stream. As the rhyme says—

> Wharfe is clear and Aire is lithe,
> Where Aire drowns one, the Wharfe drowns five.

The fishes of the Aire, before pollution began, were those of the Wharfe and other north-country streams. The Rev. Miles Gale, Rector of Keighley, wrote a history of the parish in 1710, which has been since printed. Keighley, he says, is midway between Bradford and Skipton, six miles from each (the Rector uses the old customary mile, or rather one of the many local measures which were once recognised). "At the meeting of two brooks, that running a mile farther joins with the river Aire, whose head is twelve miles north-west, at a place called Malham Cove. It affords dares" (otherwise dars or darts—lampreys), "oumers" (umbers or grayling); "minnows, perches, eels, gudgeons, and salmon, when out of season, come up to the town at Michaelmas, when poor people begin to catch them with blazing iron forks. Here are otters, which we suppose to be fed on muscles, because the shells are generally found empty." A copy of the manuscript of Miles Gale probably found its way into the hands of Thomas Gent, of York, who published in 1733 what he called "The Ancient and Modern History of the Loyal Town of Rippon." Bound up with this are descriptions of other Yorkshire towns, among others of Keighley. He says of this place, evidently borrowing from Gale;—

"The town of Kighley is pleasantly situated in a low Valley, surrounded with Hills, from one of which, above Haworth, I have seen

> Pendlehill, Pennigent, and Ingleborough high,
> More large and lofty Mountains none can spy;
> Search we this Realm, our Labour will be vain;
> These, only these, their Honour will maintain.

All of which are within 25 miles. The Town is in the Midway between *Bradford* and *Skipton*, six miles from each; at the Meeting of two Brooks, that, running a mile farther, join with the *Are*, whose Head is 12 miles N.W. at a place *Maum-Cove*. It affords Dares, Graylings, Menards, Bone-stickles, Pearch, Eeles, Gudgeons, Ruff, Chub, Trout, Salmon, and Salmon-Smelts; the former, when out of season, come up the River to spawn, and return into the salt Water again. There is Plenty of Millers-Thumb and Pike, which the River was first stored with by Mr. Tempest's Fish Pond of *Broughton* breaking into the River.

"Here are otters, which we suppose to feed on Muscles, because the Shells are generally found empty."

Mr. J. J. Brigg, of Kildwick Hall, supplies me with the following list of the fishes now found in this part of the Aire :—

Aire above Stock Bridge.

Trout.—Average, a little under ½-lb.; between 2 lb. and 3 lb. not uncommon.

Grayling.—In the upper waters, the progeny of fourteen fish brought some fifteen years ago* from the Wharfe.

Pike.—Small and infrequent.

Perch.—Growing scarcer every year.

Chub.—Large and ubiquitous.

Eel, Tench, Dace.—Practically extinct.

Roach.—Fairly plentiful, and of good size.

Gudgeon, Pope or Ruffe (locally called Prickleback), Miller's Thumb, Loach, Minnow, River Lamprey, Three-spined Stickle-back.

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* (1888).

Aire below Stock Bridge.

Chub.—Mostly very small.

Minnow, Stickleback, Gudgeon, Roach (occasionally).

None attain the size of those above.

Otters are occasionally hunted as low down as Saltaire.

At Esholt, in 1821, a trout weighing 7 lb. was taken by Mr. Crompton. The late Samuel Smith, surgeon, of Leeds, when a boy, used to catch plenty of fish upon the island called School Close; two or three miles higher up he occasionally got a trout; four miles down the river abounded in trout and grayling. Fifty years ago large numbers of fishes were taken at times of flood by the men from the Leeds woollen mills. Large nets, used in the dyeing of wool, were fixed to a long pole, and drawn through the river. This business was very productive, and when a fresh was on the river many men would leave their work to fish.*

THE RIDDLESDEN HALLS.

BETWEEN Bingley and Keighley stand the fine old halls known as East Riddlesden and West Riddlesden. Both are of the seventeenth century, East Riddlesden, the "Old Hall," dating from 1640; West Riddlesden from 1687. Long before this the estate was in the hands of the Paslews, anciently of Potternewton, whose arms were once to be seen in Keighley Church, and are still visible in the church of Bingley. To this family belonged Abbot Paslew, of Walley, who was hanged at his Abbey door for the share which he took in the Pilgrimage of Grace. In the seventeenth century East Riddlesden was bought by John Murgatroyd, of Warley, near Halifax.

John Murgatroyd was living at Riddlesden in 1657, and probably it was he who rebuilt the hall. The Rev. Oliver Heywood, who was conversant with these parts, and often slept at West Riddlesden, says "he was a profane and

* For this fact I am indebted to Mr. James Swales, who speaks from his own recollection.

debauched man, who disinherited his eldest son, Thomas, for marrying Elizabeth, daughter of Robert Savile of Morley," and that his four sons killed themselves by drinking, and died early in life. As they left no issue, the estate ultimately came to Thomas, the eldest son. Of this Murgatroyd, Oliver Heywood says—"He hath lyen several years in York Castle. Making an escape yrons were layd on in low jayle, where they have in process of time eaten off his leg."

The grounds of this imprisonment cannot now be ascertained, but a set of interrogatories put in a Chancery suit, and still extant, give the Murgatroyds' version of the story. It appears that owing to the depreciated character of his patrimony, William, one of the sons of John Murgatroyd, had to apprentice himself to one Nathaniel Spencer, a merchant of Leeds. His uncles, Henry and Thomas, out of sheer kindness, entered into a bond for his good behaviour to the amount of £1,000. The apprentice's conduct was all that could be desired, but at the time that he was loose his master seems to have been in pecuniary difficulties. In order to pacify his creditors for a time, Spencer sued upon the bond against Henry and Thomas Murgatroyd, and refusing to take their bail, had them imprisoned. Whilst in prison, he compelled them to give bonds amounting to £1,900, and straightway put the instruments of distress in force, and obtained the amount out of the Murgatroyd property. Not content with this, he caused them to be arrested for the same debt again, and upon a pretended debt of £3,000, cast them into the gaol at York. Here Thomas was double-ironed, his legs being fastened together for six years, during which the irons were never taken off, nor were his clothes. He and his brother Henry suffered unheard-of misery. At the end of six years there came fresh oppressors, pretending that Spencer owed them £1,000, and was bankrupt for £8,000, and told them there was no hope of release unless they consented to pay £2,000 to them or their assigns. Being almost weary of their lives, and much weakened by long confinement, the Murgatroyds consented to these hard terms. They never regained their property, which passed to a nephew, Edmund Starkie. The

popular belief was that the Aire changed its course to mark indignation at the wrong done to the real owners.*

THE DRUIDS' ALTAR.

ABOVE Bingley is the remarkable sandstone cliff known locally as the Druids' Altar. I need hardly say that there is not the slightest ground for the name which it bears. All tradition as to the Druids in Britain has been cut by the change of race effected by violence in an age which cared nothing for the past. The written history of the order is sadly defective. Cæsar's scanty, but probably exact information was supplemented by the incredible tales of Pliny the elder. Long afterwards arose what must be called the sect of the Druidists. John Toland (1726), Stukeley (1740), Davies (1809), and Herbert (1838) piled up that fabric of learned conjecture which has by this time created a wide-spread popular belief. For the last hundred years people have tried to connect all remarkable stones, whether cliffs, rocking stones, sand-worn pinnacles, menhirs, circles, or cromlechs, with the Druids. The high-born, exclusive, and mysterious order which Cæsar describes, the depository of whatever science, philosophy, or religion was taught among the Celts of France and Britain, is now believed to have haunted rugged solitudes, and there to have practised the rites of prehistoric savages. The Harden Valley, with its beautiful woods, forms one of the prettiest side valleys of Airedale.

THE LOWER COAL MEASURES IN AIREDALE.

THE Geological Survey† include under Lower Coal Measures all the rocks between the Rough Rock and the Silkstone, Barcelona or Blocking Coal, which are believed to be identical. The chief

* These particulars are taken from a paper read by Mr. W. A. Brigg to the Bradford Historical and Antiquarian Society, and published in the *Mercury Supplement*, February, 1888.

† Geology of the Yorkshire Coalfield (Mem. Geol. Survey). By Prof. A. H. Green, R. Russell, and others.

members are (in ascending order, which is also the order in which they occur as we pass down the valley) :—

Sandstones and shales, thickness very variable but under 100 feet.

Soft Bed Coal, a very thin seam, but worked when easily accessible.

Measures, which may include a sandstone (the Middle Rock) and one or more beds of a fine grained, highly siliceous sandstone, known as Ganister.

Hard Bed Coal, resting upon Ganister. The seam is thin along the northern edge of the coal-field, often attaining only a few inches, or even dying out altogether in places, but largely wrought for engine coal and brick burning where it is thick enough to be workable. The roof of this seam is a shale containing Goniatites, Aviculopecten, and other marine shells and fish remains.

Shales, sandstones locally, and sometimes thin seams of coal. Thick sandstones occur in this part of the series in the Bradford valley, at Baildon and at Rawdon. These are represented to the north of Leeds, as at Meanwood, by a shaley sandstone and a bed of Ganister.

The Elland or Bradford Flagstone is a prominent feature of the Lower Coal Measures. Though variable in thickness and quality, it is continuous throughout the whole coal-field, and is recognisable in the Lancashire coal-field also, where it is known by the name of the Rochdale or Upholland Flags. There is no other member of the two coal-fields, now divided by upheaval and denudation, but once continuous, which can so clearly be identified on both sides of the Pennine Range. The Flagstone is of great commercial importance, especially near Huddersfield, Halifax and Bradford. North of Leeds it has been largely worked at Woodhouse, Potternewton and Gipton, The Flagstone constitutes a well-marked feature wherever it occurs, forming ridges and hills which are generally scarred by lines of quarries.

Above the Elland Flagstone come on the valuable coals known as the Low Moor Better Bed, Black Bed, Crow Coal,

Beeston Coal, and the Blocking or Barcelona Coal, which has been shown by the Geological Survey to occupy a place in the series corresponding with that of the Silkstone Coal further south. The Better Bed Coal, though rarely exceeding 18 in. in thickness, is a remarkably pure coal, free from sulphur, phosphorus, and other substances which impair the quality of iron. The high quality of the Low Moor, Bowling and Farnley iron is mainly due to the use of the Better Bed Coal in smelting. This coal has been extensively worked around Low Moor, Wortley, and Farnley, as well as in and around Leeds. The seat-earth of this coal is a valuable fireclay, which is largely worked at Wortley and Farnley. Microscopic examination of the Better Bed Coal has shown that it is exceptionally rich in the spores of Lepidodendron or allied plants, which are rarely so densely aggregated. The Torbane Hill mineral shows the same peculiarity of composition. Near Low Moor the roof of the Better Bed Coal contains many fossils, both animal and vegetable, of great interest and usually fine preservation.

The next important seam above the Better Bed is the Low Moor Black Bed Coal, which lies about 40 yards higher up This is an important second-class coal, often twice as thick as the more valuable Better Bed. It is extensively worked at Low Moor, Farnley, and Beeston. Above the seam, in the shaley roof, occur nodules of ironstone, which have been long worked and smelted. The ironstone contains about 30 per cent. of metal. The Crow Coal is a thin seam of much less value, but yielding abundance of gas, and hence used for the supply of gas-retorts at Leeds. It lies from 12 to 20 yards above the Black Bed.

Above the Crow Coal comes in a sandstone of some importance, the Oakenshaw or Clifton Rock, which has been worked for building stone in many places. A little above this comes in the Beeston Bed, the most valuable in this part of the coal-field, which is extensively worked to the east and south of Leeds, and attains in places a thickness of more than 6 feet of workable coal. Passing westwards the seam divides into two,

the Churwell Thick and Thin Coals, while the Thick Coal again subdivides.

The next seam of importance is the Silkstone, Blocking or Barcelona Coal, which, however, is not of commercial value in the Leeds district. This is regarded by the Geological Survey as the bottom bed of the Middle Coal Measures.

The Middleton Main (somewhat higher in the series and classed with the Middle Coal Measures) is one of the principal seams of the northern part of the Coal-field, and the last which we shall notice here. It is extensively worked at Ardsley, Rothwell Haigh, Middleton and Garforth. The shale roof of this seam contains many remains of fossil fishes, the most remarkable of which are the skulls of the Ganoid fish, Megalichthys, preserved in the Museum of the Leeds Philosophical Society. A still more perfect example of the same fish is to be seen in the Museum, which was obtained from the roof of the Halifax Hard Bed Coal at Idle, and presented by Mr. F. B. Ellison.

The dip of the Coal Measures is in general S.E., and as we descend the valley of the Aire, we pass constantly into higher and higher measures. In the same way, if we follow any particular bed of rock down the valley, we find it gradually sinking, though faults interrupt its regular course. Thus, the Rough Rock forms the summit of Rombalds Moor (1,323 feet) ; its top beds sink to 500 feet at Windhill Crag, near Shipley, and to 200 feet at Apperley (in the cutting near the station). The Rough Rock is then cut off by a fault, but reappears at Horsforth, Kirkstall Wood, and Bramley Fall. The Halifax Hard Bed occurs in the outliers of Baildon (700 feet) and Rawdon 500 feet) ; at Cragg Wood, Apperley, it is only a few feet above the level of the river. The Better Bed Coal has been cut through on the northern side of Woodhouse Moor, and at the Baths in Cookridge Street, Leeds. It was formerly worked in Park Lane, Leeds. The Black Bed crops out at Burmantofts Cemetery, in Briggate and Kirkgate (where it was anciently much worked), in the railway cutting at Wortley Station, and many other places in and

around Leeds. The Beeston seam comes to the surface in Farnley Wood, in the railway cuttings at Beeston and Hunslet, and at Jack Lane Pottery.

ESHOLT.

ESHOLT, known to Leeds ramblers for its beautiful avenue and stately woods, has lost much of its charm within my recollection. Two railways cut through the woods, the elms of the avenue have lost many fine trees by decay or accident, the river and the stream which flow through the glen are both foul with sewage, and high stone walls deface the walk to Guiseley. On the site of Esholt Hall, there once stood a Cistercian Priory dedicated to St. Leonard, and occupied by six nuns. At the dissolution, Esholt was given to Henry Thompson, and afterwards passed (by the marriage of the heiress) to the Calverley family. The house and avenue date from the beginning of the last century. Esholt means Ash-wood.

KIRKSTALL ABBEY.

I have not space to tell here the now familiar story of Kirkstall Abbey. It must suffice to say that Kirkstall was one of the many daughter-monasteries of Fountains, and was first planted at Barnoldswick, but afterwards removed to the pleasanter and more fertile valley above Leeds. It was always poor, in comparison at least with Fountains, and has hence preserved more of the primitive Cistercian simplicity. The tower, which belongs to the last days of the Abbey, is a striking, though common, infringement of the founder's rules, which insisted upon absolute plainness in architecture, furniture, and worship alike. "Turres lapideae ad campanas non fiant, nec ligneae altitudinis immoderatae, quae ordinis dedeceant simplicitatem," say the statutes of 1256; that is, "Stone bell-towers may not be built, nor wooden ones of unreasonable height, so as to detract from the simplicity of the Order."

Leeds and Yorkshire have treated the beautiful fabric of Kirkstall, which no money can ever restore or replace, with savage cruelty. In the early part of the sixteenth century the monks of Kirkstall, little foreseeing what was coming,

were busy with their new tower.* Before the end of the century the Leeds people were carrying away the big stones of the Abbey to build steps to the bridge at Leeds.† The lead was stripped off the roof; the weather was suffered to rot the woodwork and the walls. But mere natural decay deals tenderly with the relics of a past age. In 1769, Gray describes what he saw in these words :—"Kirkstall is a noble building, in the semi-Saxon style of building; as old as King Stephen, towards the end of his reign, 1152. The whole church is still standing, the roof excepted, seated in a delicious quiet valley, on the banks of the river Aire, and preserved with religious reverence by the Duke of Montagu. Adjoining to the church, between that and the river, are variety of chapels and remnants of the Abbey, shattered by the encroachments of the ivy, and surrounded by many a sturdy tree, whose twisted roots break through the fret of the vaulting, and hang streaming from the roofs. The gloom of these ancient cells, the shade and verdure of the landscape, the glittering and murmur of the stream, the lofty towers and long perspectives of the church, in the midst of a clear, bright day, detained me for many hours, and were the truest objects for my glass I have met with anywhere." Since that time what desolation has invaded the quiet ruins of Kirkstall! great ironworks have been set up within a quarter of a mile; the river-banks are turned into cinder-mounds; the Aire, which flows past, has become an open sewer. The recent acquisition of the Abbey by the town of Leeds, a memorial of the generosity of Col. North, gives hopes that the buildings will be more carefully looked after in future.

During the present year (1890) the soil and vegetation which for three hundred and fifty years had been allowed to gather about the ruins have been in great part cleared away, and some architectural features of interest have thereby been brought to

* The initials "W.M." on the buttresses of the tower probably designate William Marshall, Abbot from 1509 to 1528.

† Thoresby found by the churchwardens' accounts that the "greice" found on the west side of the bridge was built in 1583 of stones brought from Kirkstall.

light. There are many of our townsmen to whom the consequent loss of picturesque beauty seems disastrous and almost sacrilegious. It may console some who lament the change which they have witnessed to read the advice given by Sir Walter Scott in the matter of Melrose Abbey, a monument of the past which he regarded with reverence and affection. He recommends thorough repairs, pointing, the closing of fissures, the eradication of every tree and shrub, and the covering of wall-tops with Roman cement or lead. In his judgment effective preservation justified any temporary loss of romantic beauty.*

GEOLOGY OF THE COUNTRY TO THE NORTH OF LEEDS.

THE rocks of this district include the Lower Coal Measures below the Better Bed Coal, and the upper measures of the Millstone Grit. The country is cut across by an important fault, called in the Geological Survey the Weetwood Fault. This fault, which runs in an E.-W. direction through Weetwood Reservoirs, Carr House, Moor Allerton, and Roundhay Park, naturally divides the country into two parts, and it will be convenient to treat of these separately.

Southern Area. The southern portion is bounded on the south by the Wrangthorn Fault, running E.-W. through Wrangthorn, Woodhouse Carr, and south of Harehills. This fault throws up the rocks to the N., bringing the flagstone on the N. side against the shale above the Better Bed Coal. This southern portion is mainly occupied by the valleys of the Meanwood and Gipton Becks. The measures consist of :—

Elland Flagstone.	
Shale	50 feet.
Sandstone	20 ,,
Shale	99 feet.
Ganister	30 ,,
Shale	120 ,,
Hard Bed Coal.	

* Lockhart's Life of Scott. See letter to Lord Montague, April 29th, 1822.

The Elland Flagstone is a fine-grained sandstone, which can sometimes be split into thin slabs. Chapeltown, Potternewton, Buslingthorpe, Gledhow, and Harehills are on this rock. It forms steep escarpments at Headingley, and on both sides of Woodhouse Ridge. It is extensively worked at Potternewton, formerly at Woodhouse and Buslingthorpe. It extends towards the east as far as Roundhay Park, where it is faulted against Millstone Grit to the north, and against the shales above the Black Bed Coal to the east.

The 20 feet sandstone is a poor, shaley rock, which is seen in the steep slope over the stream in Batty's Wood, and forms a slight feature on the other side of the Meanwood Beck.

The Ganister is worked in quarries in the Meanwood Valley. It is a white, fine-grained stone, with Stigmaria, Calamites and other plant-remains. There is a thin seam of coal in it. This rock, after having been crushed to a fine powder, is used for the hearths and roofs of regenerative furnaces. It is extremely hard, and weathers with difficulty.

As we go up the Meanwood Valley we come to measures lower and lower in the series; this is because the rocks dip roughly S.E. Thus at Buslingthorpe we have the base of the Elland Flagstone only 175 feet above sea-level, while at Miles Hill, about a mile further up, it is 360 feet above it. At Buslingthorpe the bed of the stream is formed by the shale below the Elland Flagstone, and at Meanwood Tannery by the shale under the Ganister.

Northern Area. In the northern portion we find the following measures :—

Coal Measures	Hard Bed Coal		4 inches.
	Shale		50 feet.
	Soft Bed Coal		3 inches.
	Shale	(about)	60 feet.
Millstone Grit Series	Rough Rock	(about)	100 feet.
	Shale	(about)	50 feet.
	Sandstone ...	Middle Grits,	20 feet.
	Shale		
	Sandstone ...		

The Halifax Coals are found at Moor Allerton, and are cut off to the north by a small fault. The Hard Bed crops out at an old quarry in King's Lane, close to Chapeltown Road. Here Aviculopecten and Goniatites have been found. The outcrop of the Soft Bed is about a quarter of a mile further north.

The Rough Rock is a coarse sandstone, sometimes a conglomerate. When freshly quarried it is soft, but rapidly hardens on exposure. Kirkstall Abbey and some modern buildings in Leeds are built of it. This rock runs in a thin strip, mostly about quarter of a mile broad, in an E.-W. direction through Weetwood, Meanwood Wood, Alfred's Monument, the south part of Moortown, and the north part of Roundhay Park. The sandstone next below this (top sandstone of the Middle Grits) runs in a broad and broken band to the north. It may be found at Scotland Mill, the Seven Arches, Adel Crag, Shadwell Grange, Wigton, and Scarcroft. This is a whitish, crumbling rock, with some fossil plants in it. To show how the rocks slope upwards in a northerly direction, we may notice that N. of Alwoodley Crag Plantation, the base of this sandstone is 525 feet above sea-level, and at Scotland Mill, a mile further south, it is only 250 feet. Underneath this sandstone is a hard black shale in which are to be found many marine shells, as Goniatites, Orthoceras, and Aviculopecten, beside Fish-remains and Calamites. A great deal of this shale was recently brought to the surface in making the Blackmoor Tunnel, between Eccup and Weetwood Reservoirs, at a shaft half a mile to the N.E. of the Seven Arches. Under these beds are sandstones alternating with shale.

Two small patches of Magnesian Limestone occur to the N.E. of Leeds. One is about a mile east of Roundhay Park; the other is south of Scarcroft.

LEEDS.

LEEDS is situated on the river Aire and in the West-Riding of Yorkshire (53° 45′ N. latitude; 1° 35′ W. longitude). At he time of the first census, in 1801, it contained 11,599

houses, and 53,162 inhabitants. In 1881 the population was 309,000; in the middle of 1890 the number is estimated at 363,799. The rateable value (March 25th, 1890), is £1,253,333. The annual rainfall is about 25 inches (average at Holbeck, 1870-9); the ratio of actual to possible sunshine, based upon observations collected by the Leeds Philosophical and Literary Society, varies from 19 per cent. in the heart of the town to 24 per cent. at Headingley, and 25 per cent. at Lawnswood Cemetery. The death-rate for the quarter ending June 28th, 1890, was 21·2 per thousand. The debt of Leeds on March 25th, 1890, was £4,561,000; £12 10s. per head.

The History of Leeds and the chief Industries are described in special sections of this hand-book.

Among the citizens of Leeds, whose memory is held in honour, are the benefactor John Harrison, the antiquary Ralph Thoresby, John Smeaton, and Joseph Priestley.

John Harrison was born in Leeds in 1579, and inherited considerable wealth from his father, a Leeds merchant. His time and money were from an early age devoted to the public service, and to good works. In 1621, when the town received its first charter of incorporation, Harrison became Mayor, and served the office twice afterwards. St. John's Church was built and endowed by him in 1634. He re-built the Grammar School, and founded a Hospital for widows.

Ralph Thoresby was born in Leeds in 1658. He followed, not very successfully, his father's trade, and dealt in cloth and other commodities. But business was not the real work of his life. The foundation of a museum, dispersed after his death, and the compilation of two topographical works, the *Ducatus Leodiensis* and the *Vicaria Leodiensis*, were the chief results of his long and industrious life. Thoresby's Diary is of at least equal value with his more elaborate writings, and his mention of many small items in his daily life has been serviceable to the historian. He contributed papers to the Philosophical Transactions on the Roman antiquities of his own district, and was

admitted to the Royal Society in 1697. He died in 1725. Thoresby's books contain materials invaluable to the Leeds topographer, but they are not to be used without some degree of caution. A Society, lately founded to collect and preserve objects and facts relating to Leeds and its history, bears the name of the Thoresby Society.

John Smeaton was born at Austhorpe, near Leeds, in 1724. His strong bent to the mechanical arts appeared in boyhood. His father meant him to follow the law, but this did not answer, and Smeaton took to the business of a maker of mathematical instruments. In 1759, he received the Copley medal for a paper on wind and water-mills. Smeaton now became a civil engineer, and was extensively engaged in river-navigation, drainage, bridge-making, and harbour-construction. The story of the Eddystone lighthouse, of which Smeaton was the architect, is widely known. He died at Austhorpe in 1792, and is buried in the neighbouring church of Whitkirk.

Joseph Priestley, theologian and scientific discoverer, was born in 1733, at Birstal Fieldhead, about six miles from Leeds. He was educated in several dissenting schools, and became tutor at Warrington in 1761. Here he wrote books on many subjects, such as education, the history and laws of England, &c. In 1766, he was elected to the Royal Society, and by the advice of Franklin, wrote a History of Electricity, which was published in 1767. During the same year he removed to Leeds as minister of Mill Hill Chapel. His house adjoined a brewery, and Priestley was led to study the gas evolved from the vats. He investigated the solubility of carbonic acid in water under pressure (soda-water), and proved that the same gas is produced by burning or respiration in air, but removed in the presence of sun-light by green leaves. Priestley also discovered carbon monoxide, nitric oxide, hydrogen chloride (after Cavendish), and showed that the last-named gas contains hydrogen, but no oxygen. He discovered that air diminishes in volume by one-fifth when acted upon by sulphur and iron filings. In

1772, Priestley received the Copley medal of the Royal Society, and published his "History and present state of discoveries relating to Vision, Light, and Colours." Next year he left Leeds to become librarian to Lord Shelburne, and in 1780 he removed to Birmingham. Among his discoveries during this part of his life, the chief are gaseous ammonia and its decomposition by the spark, nitrous oxide, oxygen (August 1st, 1774) and its action upon blood, nitrogen tetroxide, hydrogen fluoride gas, and hydrogen phosphide. He made experiments upon the passage of gases through moist membranes and porous plates, and upon their co-efficients of expansion. He investigated the action of scents upon air, the composition of "finery cinder," and its use in the manufacture of malleable iron. In 1791, Priestley wrote fourteen letters in answer to Burke's Reflections on the French Revolution. A loyalist Birmingham mob, excited by political fury, destroyed his meeting-house and wrecked his dwelling. Priestley fled to London. The loss of his papers and apparatus, and the ill-feeling which had been roused against him, brought his scientific career to an untimely close. He removed to Hackney, withdrew from the Royal Society, and in 1794 sailed for America. In 1804 he died at Northumberland, in Pennsylvania.

THE VALLEY BELOW LEEDS.

TEMPLENEWSAM, which overlooks the broad valley of the Aire a little below Leeds, was long ago an estate of the Knights Templars, a military order, sworn to celibacy and to the recovery of Jerusalem from the infidel. When the Order was dissolved, the manor passed by Royal grant to the Darcies. In Henry VIII.'s time Lord Darcy, who held Pontefract Castle for the King, surrendered to the Pilgrims of Grace, whom he at once joined. The estates were accordingly forfeited to the Crown. Twice after this Templenewsam was granted to fortunate courtiers, the second of whom, the Duke of Richmond, sold it to Sir Arthur Ingram. Sir Arthur was the son of a

wealthy London citizen. He bought other Yorkshire lands also, and established himself in the county during the reign of James I. He pulled down the old house almost completely, and built himself a large brick mansion, forming three sides of a quadrangle. The numerous bays, the wide mullioned windows, the carved Italian doorway, and the inscribed battlements are characteristic of the age. The inscription reads—"All glory and praise be given to God the Father, the Son, and Holy Ghost on High. Peace upon earth; good-will towards men. Honour and true allegiance to our gracious King, loving affections among his subjects. Health and plenty within this house."

The son of the builder of Templenewsam took the side of the Parliament in the Civil Wars, and is said to have been carried into Pontefract Castle by a party of plunderers, who seized him in his own house, nor could he regain his liberty until he paid £1,500 as ransom.

Methley Hall, once the seat of the Watertons, and afterwards of the Saviles, is the most stately mansion below Leeds. It was rebuilt in Queen Elizabeth's reign by Sir John Savile, Baron of the Exchequer, and brother to the more famous Sir Henry Savile, Provost of Eton, and Warden of Merton. The present front is modern, but the fine old hall, with its dais, remains. The church at Methley contains the monuments of Sir Robert Waterton, Lord Welles, slain at Towton, and Sir John Savile, founder of the family. Can any local antiquary tell us where is the history of the Saviles written by Sir Henry Savile? Does it contain any account of the feud between the Saviles and the Pilkingtons? "In the first half of the seventeenth century," says Canon Raine, "I find the witnesses every now and then counting time, not from the accession of Henry VIII., or from some one of the conspicuous incidents in his too conspicuous reign, but from an affray which took place between the Saviles and the Pilkingtons. One man says that he had good reason to remember it, because his father was then killed; another says that he brought away from the encounter an arrow sticking in his

arm,—a little souvenir of the day which he was not likely, I think, to forget." *

Ledsham and Ledstone are associated with the memory of Lady Betty Hastings, a noble friend to learning, whom many in her own day and ever since have remembered with gratitude and honour.

Castleford, the Legiolium of Antoninus, occupies the junction of the Aire and Calder. Here the Rudgate, or Roman road southward from Isurium, crossed the Aire.

Birkin, about a mile north of the Aire, between Castleford and Selby, is interesting from its beautiful Norman church.

Howden hardly belongs to Airedale, lying, as it does, beyond the Ouse, though very near the junction with the Aire. The church is one of the finest in Yorkshire. The choir and chapter-house are in ruins, but still preserve features of their ancient magnificence. From the top of the tower, which is 135 feet high, a wide view is got of the flat plain through which the Aire and the Ouse, now tidal rivers, roll sluggishly to the Humber. The tide formerly came up to Knottingley Mill Dam, about eight miles higher than at present.

It has become a point of ancient history to note that the Don used to enter the Aire at Snaith. Its waters are now delivered into the Ouse at Goole by the Dutch river, which commemorates the nationality of Vermuyden and many of his workmen, who undertook the work to save much valuable land from inundation. It was completed about 1630. The old channel can still be traced.

EXTINCT QUADRUPEDS OF AIREDALE.

In the year 1852 there were found at Wortley, in a brick-field belonging to Messrs. Longley, of Leeds, a number of bones of large animals. Among these were a nearly complete skeleton of the hippopotamus, besides bones of the mammoth and wild ox (*Bos primigenius*). The same animals have been met with elsewhere in Airedale (for instance, in a deep fissure

* Yorkshire Architectural Journal, Vol. I., p. 21.

at Raygill near Skipton), and belong to the old prehistoric fauna of Britain. These big creatures have met the fate which commonly befalls animals formidable to man—they have become extinct, or have been driven to take refuge in uninhabited wilds. It is true that in Britain we have no distinct proof that the elephant and hippopotamus and rhinoceros were exterminated by man ; but the whole record of the disappearance of large post-tertiary quadrupeds is very significant. They can be traced down to the time when the works of man began to show themselves, and then begins a sweeping destruction, which is not the effect of any change of climate, for it affects only the dangerous species. If we attempt to picture to ourselves the valley of the Aire as it was when human eyes first scanned it, we must clothe the hills with wood, and choke the broad flats with swamp ; we must bring back the bear, the wolf, the hyæna, the lynx, the lion, the reindeer, the great Irish elk, the bison, the rhinoceros, the hippopotamus, and the elephant. All of these have occurred in Yorkshire ; and as well as we can judge from evidence which is necessarily fragmentary, all came down to the human period. Though direct proof of the manner of their disappearance is not to be had, the savage man of prehistoric Europe labours under a strong presumption of being concerned. At any rate, the big quadrupeds now extinct were last seen in his company.

STATISTICS OF THE RIVER AIRE.

Length from Malham Tarn to Howden, direct	58 miles.
,, ,, along the river	90 ,,
Area of basin of river above Castleford ..	342½ sq. miles.
,, ,, below Castleford ..	85½ ,,
Total Area..	428 sq. miles.

Area of chief geological formations in Airedale :—

Mountain Limestone, &c.	95 sq. miles.
Millstone grit	137½ ,,
Coal Measures	110 ,,
Magnesian limestone	30 ,,
New red sandstone and river alluvium ..	55½ ,,
	428 sq. miles.

The annual rainfall may be estimated at 20 inches for the lower section of the basin (180 square miles), which amounts to about 233,000,000 tons, or about 52,000,000,000 gallons ; and at 35 inches for the upper section (248 square miles), equivalent to about 561,000,000 tons, or nearly 126,000,000,000 gallons. The total is 794,000,000 tons, or 178,000,000,000 gallons, of which about three-fourths are supposed to evaporate, leaving over 198,000,000 tons, or over 44,000,000,000 gallons as the yearly discharge into the Ouse. In the Thames basin it has been calculated that one-sixth of the rainfall forms springs, one-sixth passes off as flood water, and two-thirds are evaporated ; while in the basin of the Lea, nearly four-fifths are said to pass off by evaporation. The gradients and the proportion of rocky ground in Airedale are somewhat more favourable to the discharge of the rainfall by streams. The total annual rainfall of the Aire basin would fill a rectangular reservoir a mile square, and 341 yards deep. A similar tank to hold the annual rainfall of the Thames valley would be a mile square and two and a half miles deep.*

Our information respecting the mineral substances dissolved in the waters of the Aire is as incomplete as our knowledge of its organic impurities. At Malham and elsewhere on the Mountain Limestone tract, the water contains about twelve grains of limestone to the gallon (third report of Rivers Pollution Commission, 1867), while the water of the Millstone Grit tract contains much less. Some springs and brooks of the Millstone Grit are, indeed, practically free from carbonate of lime. The water of the Coal Measures is liable to contamination with iron, but in general it is tolerably soft, sometimes distinctly alkaline. Magnesian limestone yields a hard water. Even the limestone waters of Yorkshire fall far short of the hardness of chalk springs, which often contain more than twice as much carbonate of lime. The Thames contains about fifteen grains of carbonate of lime per gallon, the Severn only six-tenths of a grain.

* A gallon of water occupies a little less than two square feet by one inch, and weighs 10 lbs. An inch of rainfall amounts to 101 tons per acre, or 64,640 tons per square mile.

The solvent action of water charged with carbonic acid is a wasting agent of importance in Upper Airedale, as in all limestone countries. Suppose that a river 60 feet wide and 4 feet deep contains 12 grains of carbonate of lime per gallon, or 75 grains per cubic foot, and that it flows at the rate of 3 miles per hour: it will carry down in a year 159,400 tons of carbonate of lime, or 2,000,000 cubic feet of solid rock, equal to a cubic block measuring 126 feet along each edge.

The Aire is navigable to Leeds, the first Improvement Act dating from 1698. When the navigation was first projected, it was thought enough to make a channel 3 feet 6 inches deep; the locks were 60 feet long and 15 feet wide. Now the locks are 215 feet long and 22 feet wide, and there is 9 feet of water upon the sills. Vessels of 167 tons can ascend to Leeds, where the Leeds and Liverpool Canal joins the Aire. The canal takes vessels of from 45 to 50 tons.*

* These particulars are given by Mr. W. H. Bartholomew, in his evidence before the Select Committee on Canals, 1883.

CARBONIFEROUS ROCKS
IN
THE UPPER AIRE VALLEY,
AND THEIR PHYSICAL HISTORY.

By R. H. Tiddeman, M.A., *of the Geological Survey.*

During the last few years these rocks in this area have been mapped in considerable detail by the Geological Survey, and the results which are coming out seem likely to throw much light upon the physiography of Carboniferous seas and perhaps upon the genesis of some limestones of other ages.

It was always a puzzle to those geologists who knew the ground how it came to pass that the well-known and very persistent series of the several limestones of the Yoredale Beds ran with such regularity over the great area of the Yorkshire dales and yet were not recognizable over the area of Bowland and the southern part of Craven.

Until the area of which we now speak was carefully surveyed, it was assumed that there was a rapid transition of type in the Carboniferous Rocks between Clitheroe and the big fells north of Settle and Malham, but as to the cause of such a rapid change no explanation was forthcoming. Even Professor Phillips, who knew the country perhaps best of any among the old pioneers of Geology, often expressed himself to me as quite unable to account for it. If there is one thing more clearly brought out than another by the mapping in detail of this ground, it is this, that there is absolutely no transition from one type to the other. The two types run unchanged in their respective areas and with complete discordance with each other, quite up to a common boundary where the differences are rather accentuated than smoothed down. They might be Jews and Samaritans, agreeing in nothing save a common boundary to their territories and a determination to have nothing to do with one another.

The line of demarcation is given by the Craven Faults, and more particularly by that which runs by the South End of Malham Tarn and that which passes between Malham Cove and Malham.

With these preliminary remarks we may introduce a table showing the rocks in the two areas and their principal divisions and thicknesses.

TABLE OF THE CARBONIFEROUS ROCKS IN CRAVEN.

Southern or Bowland Type.	Feet.		Feet.	Northern or Yoredale Type.
COAL MEASURES (Ingleton)	1,500	+	...	COAL MEASURES } Incomplete near the faults in this area.
MILLSTONE GRITS	3,900		...	MILLSTONE GRITS }
BOWLAND SHALES	300-1,000	} The great Craven faults.	400-900	YOREDALE SERIES.
PENDLESIDE GRITS (inconstant)	0—250			
PENDLESIDE LIMESTONE (with Knoll-Reefs)	0—400			
SHALES, with Limestones	2,500		400-800	THE CARBONIFEROUS LIMESTONE (with conglomerates at base).
CLITHEROE LIMESTONES (with Knoll-Reefs)	+3,250	+		
	No base.			

The rocks on both sides of these faults seem to have been formed on slowly subsiding areas, but the Bowland area appears to have been subsiding more quickly and to a greater extent than the area occupied by the Yoredale type. It represents the downthrow side of the faults. The other side of the faults of course is relatively an upthrow.

The question next arises: When did these earth-movements take place?

We know that some of the movements have occurred since the deposition of the Permian rocks, because these have in

places, near as Ingleton, been tilted up at high angles thereby; but we also know that a far greater part of them were going on before the Permian rocks were deposited, because these lie at different places by unconformity on all the members of the Carboniferous—a series which shows near Burnley a vertical thickness of three miles of rocks without base or completed top. The movements necessary to subject so great a thickness of rocks to denudation in all its members before the advent of the Permian epoch must have been enormous. We may, therefore, well believe, and indeed can hardly doubt, that the crust was subjected to great movements during Carboniferous times.

When further we consider how great is the discrepancy between the rocks of the two areas in series and in thickness—that the Craven Faults form the boundary, and that a sharp one, between them—that these two series proceed from that boundary with scarcely any change, one as far as the Tyne, and the other to the western limit of the Carboniferous Rocks on the seaside plain of Lancashire—that the greater thickness is on the downthrow side of the Faults—if we take all these points, I say, into consideration, it is impossible to come to any other conclusion than this :—

That the Craven Faults were to a very considerable extent going on during the formation of these rocks and that they are responsible for the lack of agreement between the two series which were being simultaneously deposited in the two adjacent areas.

This appears at first sight to be a rather large subject to be introduced into a description of the small valley of the Upper Aire, but it so happens that it was this valley in the neighbourhood of Malham together with the adjacent country on either side, along the faults westwards to the Ribble and eastwards to the Wharfe, which gave the key to unlock the mystery to which I have alluded. I had long suspected that these faults had been at work in Carboniferous times, but until this particular piece of ground lately fell to my lot to map, the actual demonstration was wanting. I then not only found my suspicions confirmed, but the uncompromising nature of the

two adjacent types set forth in a manner most unmistakeable.

If we are driven to the conclusion that the movements of the Craven faults and the consequent alterations of conditions of deposit were the causes of the two distinct series in the areas north and south of the faults, several interesting questions arise. We may expect that on the downthrow side we shall get a series of deposits of which a greater portion has been formed under deeper water conditions than we shall find on the upthrow, or rather lesser downthrow, side.

Though doubtless the movements proceeded by fits and starts, and were not always at uniform rates, still there will be a greater number of beds representing deep water conditions than shallow, on the downthrow side. And conversely on the other side there will be more beds representing shallow than deep water conditions.

If we can ascertain which beds are which, we shall be able to get a juster notion of the relative rate, duration and extent in depth of the several successive movements which combined have brought about the final results. *Relative* only, for so far we have no positive scale to give us either the rate of the earth movements or of the formation of the deposits whose character was dependent on them.

There is in the first place much presumptive evidence to be gained by consulting the Table of Rocks by any one who has a little personal knowledge of them. For instance, let us take (on the shallow side) the Carboniferous Limestone, 400 ft. It is nearly all a whitish or light crystalline limestone. Shales are seldom seen in it or are very thin. On the deeper side this is represented by Pendleside Limestone 0—400 ft., Shales with Limestone 2,500 ft., Clitheroe Limestone 3,250 ft. Of these three the first is very variable in thickness and sometimes absent ; the second consists much more of shale than limestone, and its contained limestones are often, in fact usually, very impure, besides being untraceable for any distance ; and the third, the Clitheroe Limestone, includes great thicknesses of shale. Then to go higher. The Yoredale Series on the shallow side contains

many beds of pure limestone, persistent for the most part throughout the area. The Bowland shales on the deeper side contain no limestones at all.

What is the general result to be gleaned here? This: that in the shallower waters the limestones predominate, in the deeper waters the shales and mud.

But we must be cautious; all limestones are not shallow-water deposits; all muds are not deposited in deep waters. There are differences in limestones, and we are enabled to determine that some of them are of shallow water formation and others probably made at greater depth.

There are two very distinct kinds of limestone in the country on the downthrow side of the faults—the black, or blue as it is often called, and the white or light coloured limestone. They not only distinct in lithological character but in bedding and general arrangement, as well as in their form in the mass, and the character which they give to the landscape. The black limestone is always well, evenly, and usually thinly bedded, and contains shaley partings. The strike, except in a contorted country, is generally very regular and continuous. On minute examination this rock is found to be full of Foraminifera, and fragments of other organisms in a state of disintegration, though perfect fossils of certain kinds frequently occur in it. It would be called by a geologist a distinctly well stratified rock; it gives good regular features along its strike, and extends over wide areas.

The white limestones south of the faults, on the other hand, are notable for their comparatively massive character and irregular bedding. They occur sporadically, rising into big mounds of conical form which usually rest on the black limestones. They contain great quantities of Cephalopods, Brachiopods, Lamellibranchs, Gastropods, Corals, etc., and these are often in a wonderfully perfect state, and, from the way in which they compose the rock, appear to have lived and died on the spot.

The general structure of these big mounds, or Knoll-Reefs, as I have called them, is very peculiar. They do not obey the

rules of dip and strike which are usually found to obtain in ordinary parallel-bedded deposits, and any one seeking to apply these rules to them in mapping will be landed in numerous puzzles and difficulties. When, however, from the examination of several of them, the general structure is once mastered, their peculiar forms soon become easy of comprehension. Where they are quite perfect, a condition in which weathering has seldom left them, they are seen to consist of a flat top, the dip of which usually agrees with that of the other rocks of the country around in direction and angle of dip, and steep sides all round, the dip of which is away from the centre of the hill. This dip averages 30° to 35°, but may be much higher or lower, in proportion as the dip of these flanking beds is increased or lessened by the general dip of the country round. The dip of the flat at the top is a plane of deposition, which was once horizontal. The dip of the flanking beds represents on the other hand an *original angle of deposit*, plus or minus any subsequent tilting by movements of the crust.

In other Knoll-Reefs, which have been cut into by weathering or quarrying, we find that the beds within, though sometimes obscure, present the usual dip of the country, but following them outwards we find them running into, and continuous with, the flanking beds.

It is pretty obvious from their structure that the internal beds represent successive layers, limited in their area, of growths of organisms, and that they pass into steeply-shelving banks of similar *débris* lying on the flanks of the knoll at an angle of rest. The study of the fossils composing these respective beds quite confirms this idea.

From these and other considerations, which would be too long to enter into here, there can be very little doubt that the mounds, or knoll-reefs, have been formed in a similar way to coral-reefs, by growth upwards under favourable conditions of the animals of which they are composed, and by the piling up by waves, perhaps also in some places by winds, of the resulting débris. This has no doubt been going on upon a slowly sinking area, and it is a remarkable fact that none of these mounds so

far have been found except on the sinking area on the down-throw side of the Craven Faults.

It is evident from facts collected in this area that large portions of those reefs, if not all successively, have been exposed to the wash of the waves between wind and water, as is the case with coral-reefs. Breccias composed of fragments of limestone, mostly sharply angular, some more rounded, and others, less frequently, worn into pebbles, have been found abundantly in many places. In some cases the breccia forms part of the inner beds of the reef; in others it is well developed in the flanking beds; and elsewhere we find beds of breccia formed on the sea bottom adjoining the reef, and inter-bedded with the lowest beds of shale accumulated on the sea bed from which the knoll has grown up.

Here then we have good evidence of these white limestones having been formed in shallow water, so shallow that the breakers could play upon, break up, and re-arrange them on the shore platform above, or consign them to deep water below.

Furthermore, some of the white limestones in certain places present phenomena which suggest that they have been formed, or rather re-constructed from calcareous débris, by wind-drifting, or have at any rate been consolidated in the open air, but as this matter is still under examination, I must postpone any further remarks on this part of my subject.

Although the white limestones, from their sporadic distribution, their physical structure, and their material, are evidently, if not coral-reefs, something formed in a kindred way, the black limestones show marked contrast to them in every way, and evidently have had a totally different origin. Most of these black limestones, which to the eye appear to be structureless, are found, when sliced and examined by the microscope, to be to a very large extent made up of Foraminifera and fragments of other organisms in a state of minute disintegration. Not that there is altogether a lack of larger and more perfect specimens, but these are not nearly so abundant as in the white limestones. Then the strongly marked bedding, so regular and

parallel, the frequent alternations with thin beds of shale, and the wide and uninterrupted spread of these deposits, are all suggestive of deposition in waters which were not shallow, and in which similar conditions prevailed over wide areas.

Without going further into the evidence here, we may say that it is highly probable that the black limestones are successive floors of the ocean bed of Carboniferous times, and that the white limestones are the islands which dotted its surface.

These conclusions are derived from minute examination of a wide area, and it now remains to apply them to a part of it, the Upper Aire Valley. The portion of the Aire Basin which I propose to allude to is that N. and N.E. from Skipton, containing the head waters of the Aire from Malham Tarn downwards and its tributaries, Winterburn Beck, Flasby Beck, Linton Beck, and Skipton Brook.

Limestones from Malham Cove Southwards.

If we take these areas in order from the South, as seen in one-inch maps, 60 and 61 (New Series) of the Geological Survey, we shall find that, after leaving that portion of the valley which cuts the Millstone Grit Series with its escarpments, we have (1) a great anticline which runs E.N.E. and W.S.W. from Skipton, passing by or near Bolton Abbey; next (2) a syncline of which the centre lies near Gargrave, and which brings down in its fold the Millstone Grits along a line from Flasby Fell, or Sharp Haw (pronounced Sharpa), to the Wharfe at Bolton Strid. (3) North of this comes another anticline, marked by the limestones running from near Otterburn to Grassington, also on the Wharfe. (4) A lesser anticline runs out from this, budding off as it were from it on the North, near Airton, and this is succeeded by (5) A small syncline lying just south of the village of Malham.

We have already stated that the white limestones are only sporadic in their distribution. We may also state that they occur on at least two, and probably more horizons. Referring to the Table of Rocks, we may say that they occur both in the Clitheroe Limestone and in the Pendleside Limestone. They

are far more abundantly distributed on the former horizon in the Clitheroe District than in this northern part. On the other hand they are commoner in this part on the horizon of the Pendleside Limestone than on any other.

The great anticline of limestone so much worked near the Leeds and Liverpool Canal to the north east of Skipton at Haw Park and Skibeden is mostly of black limestone. It is probably of the same horizon as the Bold Venture Quarries at Chatburn, and certainly belongs to the Clitheroe set of Limestones.

The big patch of limestone extending from Otterburn by Winterburn and Hetton to Rylstone, is on the Clitheroe horizon, and is all of the black limestone, except a small patch on its surface at Haw Crag Quarry, above Bell Busk, where the limestone has a decided reef character, and perhaps also on the hill east of Winterburn, but this is more doubtful. This anticlinal area of limestone shows a thickness of upwards of 2,000 ft. without a base.

Limestones of reef character also occur near Pot House and Holmes Gill Green, but they are much disturbed, and cannot be regarded as typical examples of reef-knolls. They also probably belong to the Clitheroe limestone series. The Pendleside Limestone in this area shows the most perfect and typical examples of reef-knolls.

The Pendleside Limestone is separated from the Clitheroe Limestone below by a thickness of 2,500 or 2,000 feet of shales with impure limestones and mudstones, which may be seen in the Winterburn Valley, in the Aire Valley from Newfield Quarry to and beyond Kirkby Malham, east of Rylstone, and in other places.

The great interest attaching to them lies in their approaching with this thickness so near to the faults in this area, though entirely absent to the north of them. The range of the Pendleside Limestone may be followed on the maps without much difficulty. It crosses the Aire Valley between Kirkby Malham and Malham. A good section of it with beds of reef character may be seen on the east side of the stream here.

A little further south and on to Calton it is much contorted and also faulted. From this village eastwards it is much concealed by drift, but shows again with sections of great interest at the Winterburn Reservoir. Here we have black, well-bedded limestone surmounted by white reef limestone with little bedding, but the upper sloping surface of it as seen, or lately seen, in the dam of the puddle trench, consists of a close breccia of angular fragments of limestone. The Bowland shales in Calfgill (or Way gill, one-inch map) hard by are full of beds containing fragments and pebbles of limestone, and even large detached boulders are found in them. These interesting sections will unfortunately be drowned in the waters of the Reservoir.

To the East this limestone is only obscurely shown for some distance, but it swells out again into bigger dimensions at the great long knoll of Swinden, and on the other side of a peaty swamp, containing a trough of Bowland Shales, is conspicuous in a wonderful assemblage of knolls, bearing the names of Skelterton, Carden, Butterhaw, Stebden, Elbolton, and many others, running by Burnsall to the Wharfe. Elbolton and Stebden are extremely fine and conspicuous examples, Stebden in particular rising high towards the Grit Fells, and showing well the quaquaversal dip of its flanking beds. Skelterton appears rather to exhibit a section of the internal economy of a knoll, showing great stools of coral running in beds, the interspaces being filled up with crinoidal remains.

As we trace these beds away on the south side of the anticline they lessen much in feature and thickness, so much so that we cannot follow them with certainty beyond Flasby. On the north side of the Skipton anticline, however, they come in on the same horizon, and may be traced for some miles, exhibiting in places a decidedly brecciated character.

The well-known Draughton Limestone on the south side of that anticline, so popular as an instance of a contorted limestone, is seen on weathered surfaces to be made up of breccia in some of its beds, a fact which I believe has

hitherto escaped notice. This is well seen also in a quarry close to the right side of the road, where there is a lime-kiln, on the way from Skipton, just before getting to Draughton.

The general arrangement of the Pendleside Limestone in this area is a dark, well-bedded limestone below, with white crystalline limestone above ; where thin, the latter often consists of a breccia, but where thick, it grows into great knolls; and these appear to increase in size and frequency in proximity to the Craven Fault.

We started to follow the range of the Pendleside Limestone in the Aire valley, between Malham and Kirkby Malham. To resume it there :—we find that it dips to the north and disappears beneath the Bowland Shales, which are seen in several places, but this is only for a short distance, for it rises quickly again and forms those two great knolls between which the village of Malham snugly nestles. Then comes the fault, not very clearly seen in the river course, then Malham Cove, and further east Gordale Scar, two of the grandest features of the district.

Breccias of fragments of limestone occur in the lower part of the Bowland Shales in ascending Tranlands Beck where the first little stream joins it from the north, and still better are they seen higher up the same little gill, near the " M " of Malham on the one-inch map, close to " Heads Barn."

Further to the south and west good exposures of these beds may be studied in the Gill a few hundred yards above Pott House, and a greater thickness in Newton Gill about a mile east of Long Preston. East of Malham we have already alluded to breccias at Winterburn Reservoir. They occur also between Carden and Elbolton Knolls, and in two or three places beyond the village of Thorpe in the Wharfe valley. At these localities they are all in Bowland Shales.

If we ascend to the top of the crags above Malham Cove, we soon find ourselves upon the great plateau of the Mountain Limestone proper. This, though broken at the foot of Malham Tarn, by the North Craven Fault, which throws up

its base, and shows us how thin it is, and crossed by many minor faults, is one and the same as the great spread of Mountain Limestone which lies beneath all the Yorkshire dales and extends north to beyond the Tyne valley. We have crossed the Fault, and in so doing have exchanged the Clitheroe or Bowland series for the Yoredale type, and if we could realise the state of affairs when these rocks were forming, we should probably say that we had left a deep sea dotted with islands and come on to a wide and long and shallow reef.

The long history of that reef and its denizens from its early foundation on a slowly sinking plateau of slate rocks, to its last phase when the animals which lived on it, and formed it, had to succumb to conditions fatal to their existence, the recurrence oft-repeated of favouring or fatal environments, the movements of submergence and emergence connected therewith, the set of tides and currents, the transport of material, these and many other matters may be read in the Mountain Limestone and Yoredale Series, but as yet they are written only in the rocks.

THE HISTORY OF LEEDS.

By Prof. C. Ransome, M.A.

Any interest which attaches itself to the borough of Leeds, depends almost entirely on its being a centre of manufacturing industry. In all the qualities which constitute historical attractiveness, Leeds is notably deficient. It has not, like York, the prestige which attaches to the capital of an ancient kingdom: nor is it dignified, like Durham, by the presence of a glorious cathedral. There are here no such examples of Norman fortification as Newcastle possesses, nor such relics of Roman civilization as form the attraction of Bath. It is not like Nottingham or Exeter, a type of ancient municipal life, nor was it like Lincoln or Oxford, a great centre of mediaeval traffic. It has neither castle, monastery, nor port. No Parliament ever sat within its borders, no great assembly of mediaeval ecclesiastics ever gathered to its church, no mighty hosts ever choose Leeds as the battle-ground, in which to decide the destinies of a nation. On the contrary its life has always been in the strictest sense provincial, and yet, only an imperfect view of the development of England can be gained without taking account of the changes which have made the growth of such a place as Leeds a possibility.

The site of old Leeds, now lost among a wilderness of suburbs, each of which, as its turn comes, is being absorbed by the ever growing town, is to be found in a quadrangular space situated on the north bank of the river Aire and in a fork made by that river with a tributary now called Sheepscar Beck, which joins the main stream from the north in the neighbourhood of the parish church. This is the true Leeds, the memory of which is preserved by the phrase "going into Leeds" still used by the inhabitants of the suburbs, and it is possible even yet to be asked the way to Leeds within a couple of stone-throws of its Town Hall. Anciently, however, the

name Leeds appears to have been used, not of a place, but of a district, so that here, as in the case of Kendal, a district name has been restricted to the site of its chief town. The site of old Leeds town measures along each face some four hundred yards or more, and is divided into two oblong portions by the Briggate or Bridge road, which leads down to the site of an ancient bridge over the river Aire. The suitability of this place for a settlement is marked by a strong situation between two streams, and by proximity to an ancient ford which was afterwards superseded by the bridge.

Whether Leeds was ever the site of a permanent Roman settlement, is uncertain. There was a Roman station at Ilkley ; Roman remains have been found at Adel and Roundhay, and in the time of the antiquary Thoresby, who lived in Leeds from 1658 to 1725, there were remains of a very large camp (probably Roman), on the eastern side of the Sheepscar Beck, but there is no satisfactory evidence to prove that the town of Leeds itself owes anything to the Romans. Indeed, until the compilation of the Domesday Book, its history is wholly uncertain, for the name never found its way into the Saxon Chronicle, and though Bede mentions the district of Loidis, he never speaks of Leeds itself. With the Domesday survey, however, we come upon firmer ground. The surveyors' report shows us, that in the time of Edward the Confessor, Leeds was divided into seven manors, held by seven thegns, a very curious tenure, and that it was then somewhat larger than any of the neighbouring villages. Between the death of the Confessor and the making of the survey, Leeds had increased in value from six pounds to seven. It had a mill, a church, and a priest ; but the population cannot well have been more than about two hundred souls. At the Conquest, Leeds fell into the hands of Ilbert de Laci, and was made by him part of the liberty of Pontefract, but apparently it was sublet to the family of Paganel, for in 1089 Ralph Paganel made over the advowson of the parish church and of the chapel of St. Helen's at Holbeck, to the Priory of the Holy Trinity at York. The manor remained in this family for many years, and seemingly throve in its hands,

for in 1207 Maurice Paganel granted the burgesses of Leeds a charter which, in respect of privileges, placed them on a similar footing to those of Pontefract, the capital of the Liberty. This charter, if genuine, is an interesting example of the beginnings of English municipal life. The town was to be ruled by a praetor, which is equivalent to a town-reeve, appointed by the lord of the manor, and he was to be responsible to the lord for the payment of the customary dues, which were fixed by the charter according to a regular tariff. Justice was to be administered by the praetor according to the ancient practice of compurgation, and the burgesses were to be exempt from answering pleas brought against them in other courts, those of the crown excepted. In the case of charges of larceny, no less than thirty-six compurgators were required, and on the second offence the accused had to submit to the ordeal of water or to fight a judicial duel with his accuser. The severity with which theft was dealt with, and the careful provision which is made for the collection of debts, shows that commerce was expected to increase. By another clause, the burgesses were allowed to transport grain and goods for the purpose of sale whithersoever they pleased, and no woman was required to pay a toll for selling beer. At the battle of Lincoln in 1217 the granter of this charter had the misfortune to fight on the losing side, and his rights passed to Ranulf, Earl of Chester, from whom they reverted to the De Lacis. Through the marriage of Alice de Laci to Thomas, Earl of Lancaster, the manor of Leeds became part of the Lancastrian estates, and in 1399 passed to the Crown.

Owing to the circumstance that the rolls on which the payments of poll-tax made in the West Riding in 1379-80 are preserved intact, an accurate idea may be formed of the Leeds of the thirteenth and the fourteenth centuries, which is in curious contrast to the somewhat grandiloquent language of the charter. The number of its inhabitants of the age of sixteen and over, exclusive of clergy and notorious mendicants, was one hundred and fifty-three, composed of forty-eight married couples, twenty-eight single women, and twenty-nine single

men. Of these, one only was of the rank of esquire, and paid twenty shillings; two innkeepers, one butcher, one smith, and a merchant pay each one shilling; one dyer, one tanner, one shoe-maker, one tailor, one smith and one mason pay sixpence each; and thirty-six married couples and fifty-seven single men and women of the villein class pay each a groat. At this date, Leeds only ranked as the tenth town in the Riding in point of wealth, and had not a sixth of the population of either Pontefract or Doncaster. In spite of this backward condition the town was not altogether without signs of progress. In 1327 she had repaired and possibly re-erected her bridge, and in 1337 had done something by way of paving the streets. Still with all this, it is difficult to reconcile the actual state of the town in 1379 with the language used in granting the charter of 1207.

After the poll-tax rolls some light is shed upon the history of the town by the accounts of the Ulnagers. From these we learn that whereas in 1379 Leeds had only possessed one lyster or dyer, she was stated in 1395 to have four clothiers and to turn out yearly one hundred and twenty pieces of cloth. Her trade, however, was only beginning, for Pontefract, Doncaster, Ripon, Barnsley, Skipton and Selby, the poorest of which had five clothiers, were all ahead of her; but in 1469 she had passed Doncaster, Barnsley, Selby and Pontefract, and was only beaten by Wakefield, Halifax and Ripon. We should therefore be justified in taking the reign of Richard II. as the turning point in its history, for from that date Leeds took its full share in the revolution by which England, which till then had been mainly a wool-exporting country, set out upon a career which has made her the great cloth-making country of the world. In such a change the West Riding was well fitted to share. The abundance of spring water for dyeing and washing cloth, the prevalence of valueless land suitable for bleaching and drying grounds, the proximity to vast tracts of sheep pasturage, the freedom from the guild restrictions which in the older towns were beginning to weigh heavily upon industry, nay, even the isolation of the district and its comparative freedom from strife, created a condition of affairs which was

eminently suitable for the development of a new trade. Accordingly, Leeds was well qualified to profit by the "Tudor Peace" which followed upon the wars of the Roses, and on the coming of the Stuarts, she was in the front rank of West Riding towns, and in all probability had not less than five or six thousand inhabitants. Except that in 1583 the parishioners of Leeds were enabled to purchase from Oliver Darnley the advowson of their church, which had formerly been in monastic hands, Leeds was little affected by the dissolution of the religious houses; for Kirkstall, the only monastery in her neighbourhood, had been too far from the town to give a character to the place. With the whole district, however, she was strongly influenced by the Reformation, and soon began to show the Puritan feeling which distinguished the manufacturing districts of the seventeenth century. So early as 1569 we find that the spirit of the clothing towns was different from that of agricultural Yorkshire, for no Leeds man appears to have joined the catholic rebellion of that year, and Leeds bridge was held against the insurgents, while Halifax sent a body of troops to the aid of the Royal forces. The purchase of the advowson of the parish church seems to have secured popular ministers, for in 1615 no less than three or four thousand communicants are said to have resorted weekly to its services.

Under James the First and his son the connection with the duchy of Lancaster ceased, for money was made out of the manorial rights by selling them to private persons, and on the other hand, Leeds, for the first time secured incorporation under the crown by the grant of a charter from Charles the First in 1626. By this charter, the government of the town was vested in an alderman, nine burgesses, and twenty assistants. The charter is said to be modelled on that of Grantham, and to be designed for the better government and advancement of the trade of clothing. In pursuance of this design, the corporation proposed to embody the clothiers in a company, a step which was strongly resisted. As Leeds had joined with Hull, Wakefield, and Halifax in providing a ship of war against the Spaniards, the town was again called

upon to do the same in 1627, again in 1638, and also in the interval for pecuniary assistance. The town was steadily growing, and in 1639 it petitioned, not only for a revised charter, but also for two members of Parliament ; and in spite of a former petition against ship-money, asserts that "upon all occasions of public taxes and charges for His Majesty's service, it has ever been willing and forward." The cloth trade of Leeds was then valued at £200,000 yearly, and the customs paid at £10,000. Possibly these figures are exaggerated, as the petitioners wished to make the best of their case, but in any event, the volume of trade must have been considerable. It is clear also that it was making rapid development, for the clothiers had been able to set at defiance the statute of Elizabeth, which enjoined that no apprentices should be taken whose fathers were not free-holders to the value of forty shillings. Leeds, too, was much more than a manufacturing town, she was the market town for the cloth of the district. This market was originally held on the Bridge, but was afterwards removed to Briggate, and the cloth was exposed for sale on counters in the open street. Thither the clothiers from the neighbouring villages brought their cloth on a Tuesday, and, having sold it, returned with a supply of wool for the next week's work. The cloth was transported either on the shoulders of men, or on pack-horses, and the tracks of paving stones, along which the horses made their way, may often be recognized.

Such a population of free and independent workmen was certain to hold strong views on religious and political matters, and accordingly, we find that in the civil war, the clothing towns of Yorkshire, like those of Somersetshire and the Eastern counties were enrolled on the side of the Parliament. At the same time, the obligations which Leeds owed to Charles the First, and the popularity of Henry Robinson, the Vicar, led to the existence of some Royalist feeling. A new church dedicated to St. John, had been erected in 1634 by John Harrison, whom Leeds still speaks of as *the* benefactor. The doctrine of both churches, was distinctly of the

kind opposed to Laud, and the Vicar himself had been complained of for a sermon preached on the text of "keep yourself from idols": still, when the great division was made he was found on the side of the king. Charles too had some claims to the gratitude of Leeds for granting the charter; and on the very eve of the war, while at Nottingham, he made a further appeal to its goodwill by granting the petition of 1639, so far as it referred to the revision of the charter, but the outbreak of the war prevented the new scheme from being carried into effect. In consequence of this, the opinion of Leeds was, at the outbreak of hostilities, more divided than that of other towns, and as soon as Sir Thomas Fairfax had been compelled to abandon the defence of the Wharfe, Leeds submitted to the Royalists, and an attempt was made to hold it for the king. This led to its being attacked by Sir Thomas Fairfax, who gathered a force from his father's estate and from the neighbourhood of Bradford, and took the town by storm, on the 23rd of January, 1643. After the battle of Adwalton Moor, Leeds again fell into Royalist hands, but was recovered in 1644 on the retreat of the Marquess of Newcastle from South Yorkshire. Henceforward it remained in the hands of the Parliamentarians, but proved for them no desirable possession, for in the spring of 1645 the plague broke out, a fifth of the inhabitants perished, grass grew in the streets, and the weekly market was held on Woodhouse Moor. A year later, Leeds was visited by Charles, then a prisoner in the hands of the Scots, and saw with her own eyes the ruin of the Royalist cause. Naturally, these reverses of fortune led to changes in the government of the town. During the war, authority was wielded by a military officer, but on the cessation of hostilities, power was restored to the corporation. Changes, however, were made in its constitution, and new men favourable to the new order of things, took the place of the old members.

Other changes, typical of the times, followed. The Vicar, Mr. Henry Robinson, though he had been looked on as

"one of the faithful and painful ministers in these parts," had joined the Royalists, and with difficulty escaped when the town was stormed by Fairfax. After some wanderings with the Royal armies, he was imprisoned at Middleham Castle and at Cawood, and his living was sequestrated. At the Restoration, being then Rector of the neighbouring parish of Swillington, he declined to return to the vicarage of Leeds. It is interesting however, to note that the Commissioners of State, who were sent by Cromwell to examine the fitness of the beneficed clergy, reported of Swillington, that the Rector "was an able and painful preacher, appointed by the Honourable Conyers Darcy, Esquire, and allowed by the Broad Seal of England, who diligently performs the cure, to the great comfort of the inhabitants. This parish is competent and needs no alteration." His place at Leeds was taken by Mr. Peter Saxton, a man of extreme views, who held it from 1646 till his death in 1657. His successor, William Styles, refused to take the "Engagement to be faithful to the government, established without King and House of Peers." But on the petition of his parishioners, he was allowed to keep his place, which he did till 1659, in spite of the fact that he had prayed publicly for the King, then in exile. After some contention, Mr. John Lake, another Vicar of Royalist views, took his place and held it at the Restoration. He was the first Vicar of Leeds who, like so many of his successors, was raised to the episcopal bench, for Lake, who had as a lad been a soldier, lived to be one of the seven Bishops. From Cromwell, Leeds received the Parliamentary representation, which she had requested from Charles I, and in the first Protectorate Parliament of 1654, Adam Baynes of Knowstrop, an officer in the Parliamentary Army, sat as member, and in the Parliament of 1656 she was represented by Adam Baynes and Francis Allanson, both of whom voted against the proposition to make Cromwell king. On the whole, Leeds seems to have been of a moderate Puritan type, not very strong in either direction.

Her Vicars were moderate Royalists, while her members and Corporation were Republican, but as a town she was prosperous and, in later times, men looked back with envy to "Oliver's days."

When the Restoration came, it was not likely that the Royalists of the town would be content with a Republican Corporation, and accordingly, in 1661, Benjamin Wade and William Marshall, who had been aldermen in 1632 and 1651 respectively, with three of the assistants to the aldermen, and many of the wealthiest inhabitants of Leeds, petitioned the king to examine into the character of the present aldermen, on the ground that during the late troubles, persons of ill rank had been brought in, with no other qualification than affection to the usurped power, and asked that the grant of Charles in 1642 to a mayor and twelve aldermen may be confirmed. This request was supported by Lord Langdale and other nobles and gentlemen, and in spite of a counter-petition from the Corporation a new charter was granted, in which the king named the first members, with the proviso that henceforth the vacancies which arose were to be filled up by co-optation.

The history of this revised Corporation is not uninteresting, for it shows how difficult it is to judge of the real feelings of a place by partial evidence. If we believe one set of informants, Leeds, under Charles II, was a "nest of fanatics," and foremost in disaffection, where horse and foot had to be quartered to keep the peace; if we believe the records of the Corporation, it was a very picture of unquestioning loyalty. For in 1680 we find the Corporation complacently dwelling on the rigour with which the laws against Nonconformists were enforced, and in 1681, when Charles had dissolved four Parliaments in two years, and had made up his mind to do without one in the future, we find not only the Corporation, but also three hundred and eighty-four inhabitants of the borough expressing their belief "that the king was always for and will call frequent Parliaments," and their hope that when such meet, "they may be obeisant and obsequious to your majesty." Even this show of submission did not save them, for when Charles issued his

writs of "*Quo Warranto*" against the Corporations, Leeds did not escape, but was compelled to surrender its old charter, and receive a new governing body, from which even some who had signed the above-mentioned document were excluded. So far, however, from the town being dissatisfied, over six hundred persons were found to sign an address to James II, and to assure him of their sorrowful condolence with him "on the death of our late gracious sovereign (of blessed memory) your majesty's most dear and entirely beloved brother," and assuring him that it was their firm intention to support his "royal crown and dignity" with "their lives and fortunes for ever." Within three years, however, the Revolution compelled the townsmen to trim their sails to yet another gale, and they were not unequal to the demand put upon them, for in 1695 we find an address signed by eight hundred and ninety signatures, assuring King William of their loyalty, and of their readiness "to support his most sacred person and government against the late King James, and all his adherents." Indeed, the townsmen of Leeds seem to have been almost as sensitive as the Vicar of Bray, when any aspersion was cast upon their loyalty to the powers that be, and in 1712, when rumours had reached the Court that the Corporation had not been sufficiently adroit in following the change, which had made "the Church and Dr. Sacheverell" the popular cry, they hastened to assure Queen Anne of their devotion, and to set up a statue of her, in front of their Moot Hall. They were equally ready to express their loyalty to George, and though in 1717, it was declared that the members of the Corporation were Jacobites to a man, by 1746 they were enthusiastic over the victory of Culloden, and since that date, the loyalty of the town, which had remained true during so many changes of government, has never been called in question.

But, throughout all these political vicissitudes, Leeds had kept the attainment of material prosperity clearly in view. In 1662 the trades practised in the town are enumerated as those of the cloth-workers, mercers, grocers, salters, drapers, mill-wrights, carpenters, joiners, plasterers, coopers, bricklayers,

cord-wainers, tailors, ironmongers, smiths, glaziers, cutlers, and pewterers, and although the years that followed the Restoration were times of such depression that men were said to be driven by desperation "into disaffection to government," the progress was on the whole steady. The appearance in 1674 of complaints against forestallers and regrators, proves that business was being conducted upon a larger scale. In 1620 a Moot-hall was erected; in 1661 a regular postal service was established between Leeds and Pontefract, through which town the great North road passed; and in 1679 the improvement of the navigation of the river Aire was undertaken by authority of an Act of Parliament. In 1694 a scheme of water-works was set on foot, and in 1710 the Moot-hall was rebuilt. The reign of George I and the early years of George II were uneventful except that in 1745 a detachment of General Wade's army was quartered in the town, and that in 1753 a riot occurred against the toll bars, which had been erected with a view to the improvement of the roads. But in 1753 Leeds made a great step, by deciding to petition Parliament to pass an Act, erecting a court of Conscience, for the recovery of small debts within the borough of Leeds: and for making a common sewer, and for "paving, cleansing, and enlightening the said town of Leeds." The Act passed in consequence of this resolution effected an immense improvement. The cloth markets were removed from the streets and concentrated in two halls, one for white, and one for coloured cloth. In 1760 the bridge over the Aire was widened. The desirability for further water communication led in 1770 to the commencement of the Leeds and Liverpool Canal, and in 1772 the Corporation petitioned for an Act to authorize the making of a canal from Holbeck to the river Ouse at Selby. This plan was not carried out, but it had the effect of causing the proprietors of the Aire and Calder to improve their navigation system, which they did by making a canal by Haddlesey to Selby, under an Act of Parliament obtained in 1774. In 1790 another Act was passed for improving the water supply, and more effectually cleansing and lighting the streets. Such was the progress made by Leeds, when the great inven-

tions of Arkwright, Hargreaves and Watt revolutionized the conditions of trade, and made the proximity of coal and iron the prime necessity of industry. In the new order of things Leeds was well able to take its part, and the beginning of this century saw it enter upon a career of commercial prosperity, from which it has never looked back. Meanwhile the town had been making progress in other matters, more important for the well-being of her people than even commercial prosperity. In 1558 a Grammar School had been established in an old chapel in North Street, it was afterwards removed by John Harrison to a more commodious site. The Leeds Mercury was set up in 1718; its publication was suspended in 1755, but resumed in 1767, and has continued without interruption since that year. The Leeds Intelligencer, now the Yorkshire Post, began in 1754. In 1727, a third church, dedicated to the Trinity was completed. In 1768, a subscription Library was set on foot. In 1767, an infirmary was established. In 1811, a court-house was built, and in 1821, a Philosophical Hall. Westmoreland slates had been introduced for roofing, and Leeds had begun to have the aspect as well as the institutions of a town.

The result of these improvements, was a desire for political recognition, and for Parliamentary representation, and in 1821, when Leeds contained 48,000 inhabitants, the House of Commons proposed to allot to it the two seats which had been taken from Grampound; but the House of Lords gave them to the County of York. From that date, its representation at the earliest opportunity was certain, and in 1832, on the passing of the Reform Bill, Leeds did itself the honour of electing as one of its members, Mr., afterwards Lord, Macaulay.

The growth of Leeds is thus typical of a great change in the condition of this country. So long as England was agricultural, and so long as industry was concentrated in towns situated on the spots marked out as suitable for traffic by the old lines of communication, Leeds, with no agricultural resources and far removed from the chief lines of communication, had no opportunity for development. But no sooner had

the tendencies of commerce begun to change, than the advantages of her situation for industrial enterprise began to assert themselves, and even before the use of steam, she was rapidly pushing herself to the front. The introduction of the factory system made her fortune, and the reputation which she acquired for success attracted to her the talent and enterprise which were capable of developing her resources. One characteristic of the Leeds of old she still possesses. Leeds has never been a place of one industry. The diversity of trades, carried on in Leeds during the reign of Charles the Second, is equally remarkable at the present day, and she is an example of what enterprise, capable of turning everything to account, has been able to do in the way of making her, with no very special facility, and no one predominant industry, one of the most prosperous towns in the world.

BUILDINGS AND INSTITUTIONS OF LEEDS.

By several Contributors; Edited by Sydney Lupton, M.A.

The Parish Church of Leeds, dedicated to St. Peter, was erected in 1838-41, during the incumbency of Dr. Hook, from the designs of Mr. R. D. Chantrell, and is supposed to be the fifth church which has stood upon the same site. Over the north main entrance is a tower 140 feet high, which contains a peal of thirteen bells. Within the porch, on the right-hand side, is a monument to natives of Leeds who fell in the Crimean war, and on the left, a statue of Michael

Thomas Sadler, M.P., F.R.S. In the south transept stands one of the finest parish church organs in the kingdom, originally built in 1714, by Price, of Bristol. It has since been reconstructed, and now contains four full manuals and 70 stops. The east windows are filled with old glass collected on the Continent in 1841. The lower walls of the sacrarium are arcaded with alabaster and filled with mosaics of the Apostles, by Salviati. The reredos was executed by Earp and Rust, from designs by Street. Within the altar rails is a cenotaph to Dean Hook (Vicar, 1837-59) by Sir Gilbert Scott, and a monument to William Beckett, M.P. for Leeds, by Baron Marochetti. On the right-hand wall are some ancient brasses removed from the floor of the church, and the monument of Ralph Thoresby (d. 1661) the Historian of Leeds. Outside the sacrarium, on the south side, is the interesting tomb of the Hardwicke family (1577) with fresco figure paintings. Close by lies the stone effigy of a knight, bearing a shield with the arms of Manston, which was found at some depth beneath the chancel floor. The ancient cross, which stands upon the chancel steps, is constructed of fragments found in the wall of the old church, and is assigned by Prof. Westwood to the ninth or early part of the tenth century. These fragments, with others, some of which were inscribed with the words "Cyni" and "Anlaf," or "Onlaf," were taken away by the architect, but recovered by Dean Gott, a former Vicar. They altogether formed parts of six crosses. A full account of these interesting remains is given in the Parish Church Magazine for 1881. In the north chapel stands the elaborate canopied tomb of the Beckett family, and on the south side, a monument by Flaxman, to Captains Walker and Beckett, who fell at Talavera. High up in the north wall is set a stone monogram, formerly in the chantry of St. Mary's, at Leeds Bridge, while numerous brasses, chiefly of the seventeenth century, have been placed beneath the windows. In the vestry, is a picture of the Agony in the Garden, ascribed to the school of Correggio, a former altar-piece of the church, and registers dating back to 1572.

The Church of ST. JOHN THE EVANGELIST, was built (1631-3) by the munificence of John Harrison, merchant, of Leeds. This liberal benefactor amply endowed the church, built the quadrangle of alms-houses, increased since by others at Woodhouse, rebuilt the "Old Grammar School," and provided the town with a market cross. After a somewhat troubled life (1579-1656) he was buried in his own garden, now Kirkgate Market, but his body was subsequently removed to St. John's Church. His tomb has been recently rebuilt, but a solitary column of the original structure is to be seen on the south wall outside the screen.

The church was consecrated on St. Matthew's day, 1634, by Richard Neile, Archbishop of York. The sermon in the morning was preached by the eminent Liturgist, Bishop Cosin, of Durham, and in the afternoon, by Mr. Todd, the first incumbent, who was at once suspended by his Grace for Calvinistic teaching.

The church consists of two naves, side by side, divided by an arcade, the arches of which are on mediæval or Gothic lines, but the capitals and pillars are treated with Renaissance or Jacobean detail—a characteristic of the church throughout. The church has undergone at least two restorations; to the earlier one, which was probably only external, we owe the present tower, the large windows in the south nave, and the Gothic foiling in the heads of the square side windows. The second, in 1867-8, gave us the porch, by Norman Shaw, R.A., the font, and the east window over the altar. Several interesting features were lost, removed, or altered at this time, some of which have been restored by the care of the present vicar. The original treatment of the exterior is best seen on the north side of the church.

Internally, a magnificent Jacobean screen stretches across both naves, forming at the east end of the north nave a chancel for the altar and choir, and at the east end of the south nave, the Harrison chapel with a subsidiary altar used for daily and special services. This

screen, surmounted by the ancient scroll work, which formerly enclosed the Royal Arms, the lofty pulpit with its fine canopy standing outside the screen against the north wall, the pews of carved oak, and the hand-made plaster arabesques of the roof confer upon the church an almost unique character. Some interesting old plates of the church are to be seen in the vestry.

The window at the east end of the south nave (Burlison and Grylls, of London) has been recently erected in memory of the founder, and the lower subjects represent various scenes in his life :—(1) King Charles I., a quasi-prisoner in Red Hall, Leeds, receiving from John Harrison a tankard of nominally small beer, in reality broad gold pieces for His Majesty's necessities. (2) John Harrison superintending the building of his church. (3) John Harrison at his alms-houses. (4) John Harrison at the market cross at the top of Briggate.

TRINITY CHURCH, Boar Lane, in the Classical style (Chantrell, architect), to which Ralph Thoresby makes frequent reference in his Diary, was erected in 1722-7, by a public subscription. The spire, which had been injured by a storm, was rebuilt in 1839.

The Church of ST. GEORGE (1838) is in a poor style of mixed Gothic, but is well situated, and contains a fine altar-piece, by C. W. Cope, R.A.

The Church of ST. PAUL, in Park Square (1793), is in the Classical style. That of ST. SAVIOUR'S, East Street, was built at the cost of Dr. Pusey.

The Church of ST. JOHN THE EVANGELIST, Little Holbeck, was built in 1847-8, at the cost of J. G. and H. C. Marshall (Sir G. G. Scott, architect). It is in the early English style, and based upon the model of the Temple Church, London.

The CATHEDRAL OF ST. ANNE, Park Row, contains a fine reredos, designed by Pugin.

MILL HILL CHAPEL, Park Row (1848), School (1858), is built in the early perpendicular style, on the site of

an old Presbyterian Chapel. Priestley, who was appointed in 1767, was the first minister to take the Unitarian name. There being no minister's house, he resided next to the brewery of Jacques and Nell, in Meadow Road. His interest was excited by the curious gas given off by the fermenting vats, and he published his first papers on the subject in 1772. He soon afterwards removed into a minister's house on the site of the present schools, and left Leeds in 1773.

PUBLIC BUILDINGS, &c.

THE TOWN HALL (Cuthbert Brodrick, of Leeds, 1858), a fine, well arranged building of sandstone, in the Classical style, 250 feet long, 200 feet wide, and about 67 feet high, cost upwards of £135,000, and was opened by the Queen.

The vestibule, at the main (south) entrance, contains statues of the Queen, by Noble, of the late Prince Consort, and of the Prince and Princess of Wales, and leads to the Victoria Hall, 161 feet long, 72 feet wide, and 75 feet high, containing a fine organ, by Gray and Davidson. In the corners of the building are the Council Chamber, the Borough Police Court, and two Assize Courts with their necessary offices. On the first floor are the Mayor's Official Rooms and the West Riding Police Court. The tower, 225 feet high, contains a fine clock with four illuminated faces, and a bell weighing 4 tons 1 cwt.

The MUNICIPAL BUILDINGS, in Calverley Street (George Corson, 1885), were erected in the Palladian style, at a cost of £108,000, to relieve the pressure of business in the Town Hall; they contain various Rate and Sanitary Offices, and above, a free reference and lending Library, containing about 80,000 volumes, which supplies many branch libraries scattered throughout the borough. A Reading Room and Art Gallery (W. H. Thorp, 1888) complete the scheme.

The SCHOOL BOARD OFFICES, in Calverley Street, contain various Board Rooms, Offices, and Examination Rooms, fitted up in a substantial style. The new Higher Grade

Board School, in Woodhouse Lane (1889), with its numerous fine class-rooms for boys and girls, the mutes and the blind; its complete arrangements for elementary technical instruction, comprising a laboratory and science class rooms, a work-shop, and a gymnasium; with its playground on the roof, and many other novelties: is well worth a visit from all interested in education.

H. M. PRISON, AT ARMLEY (Perkin and Backhouse, 1847), a massive castellated structure, about a mile from Leeds, will hold about 630 prisoners.

The WORKHOUSE, INFIRMARY, AND INDUSTRIAL SCHOOLS, in Beckett Street (1858), are built in the Elizabethan style, and well adapted to their respective purposes. Nearly opposite, one of the destructors, for disposing of the town refuse by the most approved modern methods, can be seen.

Leeds is well supplied with RECREATION GROUNDS and open spaces, of which the following are worthy of a brief notice :—

WOODHOUSE MOOR was formerly a barren waste, on which town's meetings were held, and the nomination of candidates took place. The Manorial rights were purchased by the town for £3,000 in 1855, and it has gradually been laid out with trees, seats, walks, &c., while the lower portion has been recently converted into a cricket ground and open-air gymnasium.

HUNSLET AND HOLBECK MOORS serve as lungs to the south of Leeds. Across the former of these the coals from the Middleton Colliery were drawn in 1811, by one of the first successful locomotives in England, constructed by Mr. Blenkinsop.

ROUNDHAY PARK, about four miles from Leeds, was acquired by the town in 1871, for £139,000. About 430 acres are converted into a people's park, containing two artificial lakes, the lower one of which is in places 70 feet deep, gardens, refreshment rooms and other accommodation.

The STATUES are not numerous ; those worthy of note are :—Sir Robert Peel (Behnes, 1852) in Park Row.

Duke of Wellington (Marochetti, 1855) in Victoria Square.

Sir Peter Fairbairn, Mayor in 1857-8 (Noble, 1866) in Woodhouse Square.

H. R. Marsden, Mayor in 1873-4 (J. Throp, 1878).

Queen Anne (Carpenter, 1713), at first in front of the Old Moot Hall in Briggate, removed in 1828 to the front of the Corn Exchange at the top of Briggate, and in 1868 to the northern vestibule of the Town Hall. It has fitly, at last, found a resting-place in the Art Gallery.

The YORKSHIRE COLLEGE was established in 1874 for the promotion of Scientific and Technical Education. The scope of its instruction has however been much enlarged by the addition of Languages, History, and other subjects. In 1884, the Leeds School of Medicine, founded in 1831, was amalgamated with the College, though the special professional teaching is in great part given in a separate building.

The College took an active part in the negotiations which led to the creation of the Victoria University, and in 1887 became one of the three constituent colleges.

The object of the Yorkshire College is to combine University teaching with technical instruction of a type more frequently met with on the Continent. Complete courses of instruction are provided for (1) the degrees of the London and Victoria Universities in Arts, Science and Medicine ; (2) the professions of civil, mechanical, electrical, and mining engineering, chemistry, medicine and surgery ; (3) the trades of cloth manufacturing, dyeing and printing, and coal mining ; (4) commerce.

Practical work is carried on daily in the Physical, Chemical Biological, and Engineering Laboratories, in the weaving sheds, in the cloth finishing rooms, the dyehouse and printing rooms, all of which have been designed with the greatest care and furnished with the most approved machinery and teaching appliances.

The number of Registered students who attended the ordinary day classes during the session 1888-9 was 463, and there were also 559 occasional day students, evening students, and teachers in attendance on special classes—making a total of 1,022 students.

The department of Science, Technology, and Arts is situated in College Road. The buildings, designed by Alfred Waterhouse, R.A., form only part of the block of buildings which it is proposed to erect in sections as the needs of the College require. The site of 3½ acres with the present buildings and equipment cost upwards of £90,000, of which £30,000 was contributed by the Worshipful Company of Clothworkers of the City of London, to establish the Textile Industries, Dyeing and Fine Arts Departments. The space between the Engineering and Dyeing Departments is shortly to be utilized for the erection of a Hall and Library. The department of Medicine is at present in Park Street, near the Infirmary, but is shortly to be moved to an admirable site above St. George's Church, in very close proximity to the Infirmary.

The annual expenditure of the College is about £14,000, which is met by: (1) income from investments; (2) a grant of £1,800 a year from the Clothworkers' Company to maintain the Textile, Dyeing and Fine Art Classes; (3) £150 a year from the Drapers' Company for the teaching of Coal Mining; (4) surplus income from the Akroyd Charity; (5) Annual subscriptions; (6) fees, which in the session 1889-90 amounted to £8,250; (7) a parliamentary grant of £1,400 a year.

The PHILOSOPHICAL SOCIETY.—The Leeds Philosophical and Literary Society was constituted in 1820 by the association of 37 Proprietary and 82 ordinary members, in accordance with the resolution of a public meeting held in 1818. There are now more than 600 members and subscribers.

The objects of the society were the discussion of subjects in the various branches of Natural Knowledge and Literature, those connected with Religion, Politics or Ethics being expressly excluded, and the collection of books and objects bearing upon these subjects. In 1821, a building was erected

upon the present site from the designs of R. D. Chantrell, which was altered in 1826-7 and considerably enlarged in 1863-4.

In 1837 a single volume of the Societies' Transactions appeared, but since then the original papers and discussions contemplated by the founders have been superseded by popular lectures, of which about twelve are delivered annually.

The Museum is specially strong in geology and natural history, it also contains some valuable antiquities and coins.

The Library contains some valuable books and complete or extended series of several of the more important scientific periodicals.

Meteorological observations, including a photographic record of sunshine, are taken daily and posted for the use of the public.

The GRAMMAR SCHOOL was founded in 1552 by William Sheafield, priest ; in 1624 it was removed to new premises in North Street at the cost of John Harrison, and in 1858 to Woodhouse Moor. It is built in the Geometric Decorated style (E. M. Barry, R.A.), and consists of a large schoolroom, various classrooms, a laboratory, headmaster's house, and chapel.

The HIGH SCHOOL, in Woodhouse Lane, provides similar educational advantages for girls.

The MECHANICS' INSTITUTE (Cuthbert Brodrick, 1868), in the Italian style, contains a hall in which scientific and literary lectures and various entertainments are given, and a good library and reading room. The Institute includes middle-class schools for boys and girls, a school of Art, and a recently built school of Science, very well equipped for scientific and technical classes, which are mainly held in the evening.

The LEEDS LIBRARY, 18, Commercial Street, was started in 1768 chiefly owing to the exertions of Priestley, who presented the first book, a set of the "Spectator," and held the office of Secretary and afterwards of President. It consists of about 80,000 volumes, many of them of considerable interest and value, and is specially strong in biography and local history. It is the third oldest in the North of England.

The CHURCH INSTITUTE (Adams and Kelly, 1868), in Albion Place, contains a library and reading room, rooms for meetings, and a hall in which lectures on various subjects are given.

The Association was formed in 1857 to extend religious and secular knowledge in accordance with the principles of the Church of England. There are now more than 33,000 scholars and 2,400 teachers in the Sunday Schools under the supervision of the Association.

The YOUNG MEN'S CHRISTIAN ASSOCIATION (South Parade) and the CO-OPERATIVE SOCIETY (Albion Street) also provide lectures for their members.

The YORKSHIRE LADIES' COUNCIL OF EDUCATION, 90, Albion Street, assists women of all classes to improve their mental and material position by providing a students' library, a school of cookery, lectures in domestic, social, and artistic subjects, instruction in various kinds of women's work, and assistance in the sale of the work produced.

The YORKSHIRE TRAINING COLLEGE OF MUSIC (1879) is situated opposite the Town Hall.

The GRAND THEATRE, in New Briggate (Corson and Watson, 1878), seats 2,600 persons.

CHARITIES.

The Charities of Leeds are very numerous and varied.

The GENERAL INFIRMARY was founded in 1767, in Kirkgate, removed in 1791 to King Street, and in 1868 to the present building in Great George Street, which was designed by Sir Gilbert Scott, R.A., in the early Gothic style. It contains beds for 300 surgical and non-infectious medical cases, and is maintained at an annual cost of about £15,000. Additional accommodation is being erected for the large out-patient department, a children's ward, and separate rooms for patients requiring seclusion. There are several statues and portraits of eminent medical men and donors in the Hall and Board Room.

The PUBLIC DISPENSARY was founded in 1824, and the present building in New Briggate was erected from designs by Hill, in 1867. The Honorary and Salaried Medical Officers attend patients at their own homes gratuitously.

The HOSPITAL FOR WOMEN AND CHILDREN affords special Medical and Surgical aid to about 200 in- and 1,000 out-patients.

The COOKRIDGE CONVALESCENT HOSPITAL, built by the late Mr. Metcalfe Smith, and the Ida North Convalescent Home provide fresh air and good food for convalescents from the Infirmary and elsewhere. A similar institution for Fever patients is to be shortly erected.

The BOROUGH HOSPITAL, and the SMALL-POX HOSPITAL, both in Burmantofts, receive some 400 cases of infectious fevers annually.

The UNITED INSTITUTION FOR THE BLIND, AND DEAF AND DUMB (partially erected and modified, E. Birchall, 1877), provides religious services, lectures, entertainments, and a reading room for the Mutes; and a visitor to assist them when in difficulty. Workshops are provided for blind men and women, in which they are taught various trades and afterwards obtain a livelihood. A visitor relieves necessitous cases. A school was for many years provided for blind children, but has been recently taken over by the School Board, though a few children reside on the premises.

The REFORMATORY at Adel removes boys from bad surroundings, teaches them trades, and gives them a fair start in life. A somewhat similar institution is maintained by the School Board in Shadwell Lane.

There are many other institutions with somewhat similar objects, such as the Girls' Industrial Home, in Windsor Street, the Boys' Refuge in Brunswick Terrace; the Guardian Home; Home for Girls; Home for Waifs and Strays; Discharged Prisoners' Aid Society.

The Gas, Water, and Sewage Works of Leeds are described under INDUSTRIES.

THE

INDUSTRIES OF LEEDS AND DISTRICT.

EDITED BY T. FAIRLEY, F.R.S.E.

INTRODUCTION.

THE development of Leeds as an industrial centre is a problem of very great interest. In Norman times only a farming village, Leeds gradually became a market town, where not only the agricultural produce of the neighbourhood was disposed of, but where the farmers of Lancashire and Yorkshire sold their wool and sheepskins to the traders from Hull and Flanders. This was no doubt owing to its convenient geographical position. But other causes intervened. The unsettled state of the Netherlands in the fifteenth century, and the religious persecutions which followed, dislocated the manufactures of that country, and many skilled workers settled in various parts of England, acting the part of teachers to a people apt and willing to learn.

The position of Leeds—near to a great pastoral and sheep farming district—gave abundance of raw material. The processes of the local manufactures were carried on mainly in the dwellings of the people, and for operations on a larger scale abundant water and power were supplied by the numerous streams of the district. In those early days when carriage was costly and difficult the proximity of some of the most fertile parts of Yorkshire was a factor, providing a ready food supply for an industrial population.

As the means of communication improved, the immense mineral wealth of the district was also ascertained. The system of inland navigation, of the Aire and Calder to the east, and the Leeds and Liverpool Canal to the west, provided a means of cheap carriage of raw material and of manufactured products between Leeds and all parts of the country.

Leeds, standing on the borders of one of the greatest coalfields of the kingdom, has an immense advantage over less favoured districts. Much of this coal still lies untouched, while, as shown in the article on Mining Industries, supplies of iron ores, fireclay, limestone, and building materials abound in the district.

During the present century the universal use of steam power has greatly increased the advantages of cheap coal, and, with the development of the railway system, Leeds, noted as a trading centre in the days of lanes and pack-horses, has converging towards it and meeting in its bounds all the important railways in this part of the kingdom.

The natural advantages of good communications with other places, and an abundant store of power have been supplemented by the strongly marked industrial character of the population, and both combine to give Leeds a position of manufacturing importance inferior to that of few towns in this or any other country.

MINING INDUSTRIES OF YORKSHIRE,

By Prof. Arnold Lupton.

Leeds lies in the midst of a large tract of exposed Carboniferous rocks, extending from Derby on the south to Berwick-on-Tweed on the north; and from St. Helens near Liverpool on the west to Castleford near Pontefract on the east.

North of Leeds the upper Carboniferous rocks of Yorkshire have been removed by denudation (with the exception of the small coal-field of Ingleton), and the Millstone Grit and Mountain Limestone formations come to the surface.

The Mountain Limestone is extensively quarried for lime, especially near the towns of Settle and Ingleton.

The Millstone Grit formation has valuable quarries of building stone, as instanced by the well-known quarries at Horsforth near Leeds, supplying the celebrated Bramley Fall Stone.

There are in the Mountain Limestone and Millstone Grit formations, mineral veins containing ores of Lead, Barium, Copper and Zinc.

Lead in workable quantity is found in the dales of the Swale, the Ure, the Nidd, and the Wharfe. These mines have been worked from ancient days, there being evidence to show that in Nidderdale lead was worked in the first century. The mines at Grassington in Wharfedale were at one time celebrated.

Yorkshire Lead-mines have failed as a general rule to be remunerative when it became necessary to follow the vein below the water-level of the valley, and incur the expense of pumping. In 1889 the total Yorkshire production of dressed Lead ore (Galena) was 2,056 tons, mostly from the North Riding, or about 4% of the total produce of the United Kingdom. In the same year the East Grassington mine near Pateley Bridge was the only active lead-mine in the West Riding, producing 240 tons.

The mineral wealth of the Leeds district is almost entirely contained in the Coal Measures, and consists of coal, limestone, fire-clay and ganister.

Ganister, a pure silicious sandstone, is found a short distance above the Millstone grit, and is extensively used for fire-bricks and furnace linings.

Fire-clay is found at its best chiefly in the Lower Coal Measures, associated with thin seams of coal, and makes the celebrated fire-bricks, glazed bricks and other fire-clay goods of the district.

Ironstone is found throughout the Coal Measures. It contains carbonate of iron with from 25% to 39% of metallic iron in the stone. This Ironstone used to be extensively worked for all the blast-furnaces in the West-Riding, but during the last 20 years the Ironstone of the Coal Measures has been generally superseded by the purer hæmatite ores of North Lancashire, Cumberland and Spain on the one hand, and on the other hand by the more cheaply got sesquioxides of iron contained in the great deposits of iron ore found in the Lower Oolite of Cleveland, Lincolnshire, Leicestershire, Northamptonshire and other Midland and South Midland Counties.

For a time at least the inexhaustible stores of Ironstone in the Coal Measures remain untouched except in those localities where their peculiar excellence and the specialities of Iron manufacture continue to give them the preference. This is the case in the vicinity of Leeds. Here the celebrated Lowmoor Black Bed Ironstone is worked extensively for the Lowmoor, Bowling, Farnley and York Road Ironworks, which make Best Yorkshire Iron. The working of this Ironstone dates back to a remote period.

Coal-getting is by far the most important department of mining in this district, and was practised centuries ago. On many a heathery mountain, on wooded hills, and elevated pastures are to be seen the traces of former coal-mines, long since abandoned ; the working having ceased because most of the coal was got, or because coal of better quality from other mines can now enter the district by turnpike or railroad, at a moderate price.

If a meridian of longitude is drawn through Leeds it divides the Coal-field into two districts. The western portion is the

Thin Coal district, the eastern portion is the, by comparison, Thick Coal district. In the Thin Coal district coals of 2 feet and less in thickness are worked, and seams as thin as 16 inches are got.* Sometimes a seam of particular excellence is worked where it is only 10 inches in thickness, and it is remarkable that the colliers who are accustomed to the thin coal will work it at a price but little higher than that paid elsewhere for much thicker seams. This cheapness of working enables the thin coal collieries to compete in the populous towns and villages which they adjoin, with coal from the eastern field, the cost of which is increased by the railway and other charges. It is in the eastern district that the great store of coal is found which for many years to come will supply the manufacturers of the West Riding with fuel. Here the seams of coal now worked vary from about 2 feet up to 7 or 8 feet in thickness, averaging say, 4 feet 6 inches of workable coal in a seam.

The Leeds manufacturers have always had the advantage of cheap fuel supplied by mines on the outskirts of the town.

Mines of coal and ironstone once existed on or adjoining the site of the present Corn Exchange, when the minerals were got by means of "Bell Pits."

At the beginning of the present century the collieries on the Middleton Estate immediately adjoining Hunslet Common were connected to the town by a railway from the mines to Great Wilson Street. The railway is remarkable because it was worked by a locomotive as long ago as the year 1812. The engine was made by Matthew Murray of Leeds for Mr. Blenkinsop the owner of the mines. The locomotive had vertical cylinders and cogwheel gearing. It was carried on four wheels. The driving wheel (distinct from the carrying wheels) was a cog wheel which geared into a rack-rail which was laid beside one of the carrying rails. It could drag a train of 38 wagons, weighing 140 tons, on a level road, and it proceeded at the rate of 3½ miles an hour.

* There are exceptions to this rule, there being some portions of thicker coal yet remaining in the Western District.

The district has had also the advantage of water carriage, the River Aire having been canalised by virtue of an Act of Parliament obtained nearly 200 years ago. By this canal coal is brought into Leeds or carried down to the Humber for export.

The mining industry of the last century also owed much to the skill of Smeaton, the celebrated engineer, who was born at Austhorpe, about five miles from Leeds, and who did so much to improve the steam engine, that some of his engines have continued at work for 100 years. The inventive enterprise of Leeds mining engineers did not, however, cease with Smeaton or with Murray, and it was in the vicinity of this town that the chief efforts were first made to introduce coal-cutting machines into mines. Many able and ingenious men experimented for years, and a machine known as "Firth's Pick Machine" was made about 26 years ago, and worked at the West Ardsley Collieries near Leeds; with various improvements in detail it has continued to work ever since, and is well named by the colliers the "Iron Man." It is made of iron or steel, and wields a pickaxe just as a man would wield it, only the pick is 20 times as heavy as a man's pick, weighing 80 or 90 lbs. The breath of the machine is the same air which a man would breathe, only it is compressed to four times the density of atmospheric air, and by its expansion in a cylinder (like the cylinder of a steam engine) it causes the pick to strike its Herculean blows 60 times a minute.

In this district also the first electric machine for cutting coal was made, and within the last three years this invention has been developed at the Allerton Main Collieries within five miles of Leeds. In this machine a steel bar 5 feet long, armed with 180 steel points, is made to revolve on its own axis at the rate of 500 revolutions a minute by an electric motor. These revolving points scratch away the mineral against which they are pressed, and make the required cutting. At the same collieries there is an ingenious system of wire-rope haulage.

At the St. John's Colliery, Normanton, the use of electricity for transmitting power from the surface to the mine has for the first time in this country been carried out upon a large scale, and here the pumping and hauling engines in the mine are driven by electricity.

The great collieries of Messrs. Henry Briggs, Son, & Co., Ltd., and of Messrs. Pope & Pearson, Ltd., at Normanton, and of the South Kirkby Colliery Co. at South Kirkby, present fine examples of mining engineering.

The last named colliery has reached the Barnsley bed at a depth of 634 yards, and in working the coal the engineer has to deal with an overlying weight equal to a pressure of about 2,000 lbs. on the square inch.

It is difficult to give statistics of the coal-mining industry of the Leeds district, as the Government returns give the figures for the whole of Yorkshire.

In 1889 the number of mines in the East and West Ridings of Yorkshire, according to the report of Mr. Wardell, H.M. Inspector of Mines, was 371, at which 69,917 persons were employed, in raising 22,457,749 tons of mineral. These figures give some idea of the importance of the industry. The traveller from Leeds to Nottingham passes through an uninterrupted series of collieries ; Normanton for Wakefield, Cudworth for Barnsley, Masbro' for Rotherham and Sheffield, Staveley, Clay Cross, Pye Bridge and Bulwell Stations, each marking the centre of a great coal-mining district.

East and west of this line lie the collieries of the great Midland Coal-field ; on the west the coal-field is bounded by the outcrop of the coals and by the underlying rocks. On the east the mines have not explored the boundary of the coal-field, which lies covered up by the Permian and New Red Sandstone formations.

The geologists examined before the Coal Commission marked the probable eastward boundary as extending to Goole, Gainsborough, and Newark. Here lies an enormous store of fuel for the use of our descendants containing, it is calculated, upwards of 70,000,000,000 tons of coal.

IRON AND STEEL.

By Albert E. Kitson.

It was the railway system that was the means of bringing most of the engineering and iron industries into the town of Leeds. Until the railway came, Leeds had been content to live upon its cloth trade, but no sooner was the line between Leeds and Selby in operation than the men of the woollen metropolis began to exercise their minds with new schemes of commercial adventure and enterprise. It was then that the iron industry which had existed in Leeds, in a small way from a very remote period, showed signs of active development, leading to the establishment of iron manufactures of all kinds in the town.

Long before Leeds had become celebrated for its cloth, it had gained a reputation for its iron.

In digging out the foundations of houses in Briggate, the principal street of Leeds, many "bell pits" have been brought to light, from which ironstone has been removed. The new cemetery at Burmantofts, in Leeds, was in like manner found pitted over with these ancient holes. The miner seems to have dug a well about six feet in diameter, and on reaching the mineral, he worked it away all round, leaving the bell-shaped cavities in question. He did not attempt any gallery excavations, but when the pit was exhausted a fresh one was sunk. The ore, when dug out, was transported, most probably on horseback, to the adjacent districts, for the convenience of fuel, as it was easier to carry the mineral to the wood, then exclusively used for smelting, than to bring the wood to the mineral. Hence the numerous heaps of scoriæ found in the neighbourhood of Leeds—at Middleton, Whitkirk, and Horsforth—all within the borough. At Horsforth, they are found in conglomerated masses from thirty to forty yards long, and of considerable width and depth. The remains of these cinder beds, in various positions, some of them near the summits of the hills tend to show that as the trees were consumed, a new wind furnace was erected in another situation, in order to lessen the

labour of carrying the fuel. There are also deposits of a similar kind at Kirkby Overblow, a village some miles to the north-east of Leeds, and Thoresby states that the place was so called because it was the village of the "Ore Blowers"—hence the corruption of "Overblow." A discovery has recently been made amongst the papers of the Wentworth family of a contract for supplying wood and ore for iron "blomes" at Kirskill, near Otley, in the fourteenth century, though the manufacture near that place has long since ceased. Notwithstanding this historic testimony, the iron industries proper did not receive true development until the early years of the present century.

Iron made in the forges of Leeds and district has obtained a world wide celebrity on account of its superiority over all other kinds where great strength and reliability are required. Yorkshire Iron was for many years considered by the leading engineers of the world as the only material which could be safely used in the construction of various parts of locomotives and marine engines. This Iron owes its reputation to its uniform and regular quality. Its properties are due in some measure to the purity of the fuel used in its manufacture, but also in a large degree to the minute and rigid care with which its manufacture is conducted. Excessive care is taken to examine and select the puddled iron, to heat all the iron well, to heat and hammer it repeatedly to secure sound blooms, and to put a large amount of work upon the iron.

Best Yorkshire Iron is distinguished by the property described by the practical man as that of standing fire well. Bars and plates in the hands of the smith will bear repeated heating, drawing, and flanging, without deterioration, and the special methods and appliances required in the treatment of steel are not needed in dealing with Best Iron. Yorkshire Iron plates will support a tensile strain of 22 tons on the square inch, with an elongation of 16 per cent. lengthways, and 20 tons tensile strength crossways, with an elongation of 10 per cent., and Yorkshire bars 24 tons, with an elongation of 25 per cent,

The principal makers of Yorkshire Iron in the district are:

The Low Moor Iron Company,
The Bowling Iron Company,
The Farnley Iron Company,
Messrs. Taylor Bros. & Company,
The Monk Bridge Iron and Steel Company.

The Low Moor Company, as the oldest and widest known makers of Yorkshire Iron, deserve a few words of special mention. The Low Moor Iron Works, which are situated in the neighbourhood of Bradford, were founded in the year 1788, and came into the hands of Messrs. Hird, Dawson & Hardy, and the partnership after all these years still remains confined to the members of those families. The ironstone in the locality had been known to the Romans, these conquerors of our Island having had forges and made iron there. Both the coal and the ironstone are of a very superior quality. The ironstone yields about 32 per cent. of iron, or after calcination about 42 per cent. of metal, and the metal in its finished state is remarkable for the peculiarity of its granular structure, and uniform and brilliant grain, and commands a much higher price than the ordinary run of iron. All the best coal upon the estate is exclusively reserved for making the Low Moor Iron; the value of this now celebrated brand of malleable iron depending in a great measure upon the superior character of the coal which is used in its manufacture. The Low Moor coal used for this purpose is said to contain a smaller percentage of sulphur than almost any other coal.

The following analysis of Low Moor Better Bed coal has been kindly given to me by Mr. E. Windsor Richards, of the Low Moor Iron Company.

Fixed Carbon	63·16
Volatile Hydrocarbons, &c. ...	31·32
Sulphur	0·48
Ash	3·96
Water	1·08
	100·00
Sulphur left in ash...	·09

The iron produced by the Farnley Iron Company, the Monk Bridge Iron and Steel Company, and by Messrs. Taylor Bros. & Company, is very similar in point of quality to the Low Moor Iron, the ore being obtained from the same bed, and smelted with the same description of coal. The iron is produced from cold blast pig iron, which is usually first refined and also reheated previous to its introduction to the hearth of the puddling furnace. The charge weighs only from 2½ to 3 cwts. and occupies from twenty to twenty-five minutes for the completion of the melting-down stage. From the commencement to the end of the process, when the charge is collected into three or four balls, the time occupied is about one hour and ten minutes, so that nine or ten heats can be worked off during the shift of twelve hours. In these Yorkshire furnaces also the temperature is somewhat higher throughout the process than is observed in the Staffordshire district, and the stirring of the molten metal is more continuous. The puddled balls produced weigh from eighty to ninety pounds each, and are usually hammered into blooms, or "stampings" of ten or twelve inches square and 1½ to 2½ inches in thickness, which are broken up under a small hammer and the fracture carefully examined for various applications. Thus the harder and more uniformly crystalline varieties are used in the manufacture of bars, whilst the softer and more fibrous qualities are used in the production of boiler plates, wire rods, and the like.

For the latter purpose the slabs are placed in piles, reheated, and welded under the hammer into blooms or billets, which after being again heated are finally passed through the rolls for the production of bars, plates, angles, &c.

Several other Ironworks, which have since expanded into concerns of great magnitude, were established about the same time that the Low Moor Company began operations. At Bowling, only a mile or two away, an Iron Company was started in 1789, and from that time to this the Bowling Iron Works have been well known.

It is not a little remarkable that in spite of the great strides that have been made in the application of steel, the

production of puddled bar in the United Kingdom has also greatly increased. The quantity of puddled bar produced in 1889 amounted to 2,253,756 tons, which is an increase of 222,283 tons on the output of the previous year, and an increase of 552,444 tons on the production of 1887. The explanation of this increase, no doubt, is that with the enormous expansion of the purposes to which steel is applied, there has followed a multiplication of the many special purposes for which iron is needed.

The production of puddled bar has varied considerably from year to year, as the following statistics of the production since 1881 will show :—

		Tons.
Production of Puddled Bar in	1881 ...	2,681,150
,, ,,	1882 ...	2,841,534
,, ,,	1883 ...	2,730,504
,, ,,	1884 ...	2,237,535
,, ,,	1885 ...	1,911,125
,, ,,	1886 ...	1,616,701
,, ,,	1887 ...	1,701,312
,, ,,	1888 ...	2,031,473
,, ,,	1889 ...	2,253,756

The number of puddling furnaces in operation in 1889, in the West and South Yorkshire district was 349, and their production of puddled bar amounted to 232,266 tons, which is an average production of 665 tons per furnace.

At most of these works steel of a high quality made by the Siemens-Martin or Open-hearth process, is also largely manufactured, this being rendered necessary on account of the very general use of steel for many purposes where formerly iron only was employed. The open-hearth process is by many considered to be under better control than the Bessemer process, since ample time is afforded by it for the testing of the metal, and for the addition of such proportions of pig iron, or of iron ore as are required, so as to yield a more or less carbonised product according to requirements.

The Siemens-Martin process consists in the melting of scrap steel in a bath of molten pig iron, on the hearth of the

regenerative gas furnace, and was first used on a large scale by Messrs. Martin, at Sireuil. The furnace being already heated from the working off of a previous charge, has the bottom levelled and repaired, after which it is charged with pig iron, and upon this pig iron the scrap is placed, the material being all charged cold, or the scrap is sometimes previously heated to redness in auxiliary furnaces arranged for the purpose. Grey Hæmatite pig iron is generally used, although it is not necessary to be quite so grey as that used in the Bessemer process, and hence a large proportion of mottled and white pig iron is frequently employed in this process.

An average charge for tyre metal is made up of ten tons of pig iron and five tons of good steel scrap, to which from 1 to 1½ cwts. of spiegel is added, after which the charge is melted, and just before tapping, from 1¾ to 2½ cwts. of ferro-manganese is added. The heavy scrap is placed near to either end of the hearth, so as to be heated to whiteness, before rolling it into the bath of cast iron upon the bed of the furnace. A 15-ton furnace, working charges as above, will make twelve or thirteen meltings per week, thus working off a heat in ten or twelve hours, whilst about an hour will be occupied in repairing the furnace bottom, tapping out the metal, heating up, and re-charging the furnace. The number of charges worked off in a week will obviously vary with the temper of the metal produced, and upon the condition of the furnace: with softer metal the heat will be longer, and fewer charges will be worked off than when harder tempers are being melted. The average life of a furnace working the Siemens-Martin process is 150 to 200 charges.

The loss of metal in this process is from five to eight per cent. of the combined weight of the pig iron and scrap charged, while the saving in fuel and labour over other steel processes is considerable, besides which it utilizes the large quantities of scrap produced in the mills, &c.

In addition to the firms mentioned above, the Leeds Forge Company manufacture open-hearth steel to the amount of from 10,000 to 12,000 tons per annum. This steel is used

chiefly in the manufacture of steel plates, which are afterwards worked into their patent corrugated flues, or stamped by hydraulic pressure into the patent flanged frames for locomotives and bogey carriages.

The welded joints necessary in these flues, &c., are made by the use of water-gas, which gives an exceedingly hot flame, well-adapted for the welding process.

Crucible steel is made by Messrs. Catton & Co., in Dewsbury Road, and is used chiefly for the production of cog-wheels and other steel castings. In the Leeds district the Bessemer process is carried on at the Leeds Steel Works, Hunslet.

The production of open-hearth steel ingots in 1889 in the United Kingdom amounted to 1,429,169 tons, which is an increase of 136,427 tons on the quantity produced in the previous year, and an increase of 448,065 tons, on the production of the year 1887.

In the Sheffield and Leeds district, the production of open-hearth steel ingots in 1889 amounted to 121,747 tons, being 40,000 tons in excess of the production of the previous year.

Number of open-hearth furnaces at work in the United Kingdom, and average production per furnace, 1880 to 1889.

Year.	No. of Open-hearth Furnaces at work.	Production of Open-hearth Steel Ingots.	Average production of Ingots per Furnace.
1880	99	251,000 Tons	2,533 Tons.
1881	116	338,000 ,,	2,912 ,,
1882	140	436,000 ,,	3,114 ,,
1883	153	455,500 ,,	2,977 ,,
1884	133	475,250 ,,	3,517 ,,
1885	166	583,918 ,,	3,246 ,,
1886	187	694,150 ,,	3,712 ,,
1887	222	981,104 ,,	4,419 ,,
1888	230	1,292,742 ,,	5,608 ,,
1889	247	1,429,169 ,,	5,772 ,,

MACHINE TOOLS, HYDRAULIC AND GENERAL MACHINERY, AND WAR MATERIAL.

By Arthur Greenwood, Mem. Inst. C.E.

The manufacture of machine tools, hydraulic and general machinery and war material, occupies an important position in the local industries, and gives employment to about 10,000 workpeople.

The machine-tool industry originated early this century, through the general use of steam for factory, mining, locomotive and marine engines. As these increased, the ingenuity of the mechanic was directed to the invention and perfection of tools for working in metals. At the same time the great advances in the textile industry necessitated improved facilities for producing spinning and weaving machines, which, up to that date, had been made chiefly of wood. The greater strength and rigidity of iron, giving increased speed and regularity in working, has caused it to almost entirely supersede wood in the construction of machines, and has given a great impetus to the manufacture of tools for producing them. More recently, the substitution of iron and steel for wood in ship-building, the introduction of agricultural machinery, of sewing machines, and of machines for steel and iron working, corn-milling and electrical work have given a larger field and greater scope to the tool-maker.

The enormous changes in military and naval armaments since the Crimean War have also had a great influence. The introduction of rifled ordnance, first of wrought iron, and afterwards of steel, in place of the old cast-iron smooth-bores, and the mounting and manipulating of guns up to and over 100 tons, rendered wooden carriages useless, and required ingenious and elaborate mountings, worked latterly by hydraulic power.

The production of the lighter military stores, such as projectiles, rifles, ammunition and torpedoes have also led to great ingenuity in the plant required for their manufacture.

In all these developments Leeds has occupied and maintained a prominent position. Amidst the great variety of machines and tools made by different firms, the following may be mentioned as of special interest :—

Messrs. Smith, Beacock & Tannett, Victoria Foundry, Holbeck, established over 50 years ago, are the oldest firm of machine-tool makers in Leeds, and they occupy the site of the old "Round Foundry" of Messrs. Fenton, Murray and Jackson. The history of this old-established firm is almost that of the tool trade itself. Their lathes, planing and other large and special machines are found in workshops all over the world, and in Government ordnance-factories at home and abroad.

Messrs. Fairbairn, Naylor, Macpherson & Co. began about 60 years ago as machine makers, at the Wellington Foundry. The works are very extensive, and besides textile machinery for flax, &c., they make all kinds of machine tools, both heavy and light, and have held a leading position in this branch during the last 40 years.

Messrs. Joshua Buckton & Co. have a long established reputation for machine-tools of all kinds used by engineers, such as lathes, planing, shaping, and other machines in great variety, also for heavy machinery for finishing armour plates for ship-building and similar purposes. Their Wicksteed's patent testing machine is largely used in steel works and engineering laboratories, and is provided with an automatic recording apparatus.

Other firms engaged in the machine-tool trade in its various branches are :—

Messrs. Campbell and Hunter,
„ Embleton & Co.,
„ Kitchen Bros. & Co.,
„ Shepherd, Hill & Co.,
„ Scriven & Co.

Messrs. Greenwood, Batley & Co., of the Albion Works, Leeds, make both light and heavy special machine-tools, such as the lathe, weighing 350 tons, made for the Creusot Works, in France, shown at the late Paris Exhibition. They also make hydraulic machinery for forging and working metals, for extraction of oils from seeds, &c., and for compressing cotton bales, besides machines for silk-spinning, letter-press printing, and boot and shoe making.

This firm made the first Kirkaldy's testing machine 25 years ago, to test up to 1,000,000 lbs. strain. This machine is still in use, and regarded as a standard. Of other machines of this class, they have made a great number. They also produce high-speed engines and electric generating and lighting plant. They are largely engaged in producing war-material, such as the Fish or Whitehead torpedo, propelled by air compressed to about 100 atmospheres, working a small Brotherton's three-cylinder engine, and carrying a charge of 70 lbs. of gun-cotton. These machines, made at the works, are tested for running power at the Lindley Wood Compensation Reservoir, near Otley, belonging to the Leeds Corporation.

Messrs. Greenwood & Batley manufacture the special ammunition required for the new ·303 inch bore repeating rifle, adopted by the British Government, also the projectiles for rifled ordnance and the machine-made horse-shoes for H.M. Military Services.

Messrs. Tannett Walker & Co. manufacture the heaviest class of hydraulic and forge machinery, and hydraulic cranes, capable of lifting weights up to 200 tons. They manufacture the hydraulic forging-presses, which have lately supplanted the steam-hammer to a large extent. The application of hydraulic power to forging, first made by Mr. John Hasnell of Vienna, 25 years ago, was more recently adopted in this country by the late Sir Joseph Whitworth, who, at his works in Manchester, produced forgings which for quality of material and workmanship were unsurpassed. Since then, Messrs. Tannett Walker & Co. have taken a prominent part in the development

of hydraulic forging, and have supplied large presses, giving pressures from 1,200 to 5,000 tons to Messrs. Krupp, of Essen, Sir John Brown & Co., of Sheffield, and other large firms at home and abroad, including Messrs. Taylor & Co., and the Monk Bridge Iron Co., of Leeds. Messrs. Tannett Walker & Co. have recently started the manufacture of hydraulic gun-carriages for mounting heavy guns for coast defences.

Of other firms, Messrs Berry & Co., of Hunslet, and the Leeds Engineering and Hydraulic Co. also devote themselves specially to various kinds of hydraulic machinery.

Messrs. Hathorn, Davey & Co., besides hydraulic and other machinery, are known for their deep-lift and other direct expansive steam-pumping engines, also for their well-known safety motors, invented by Mr. Davey.

Mr. Robt. Middleton, of Sheepscar Foundry, makes hydraulic presses for packing, also briquette machines, and machines for use in the leather trades.

The following are noted as special machine makers. Many of them are also general engineers, tool makers, and iron founders :—

Messrs. R. Hudson & Co., Mining Machinery, Rolling Stock.
,, W. H. Baxter, Stone-Breaking Machinery.
,, H. R. Marsden, Blake's Stone Breaker.
,, W. Johnson, Brick-making Machines.
,, Pollock & Pollock, Brick-making Machines.
,, J. B. Watson, Clay-working Machines, Mortar Mills, &c.
,, Joseph Green & Nephew, Wood-working Machinery.
,, Wilson Bros., of Holbeck, ,, ,,
,, Perkins & Co., Ltd., Millwrights, Wool-washing Machines.
,, Taylor, Wordsworth & Co., Machines for the Wool and Worsted Manufactures.
,, Thomas Haley, Machines for Leather Manufacture, Hide-splitting Machines.
,, Hall & Co., Machines for Leather Manufacture, Embossing Machinery.
,, Holland & Co., Millwrights.

Messrs. Holroyd, Horsfield & Wilson, Millwrights.
,, Richard Kilburn & Son, Millwrights.
,, William Greaves, Lithographic and Printing Machines.
,, George Mann & Co., ,, ,,
,, Newsum, Wood & Dyson, ,, ,,
,, Edwin Oldroyd, ,, ,,
,, Ratcliff & Sons, ,, ,,

Messrs. Samuel Denison & Son make weighing machines of all kinds, and are specially noted for their crane-weighing machines, which weigh accurately while lifting for loading purposes.

Messrs. Booth & Co. and T. Smith & Co., both of Rodley, make steam cranes of all kinds up to the largest required in wharves, quarries, workshops, &c.

LOCOMOTIVE BUILDING AND AGRICULTURAL MACHINERY.

BY REGINALD WIGRAM.

LOCOMOTIVE Building and Agricultural Engineering in Leeds are, with the exception of Messrs. T. Green & Sons, Ltd., confined to Hunslet.

Blenkinsop's engine, built by Messrs. Fenton, Murray & Jackson, of Holbeck, working by means of a toothed wheel, gearing into a cogged rack, was the first commercially successful locomotive used in England. Four engines of this class were built, and worked on the Middleton tramway from 1812 till about 1830. Messrs. Kitson, Hewitson, E. B. Wilson, and Chas. Wardle have been most intimately associated with this industry in Leeds.

Mr. E. B. Wilson's works were closed in 1857; and here, and at the Airedale Foundry, most of these now connected with Locomotive engineering in this town, learnt their business.

The following table represents the trade at present :—

	Founded	Area in Acres	Yearly Output.	Men Employed.	Notes.
Kitson & Co., Airedale Foundry	1837	11	72	1,400	Also fixed and Tram Engines.
Manning & Wardle, Boyne Works ..	1858	5	64	500	
Hudswell & Clarke, Jack Lane	1861	3	36	400	Also 11,000 pulleys per annum.
Hunslet Engine Co., Jack Lane	1864	2½	26	300	
John Fowler & Co., Leathley Lane ..	1861	9	250	1,150	Engines of all sorts.
J. & H. McLaren, Jack Lane	1876	2	56	150	Engines of all sorts.
T. Green & Sons, North Street ..	—	—	75	—	Tram and Agricultural.

Mr. Kitson, the founder of Airedale Foundry, with the very able mechanical aid of Mr. Hewitson, and other partners, developed the extensive establishment now managed by his sons, with the assistance of Mr. Reay. The principal output of this concern is in main-line engines for India and the colonies, as well as for the English lines. In addition to these, they manufacture heavy rolling-mill and blowing engines for iron works and steel works.

Messrs. Manning & Wardle confine their business to a light type of locomotives, such as are used by contractors, and in large manufactories. This firm owes much to the great skill and mechanical ability of the late Mr. Robt. McIntyre, for many years manager at the Boyne works.

The Hunslet Engine Co. make a similar class of engine to that built by Messrs. Manning & Wardle, as well as special locomotives for various purposes, amongst them the single-line engines, known as the Lartique class. They have constructed in all 550 engines, varying from 3 to 33 tons in weight.

Messrs. Hudswell & Clarke, now managed by Mr. Clayton, make, principally, a light class of locomotives similar to those

built by the last named firm, but have a speciality known as Rodgers' wrought-iron drums. In 1889 the firm constructed 11,000 of these pulleys. They have built in all about 380 locomotives of various sizes.

The late John Fowler founded the Steam Plough Works in 1861. The productions of this concern are most varied. In 1889 they built 29 locomotives, and have produced an average of about 250 engines a year for many years past. They manufacture an entire system of narrow-gauge railway and rolling stock as well as main-line locomotives for export. Their principal business is in agricultural, mining and semi-portable engines for electric lighting and similar purposes. Mr. David Greig has been allied with this firm from its start until the present time, and has been continuously occupied in originating and developing improvements in agricultural and other machinery. Steam ploughing and traction engines form a large part of the annual output, but engines for various purposes and of many descriptions are constantly in progress.

Messrs. J. & H. McLaren commenced their business in Hunslet with the manufacture of traction engines, but now include road rollers, semi-portable engines, and steam ploughs in their list of manufactures. Their most notable production is a high-speed road-locomotive, running at 12 miles per hour on common roads, by means of which they have successfully worked a service between Lyons and Grenoble, running some 70 miles regularly in about 10 hours. Their average output has been about 30 engines per annum.

Messrs. T. Green & Son, Ltd., make a great variety of small machines for horticultural and agricultural purposes, besides fencing, garden seats, &c., and many small labour-saving appliances. Lately they have commenced the manufacture of tramway-engines for town-streets, &c. The tramways of Leeds are partly worked by their engines. In 1889, they produced 25 engines of this class, besides 50 portable and other engines.

THE MANUFACTURE OF FLAX MACHINERY.

By Arthur T. Lawson.

This is a most important industry in Leeds, employing about 3,000 men. The first great step taken was to follow Arkwright, and bring into use the so-called "roller spinning." Only the bare idea of drawing and spinning with rollers was borrowed from another trade. The early makers of flax machinery had to invent means of spreading, drawing, roving and spinning a material 26 in. long and upwards. The fibre had previously to be nicely heckled, until it became fine enough to give a suitable thread.

This manufacture may be said to have been founded in 1787, by John Kendrew, optician, and Thomas Porthouse, clock-maker, both of Darlington, who patented a machine upon new principles for spinning yarn from hemp, tow, flax, or wool. These inventors established a small factory in Kendrew's workshop, and not only made their own machines, but applied them to spinning fibre into yarn, which they sold for weaving purposes. They attracted the attention of linen manufacturers, notably of Mr. John Marshall, whose firm was the first to give a great impetus to flax-machine making. Mr. Marshall had a mill fitted up with Kendrew and Porthouse's machines, and applied himself to their improvement. In this he employed Mr. Matthew Murray, of the firm of Fenton and Murray of Leeds, noted at that time for his improvements in the steam-engine. So great was Mr. Marshall's success in his undertakings, assisted by Murray's practical knowledge, that it led to the latter being employed by many other rising spinners. Murray's works, noted for their excellent workmanship and fitting, grew and extended, and became the nucleus of many other firms of flax-machine makers. Flax mills increased in numbers over the country. In 1836, there were in Leeds alone over 40 flax-spinning mills, giving employment to numerous machine makers.

Some years prior to this time, the firm of Lawson and Walker, now Samuel Lawson & Sons, and later the firm of Fairbairn & Co., now Fairbairn, Naylor, Macpherson & Co., entered into business. These firms, by their enterprise and inventions have so developed the industry, that machinery made in Leeds is now exported to every part of the world where the manufacture of flax is carried on.

In 1825, W. K. Westley patented the famous "screw gill," which was worked by these and other firms, and still forms an important feature of the trade.

Wet spinning was invented by Girard, in France, in 1810, and in 1817-8 was practically worked in Leeds, by Mr. R. Busk and W. K. Westley. It was not at that time taken up by the large manufacturers. In 1832, James Kay, of Pendleton, patented his process of wet flax spinning, which has been the means of great extension of the manufacture of machinery for these purposes.

Leeds also supplies the world with machinery for hemp-spinning in all its branches, not the least important being that for preparing and spinning yarns for ropes for marine and other requirements. The machinery for the jute manufacture is almost entirely made in Leeds, and by the two firms named above.

THE NAIL INDUSTRY.

By Jonathan Grimshaw.

The marvellous advance in the cut-nail industry is shown by the fact that within the memory of men still employed at the writer's works, sheets of iron were cut into wedges with a fly press, and heads knocked on them whilst held in a vice. This method connected the old hand-made nails with the present manufacture by machinery alone. At one time, whole families—husband, wife, and children down to four years of age—were employed in making all kinds of nails. Now, all sizes of nails

are made by machinery, from those weighing less than one ounce per thousand, to spikes 8 inches long, weighing 8 ounces each. One machine, in half-an-hour, produces what would formerly have taken a whole family twelve hours to make.

Bessemer and Siemens-Martin steel is almost universally employed in the cut-nail trade, and the quality is superior to that of the old wrought nails. These cut-steel nails can be made so hard and fine, that they can be driven at one blow into a pine-wood knot, so that in another fifty years wrought-iron nails may only be seen as curiosities in museums.

Cut-nails were first made in 1832 by one firm, who turned out half-a-ton per week. Now 250 tons per week is an under-estimate for the production in this town, and the price is, in many cases, less than a fourth of what it formerly was.

Wire-nails are also largely manufactured in Leeds, but the case-makers who used wire-nails, are now finding that cut-nails hold better.

The casting of malleable nails, and boot protectors has only recently been added to the trade of the town. These are manufactured for one firm at the works of the writer. The metal must be heated to such a temperature that it runs almost like water, so as to take the finest markings of the moulds. By careful annealing, they are made almost as ductile as wrought nails.

The following five manufacturers employ about 450 hands, and produce about 13,000 tons of nails per annum :—

Messrs. J. Grimshaw.
„ I. & J. Ingham.
„ B. Mountain & Sons.
„ C. & E. Roberts.
„ J. Roberts & Son.

THE FIRE-CLAY INDUSTRY.

By the Late James Holroyd.

This industry owes its origin and development to the excellence of the local raw material—the fire-clay found in the Coal Measures along with thin seams of coal. It consists of silica and alumina, chiefly in combination as hydrated silicate of alumina, but it varies considerably even within a small area. It occurs at various depths, but its workableness does not vary as might be expected according to depth.

The Wortley, or Better Bed Clay, forming the seat earth of the Better Bed Coal in the Lower Coal Measures, underlies a great part of the East and South of Leeds. Thoresby, in 1714, refers to "a good vein of fire-clay" in the Wortley Hundred, used for making tobacco pipes. Such clay, found at the outcrop, would be less refractory than the clay now used.

An analysis of the Better Bed Clay selected for refractory qualities gives the numbers :—

Silica *	64·93
Alumina	22·54
Oxide of Iron	1·61
Lime	0·19
Magnesia	0·02
Alkalis	0·15
Combined water with traces of Organic Matter	8·28
Moisture	2·28
	100·00

This analysis shows the absence of impurities, which interfere with the colour and the refractory qualities of the clay. The thickness of the stratum worked is from 2 to 3 feet. For all purposes in which great purity of colour is a desideratum, the quality of the coal used in the burning of

* Containing about 0·9 per cent. of Titanic Acid.

fire-clay products is only second in importance to the quality of the clay itself. The clay has the character of a strong-blue marl, sometimes striated, sometimes charged with Stigmaria-roots, which, in their carbonised condition impart varying colours. The clay is generally got by mining in the usual manner, but frequently requires to be blasted on account of its tenacity and hardness.

There are in the district about twelve clay-mines in full operation, several mines being worked by one firm.

The principal works in the district are—

Joseph Cliff & Sons, Wortley.
William Ingham & Sons, Wortley.
The Wortley Fire-clay Company.
Messrs. Wilcock & Co.
E. Brooke & Sons.
Joseph Brooke & Sons.
} Forming the Leeds Fire-clay Co. Ltd.

The Farnley Iron Company.

The products of the Leeds Fire-clay Industry may be classified as—

1st.—Refractory.
2nd.—Sanitary and Constructive.
3rd.—Decorative.

This classification indicates the order of development of the various branches of the industry since the latter part of the last century. The founder of the fireclay industry was Mr. John Cliff, of Wortley. For many years the manufacture was confined to the refractory fire-bricks used in the iron manufactures. The manufacture of coal-gas also led to the production of fireclay retorts and similar articles in quantity, and in 1845 the manufacture of sanitary tubes was begun. The salt-glazing process applied to these, gives a glaze simply applied and very permanent. In the Leeds district, machinery is now used in the production of all sizes of tubes, from 2 to 36 inches in diameter. The production of sanitary pottery has been further developed by the introduction of a porcelain enamel glaze, possessing the cleanliness, purity, and smoothness of surface

characteristic of the finest earthenware. By this process it is possible to produce a variety of articles, for which stoneware or earthenware, as generally understood, would be inapplicable. Another branch of the trade, which was started about 25 years ago, is the manufacture of glazed bricks. The bricks are largely used in the erection of hospitals, dairies, and other buildings where it is desirable to have a bright, cleanly, and imperishable wall-surface. The new Royal Infirmary at Liverpool, and the West Riding Asylum at Menston, opened last year, are examples.

Terra Cotta, a material long known, but often made and used unskilfully, has had its good qualities exhibited by Mr. Waterhouse and other leading architects, notably in the Natural History Museum at South Kensington. The manufacture was begun seven years ago at Burmantofts, and has been developed by extensive plant and by the best artistic and manipulative skill obtainable.

The Faïence Art, left to us from the Italian Renaissance of the 15th century, has also been revived at the works at Burmantofts, and since 1882 the manufacture has grown to large proportions. The product is chiefly used for mural decoration, and may be seen in many buildings in this and other countries.

While machinery and steam power are utilised in some branches of the Fire-clay industries, yet in others the processes now in use date back to the most remote periods. Steam engines, amounting to about 500 nominal horse-power, are employed in the different works in the district. The works themselves cover an aggregate area of about 80 acres, and the workpeople employed in them, including those also engaged in getting the clay, number about 2,500 men and boys. There are also about 100 girls engaged in various processes of painting and decorating.

HISTORY OF THE WOOLLEN MANUFACTURE.

By Stephen Parkinson.

The Woollen manufacture in this district is of great antiquity. Early documents speak of the cloth made here in 1272, and of mills for the fulling of cloth in 1373. Leland, visiting Leeds in 1536, says :—"The town standeth most by clothing," and Camden, a few years later, describes it as a town rendered wealthy by the woollen manufacture. Later still, in 1626, it is set forth in the first Charter of Incorporation of the borough, how "to their perpetual praise and the great increase of the revenue" the inhabitants of Leeds had, for many years past, "skilfully exercised the art or mystery of making woollen cloths." When, in 1678, Thoresby began business, the only cloth-market in the town was held on Leeds Bridge. In 1684, it was removed to the open street in Briggate. It is amusing to read that at this time there was great alarm, lest the whole woollen trade of Leeds should be carried off by the enterprising people of Wakefield, who had erected a Cloth Hall for the accommodation of the clothiers of the district. At the instigation of Thoresby, the first Cloth Hall was built in Kirkgate, in 1711, and, less than fifty years after, a second hall became necessary, and the "Coloured or Mixed Cloth Hall" was erected, in 1758, on lands forming a portion of the park of Leeds, to the west of the town. About the year 1800, nearly 2,000 clothiers exposed their goods in this hall. As regards white, or undyed cloth, its manufacture had also so increased, that in 1775 a new and larger hall was erected in the Calls, and a few years after was attended by not less than 1,300 clothiers.

In these early days communication was often difficult, especially in the hilly clothing district of the West-Riding, many of the roads being only "pack-horse roads," along which travelled strings of pack-horses, and occasionally heavy, broad-wheeled waggons, carrying wool and raw material to the manufacturer, or bearing away the cloth for sale and distribution.

Defoe, in his "Travels of a Gentleman throughout Great Britain," speaking of the cloth trade of Leeds, about the beginning of the reign of George II, says:—"There are a set of travelling merchants in Leeds who go all over England, with droves of pack-horses, to all the fairs and towns, I think I may say none excepted. Here they supply not common people, by retail, which would denominate them pedlars indeed, but they supply the shops by wholesale, and whole pieces, and not only so, but give large credit, to show that they are really travelling merchants, and as such, they sell a very great quantity of goods. It is ordinary for one of these men to carry £1,000 value of cloth with them at a time, and having sold it at fairs or towns, where they go, they send the horses back for as much more."

Towards the close of the eighteenth century, improvements in processes and machinery, along with steam power, began to be introduced. At that time cloth was classified either as white cloth, woven from undyed wool, or as coloured or mixed cloth, from wool previously dyed; and was made chiefly in the villages around the borough, rather than in the town itself. The cloths were sold in the cloth halls in the rough, or "balk" state, as they came from the fulling mills to the merchants, who dyed and finished them ready for wear. In these processes improved machinery was gradually introduced, and, in 1796, Arthur Young, visiting Leeds, speaks of six or seven steam engines used in woollen mills, and one in a dyeing-house, and says that machinery similar to that which had done so much for the cotton trade was being rapidly introduced in the woollen manufacture. Before a Parliamentary Committee, in 1800, Mr. Benjamin Gott stated that that which fifteen years before required 1,634 persons to do, was then done by 35 in the processes of scribbling and spinning by machinery. The production of woollen cloths in the West-Riding more than doubled in the seventeen years, 1788-1805. Though the making of superfine cloths had been increasing, the bulk of the trade consisted of the coarser kinds of cloth. Other finished articles were then introduced, such as swansdowns,

toilonets, kerseymeres, and in 1823 the town was spoken of "as the principal seat of the woollen manufacture in England."

As in former days the abundant water power of the district favoured the industry, so now the cheap and abundant fuel from adjacent coal-fields supplies the steam power. This, and the costly machinery brought into use, led to the establishment of great factories, and the decline of the cottage manufacture. The late Sir E. Baines, speaking at the British Association Leeds Meeting in 1858, estimated that in the Leeds clothing district, extending eight to ten miles round the town, there were engaged in the trade 340 firms, 7,810 horse-power, 423,482 spindles, 2,344 power-looms, 1,005 gigs, and 23,328 factory operatives. These figures comprehended more than half the woollen manufacture of Yorkshire, and more than quarter of that of the whole kingdom, and the manufacture gave employment to about 40,000 persons.

The ten years 1860 to 1870 witnessed an enormous increase of the woollen, worsted, and shoddy manufactures. The paralysis of the cotton trade in Lancashire led to a greatly increased demand for the woollen and worsted fabrics of this district. These, whether all wool or wool in combination with other materials, were made into many articles of clothing formerly made of cotton fabrics only. During the terrible famine in Lancashire the woollen trade received an impetus which it has never lost.

During the last thirty years the business done in the cloth halls has gradually declined, and the removal of the old Coloured Cloth Hall marks its extinction. The business has since been done in the warehouses, the merchant ordering direct from the manufacturer goods of the exact quality and quantity to suit his requirements. The goods are delivered direct from the mill to the merchant.

Formerly the operations in the manufacture of cloth were carried on separately as distinct trades, but competition, and the necessary economy to meet it, have caused the manufacturer to take all the processes, including weaving, dyeing, and finishing, under his own management.

About twenty-five years ago worsted yarns began to be used in weaving goods for men's wear. These were at first purchased at Bradford, but afterwards the Leeds manufacturers began spinning such yarns themselves, and to-day wool is combed and spun into worsted yarns and woven into worsted goods on a large scale in the Leeds district. Worsted coatings, made entirely of worsted yarns, are produced in great variety; and worsted goods, composed partly of worsted and partly of woollen yarns, sometimes combined with cotton, are largely manufactured for the clothing trade. Besides these, a vast number of different fabrics for both men's and women's wear, into which fancy yarns of almost all descriptions are introduced, are produced in Leeds and the neighbourhood. Many of these are marvels of cheapness, and a marked advance has been made of late years in the taste displayed in the designs and combinations of colours. That the manufacturers hold their own in spite of fierce competition proves their enterprise in seizing upon the latest improvements, and their skill in adapting themselves to the changes of fashion. The relations between the employers and employed are generally amicable, and strikes are almost unknown in the Leeds woollen industry.

From a return presented to Parliament in 1870, there were then in Yorkshire 954 woollen factories, 60 shoddy factories, and 516 worsted factories, and of these there were in Leeds and its district 250 woollen, worsted and shoddy factories, employing 30,000 hands. The number is less than in 1858, and the diminution is largely owing to the extinction of small firms, and the saving and economy of production in the large factories fitted with the best machinery.

There is no doubt in the minds of those best qualified to judge that the manufacture is now more extensive than it has ever been before, and that the new developments in worsted and mixed fabrics more than make up for any falling off in the woollen cloth trade.

WOOLLEN MANUFACTURES.

By Thomas Fairley.

The two main branches of these manufactures are: woollen cloth, such as broad cloth; and worsted, such as merino, etc. A third is the woollen felt cloth manufacture of less magnitude. Comparing broad cloth with a worsted fabric, the former shows no web or woven character, but appears as a fine fur; whereas in worsted the threads are distinctly visible. Yarn for woollens is spun from short wool, with the fibres more or less transverse to the axis of the thread. In the fulling of the cloth these fibres are locked or felted together, and being afterwards raised in the teazling process and cropped to a uniform length, give a fine even surface to the cloth.

Yarn for worsteds is *generally* spun from long wool, the fibres being laid evenly and parallel with each other, and is harder spun than woollen yarn.

The processes in the manufacture of woollen cloth are:—

1. *Sorting the Wool*, which varies in length and fineness, into different grades, according to the quality and purpose for which the wool is intended.
2. *Scouring* in alkaline liquor with soap, washing with clean water, and drying in a heated chamber by hot air.
3. *Dyeing, when dyed in the wool.*—The wool is immersed in the hot-dye liquor, then washed and dried. *(See article on Dyeing.)*
4. *Willying*, to free the wool from dust, seeds, etc., on the willying or devilling machine, which consists of a drum armed with spikes working against spiked rollers, which revolve in an opposite direction. Where necessary, the burring machine, to remove "burrs," enters into this process.
5. *Blending, Oiling, and Teazing.*—Different qualities of wool are mixed carefully to suit the price and purpose for which the fabric is required. Recovered materials such as shoddy or mungo, or cotton may be added at this stage. The wool is sprinkled with oil and teazed so as to open it out, and prepare it for the carding processes.

6. *Carding operations.*—Generally three, carried on by a series of cylinders, bearing cards, or brushes of wire, the object being to blend the fibres into one thin uniform sheet of wool. When sufficiently carded, the wool is divided into strips, and rolled into slivers by the condenser.
7. *Spinning into Yarn* (*warp or weft*).—Generally on a mule, resembling those used in spinning cotton; first into single or one-ply yarn, afterwards twisted into two-, three-ply, &c., as may be required. These complex yarns may be made from the same or different kinds of singles.
8. *Winding, Warping, and Sizing.*—These are each done upon special machines, adapted first to wind the yarn on warpers' bobbins; second, to wind them into warp, with the threads parallel; and third, to size the warp threads to make them stronger.
9. *Weaving* into cloth "raw thread," the warp and weft-threads being visible.
10. *Scouring and Burling.*—The cloth is scoured to remove oil and size, washed and dried. It is then examined by the burler, who removes knots or burls, and fine-draws or darns any thin or open parts.
11. *Milling or Fulling.*—Formerly under the fulling stocks, in which the cloth, immersed in hot soapy water, was beaten by heavy mallets; now by rollers pressing the cloth, which is charged with a thick solution of soap. The milling causes the cloth to felt and to shrink greatly. The cloth is then carefully scoured, washed, and dried on the "tenter" or stretching frame.
12. *Teazling, Raising, and Cropping, &c.*—The teazling is so called from the use of the teazel, the ripe head of *Dipsacus fullonum*, whose hooked scales are best adapted for raising the nap without injuring the cloth. The teazels are mounted on a revolving drum in a gig-mill, and rub against the cloth. The nap so raised is shorn or cropped to a uniform length by a machine on the lawn-mower principle and the teazling and cropping may be repeated according to the finish required in the cloth. The cloth is then brushed by revolving brushes and pressed.
13. *Dyeing, when piece-dyed.*—When the cloth is to be piece-dyed it is, after boiling and cleansing, &c., dyed as in wool dyeing. The cloth is then again cropped and pressed under the influence of heat and moisture, so as to develop the lustre and smoothness of the finished article.

Worsted Manufactures.

The manufacture of *Worsteds** is carried on by the following processes :—

1. *Sorting, Washing, Drying, and Plucking.*—To avoid tendency to curl, long wool is dried less completely than in the case of woollens. The wool then passes through a plucker, containing a fanning apparatus, to separate dust and impurity.
2. *Combing operations.*—The very perfect machine-combs of Lister, Holden, Noble, and others now take the place of the old hand-combs. To prepare for these, long wool is straightened by means of a series of gills (combs with steel teeth), and short wool by passing through a carding machine, which lays the fibres in one direction in a continuous sliver. The combing operations all tend to straighten the fibres, and to bring them into one direction parallel with one another. The combing of long wool also separates the long fibres, the top, from the short curly fibres, called the noil.
3. *Drawing, Roving, and Spinning.*—These operations are carried out by machines generally similar to those in use in the cotton manufacture, but specially adapted for this manufacture.
4. *Reeling, Warping, Sizing, and Drying.*—Where necessary, the reeling is done on a machine for the purpose. In many works, both woollen and worsted, the warping, sizing, and drying are done by means of very compact and efficient machines invented and improved by Bywater.
5. *Weaving.*—Not only is a variety of materials used in the yarns for this branch of manufacture, but there are a great many different modes of weaving the weft and warp together, and consequently an immense variety of worsteds.
6. *Dyeing, Finishing, &c.*—Generally, worsted goods are dyed in the piece. (*See article on Dyeing.*)

Felt Cloth Manufacture.

The manufacture of woollen felt cloth is carried on in Leeds on a considerable scale. Short wool, or the short fibre from the disintegration of rags, after cleaning, is passed to large carders,

* So named from the town of Worsted in Norfolk, where the manufacture was originally carried on in England. The name may be a corruption of "Wolestede" —the place of wool.

which deliver the material in a broad thin sliver scarcely thicker than a cobweb. A number of these slivers are unwound from rollers simultaneously, so as to give a warping of about an inch thick, more or less according to the thickness of the material required. The warping is then passed between rollers immersed in hot soapy water—the rollers having a lateral or rubbing motion. The felt thus obtained, much thinner than the warping, is then dried, pressed, printed or dyed, and used for the production of table-covers, upholstery cloths, crumb cloths, carpets, horse cloths, &c.

In 1888 the total quantity of wool imported into the kingdom amounted to 639,000,000 lbs., costing about £21,000,000. Of this quantity about one-half was exported as wool.

In the same year the woollen manufactured goods of all kinds exported were valued at nearly £26,000,000, and those imported from other countries at about £11,000,000.

THE DYEING INDUSTRIES OF LEEDS.

By John William Reffitt.

Comparatively little is known by the wearers of dyed fabrics of the antiquity or the importance of the dyeing industry in Leeds and district, because the dyer never sells direct to the public; he either dyes wool before it is spun into yarn, or, commissioned by a merchant, dyes and finishes the cloth after it is woven.

A.—Wool, and Woollen Cloth Dyeing.

The business of unspun wool dyeing has been carried on in Leeds for more than a century. It is no exaggeration to state that more than half the dark-coloured clothing worn by officers of the army and navy, besides the police, and uniformed officials on the railways, is made from wool dyed in Leeds by the following firms:—Messrs. Wm. Walker & Co., Mr. Henry Fawcett, Messrs. Croisdale Bros., Messrs. Wm. Kitchin & Co.

In wool-dyeing the wool is first scoured to remove the natural oil and all dirt; it is then submerged in large dye-vats,

which for best blues contain finely ground indigo, woad, bran, and lime in suspension in warm water. Fermentation sets in, due mainly to the woad and bran, and the blue indigo becomes reduced to a colourless compound, soluble in the alkaline liquid. The wool is immersed in the dye-bath until it has absorbed as much of the dye as corresponds to the shade required. It is then exposed to the air, when the soluble colourless indigo changes to the ordinary blue indigo, giving a very fast and permanent dye. For best blacks the wool is dyed blue as above and then black by boiling with logwood and sulphate of iron. This black dyeing is repeated two or three times if necessary, to deepen the colour. The use of woad is believed to improve the depth and durability of the colour. Less permanent blues are obtained by the use of sulphate of indigo or of Prussian blue, and blacks by means of logwood or other dyewoods, with sumach. Iron or chrome is used as a mordant. After dyeing, the wool is washed, dried and sent to the manufacturer, who combs, spins, and weaves it into cloth.

The trade in superfine woollen cloths for men's wear, which were largely manufactured and dyed in Leeds and district prior to 1860, has since gradually changed in favour of such makes as meltons, fancy coatings, and worsted cloths. The dyeing of worsted cloths is a considerable industry in Leeds, the principal firms being Messrs. Wm. Walker & Co., and Mr. Cockroft Hellowell; also Messrs. Joshua Wilson and Sons, who both manufacture largely, and dye their own cloths.

B.—Stuffs Dyeing.—(1) Damasks, Moreens, &c.

The dyeworks of Messrs. H. Holroyd & Co., at Sheepscar, Leeds, date back about 150 years, when the only thin worsted material in the market was tammy cloth,* a thin fabric used for window blinds and curtains.

* At this period, the market for tammys was held at Wakefield, where a building called the Tammy Hall was erected, and the market governed by a Board of Trustees; so conservative was this body, that it is related that when an enterprising weaver had originated a new style of material and taken it to the Tammy Hall to sell, the innovation was resisted by the trustees as dangerous to the tammy industry, one trustee remarking that "the mart was built for a Tammy Hall, and a Tammy Hall it should remain."

During the last hundred years, Messrs. Holroyd have been dyers of damasks, repps, and moreens, used for furnishing purposes.

The damasks and repps are dyed in vats or cauldrons of pure tin, three-quarters of an inch in thickness. The moreens are finished by hot pressing whilst two surfaces of the cloth are laid together face to face, and this produces the curious watered or moiré antique effect seen on these goods.

(2) Dress Stuffs Dyeing.

Bradford has been for some years the seat of the dress stuffs trade of Great Britain, but the stuff merchants were formerly located in Leeds, whence they gradually migrated to Bradford, in order to be near the spinning and weaving mills of that town and district.

The dress goods dyeworks of Messrs. James Reffitt & Sons, established in 1827, is one of the oldest in Leeds, and was built at a time when dress fabrics, other than calicoes and silks, were limited to those manufactured from English wool, such as merinoes, &c.

About fifty years ago, when Australian wool, which is much finer and softer than English, came into the market, it gave a great impetus to the manufacture of dress stuffs. When used alone or when blended in various proportions with English wool, it forms the weft of such well-known goods as cashmeres, Persian cords, Cobourgs, crapes, plain serges, and estamene serges. About the same time, dress stuffs composed of cotton warps, mohair and alpaca weft, were introduced, and these goods became very fashionable both at home and abroad, and so conduced to a greatly improved trade.

During this manufacturing progress, the dyers had many difficulties to contend with in the dyeing and finishing of these mixed fabrics, so as to produce even colourings on the combined materials of the fabric, and in developing their lustre or softness. By perseverance, stimulated by competition, the various difficulties have been gradually surmounted,

and at present the dyers of Leeds, Bradford, and district, stand unrivalled in the dyeing of cotton-warp dress goods.

The work of the stuff dyer and finisher, whose business it is to take in hand woven dress goods direct from the manufacturer's looms, and to turn them out ready for the wearer, comprises a considerable number of processes, beginning with scouring to remove the oil introduced into the yarn by the spinners. After scouring, the cloth is stretched upon perforated metal rollers and steamed (by a process first introduced by Messrs. Reffitt and since adopted by the trade). This secures even shrinkage, and prevents subsequent crimping during wear or if accidentally wetted. The cloth is next singed to remove projecting fibres, by passing it rapidly and in contact over red-hot copper or iron plates. Then follows the dyeing of the worsted weft in boiling dye-vats ; the cotton warp meanwhile remaining undyed because it has no affinity for the worsted dye. The cotton warp is next dyed by dyes different from those required by the wool, but suitable to itself. Notwithstanding this curious mixture of processes, the practised dyer is able to match the required shades, so that in the result there is no appearance of double dyeing.

When required, "shot" effects are obtained by dyeing the weft with one colouring matter, and the warp with another.

After various finishing processes, ending with hot pressing, the fabrics being now ready for the wearer, are handed back to the merchant.

C.—Stoving, Tinting, and Dyeing.

"Stoving," or the bleaching of wool and other fibres by submitting them to the vapour of burning sulphur, in a closed compartment, is by no means a modern process, but the firm of Samuel Kirk & Sons of Leeds, have developed important improvements in the dyeing of delicate tints and colours by the combination of the sulphur stoving process with dyeing ; for instance, dress fabrics, such as Orleans, alpacas, and mohairs, are first bleached to pure white

by stoving, and then lightly tinted or dyed to a variety of pure and delicate colours. This firm has also a reputation for the dyeing of Italian cloths in all colours. These are mixed goods, *i.e.*, worsted weft and cotton warp, and are used for coat linings.

New Dyes.

The discovery of aniline and other dyes obtained from coal tar, has caused a revolution in colour-dyeing. Mauve, discovered by Perkin in 1856, was followed soon after by Magenta, and now colours are obtained of the greatest variety and beauty: the latest, and probably the most important, being alizarine, identical with the colouring principle of madder. Alizarine Blue bids fair to rival indigo in its fastness during exposure to air, light, and sea-water. It is not too much to say that the success of modern chemists in inventing these wonderful and useful products is almost as magical as the transmutation of base metals into gold would have been if attained by the alchemists of old.

MANUFACTURE OF READY-MADE CLOTHING.

By Henry Barran, M.A.

The industry was first commenced in Leeds, about the year 1856, by Mr. John Barran, M.P. Since then it has increased so much, both by new firms entering the business and others moving their factories here, that it has become one of the chief industries of the town.

There are probably, at the present time, upwards of ten thousand persons (mostly women and girls) capable of making four to five million garments annually, employed in this trade.

Besides supplying the home market, including the army, police, and other contracts, Leeds competes successfully in the foreign and colonial markets. It is in these latter directions that any future expansion of the trade must be looked for.

The first stimulus to the trade was due to the introduction of steam power, improved machinery, and the importation of colonial wool. About 1840, cloths were further cheapened by the introduction of mixed yarns of cotton and wool, or of wool mixed with fibre obtained from working up old materials, bringing clothing of good appearance within the reach of the poorest classes. Above all, the invention of the sewing machine, brought into general use about 1855, helped to reduce the cost of all kinds of garments.

The chief feature which distinguishes the method by which this industry is carried on in Leeds, from that employed in other places, is the "factory system," as distinguished from manufacture in the homes of the operatives. By far the greater part, indeed almost the whole, of the work in Leeds is done in factories, mostly of considerable size, under the provisions of the Factory Act, whereas in London, and many other towns, the work is given out to be made up, either in small work-rooms, many of which escape inspection, or in the living rooms of the workpeople.

In this industry, the "factory system" has many advantages for the employer, the operatives, and the public. The organisation and division of labour are very perfectly carried out, the operatives earn good wages, and work in rooms thoroughly ventilated and fitted with the best sanitary appliances.

The following are some of the principal firms occupied in this industry :—

Messrs. Arthur & Co.
„ John Barran & Co.
„ Buckley & Son.
„ Campbell & Co.
„ Gaunt & Hudson.
„ Hepworth & Son.
„ J. Rhodes & Co.
„ Schofield & Parkinson.
„ Stewart & McDonald.

THE FLAX TRADE IN LEEDS AND DISTRICT.

By W. S. Sykes.

The flax trade in Leeds is a decaying industry. Thirty to forty years ago the preparation of flax and the spinning of flax yarns for home use and exportation gave employment to large numbers of people. Now the large mills of Messrs. Marshall & Co. and many others are closed, and the only firms left in this branch of the trade are Messrs. Titley & Co., and Messrs. Briggs & Co. who spin linen yarns for weaving.

The American Civil War caused a great demand for linen yarns to take the place of cotton, prices ruled high, while raw materials were low, and spinners made great profits. The mills were extended, and new machinery introduced, but in many cases these alterations were barely completed when cotton became plentiful and prices fell.

The competition of the Belgian and North of Ireland spinners was too powerful for those of Leeds, who lost some of their best foreign markets, so that many of them had to close their mills.

The heavier spinning of Russian and Italian hemp yarns has not of late had to suffer such keen competition, and the trade is at present a growing and successful one.

THE LINEN TRADE OF LEEDS AND WEST RIDING.

By R. Buckton.

A large production of linen fabrics has been carried on in various parts of Yorkshire for several centuries, of which Knaresbro' and Barnsley were the centres. The flax, after being dressed and prepared, was distributed by the master

manufacturer to the weavers in their own homes in the surrounding villages. A workman having one, two or three looms as the case might be, the flax was spun into yarn by the women and girls. In 1788 the linen manufactured weekly in Knaresbro' and district amounted to 1,000 pieces, each worth 13s. 6d. to 30s., according to quality. In 1820 there were upwards of 63 master manufacturers in this district alone, besides a considerable number in Barnsley. The well-known firm of Messrs. Walker, Oates & Co. had a very extensive business, employing nearly 1,000 workpeople, and were famed for the excellence of their manufactures. From 1823 to 1825, there were a number of weavers' strikes, followed by the crisis of 1826. The trade was paralysed and never recovered itself in this district. In Barnsley and district in 1850, there were no less than 15 firms, doing a large trade in the weaving of various qualities of cloth, and at the present time there are about 900 power-looms, engaged in the manufacture of twills, damasks, huckabacks, linen sheetings, &c.

Down to 1845, Leeds was the great centre of flax spinning, and supplied yarns to all the manufacturing parts of the country, besides all the European countries. A considerable number of hand-looms had been for many years employed in weaving coarse linens, sacks, bags for grain and flour, and canvas for packing purposes. At this time Messrs. Marshall and Co. erected a large shed mill for power-looms for the manufacture of linen sheeting, drills, &c. They had a high reputation for the excellence of their goods. Other firms were established soon after, and Leeds manufacturers for the last thirty years have been the chief producers of canvas for waterproof covers, packing purposes, linen bed-ticks, &c. Within the last few years the trade in huckabacks, canvas for government tents, marquees, soldiers' and sailors' beddings, &c., has greatly extended.

The first introduction of power-looms for linen required a stronger warp yarn to be used, and showed the necessity for further improvements. About 1860 the U creel and warping machine was introduced. The sectional warp

machine is the latest improvement, saving much time and material. About 1864, Mr. James Combe, of Leeds, brought out his cop-winding machine for linen weft, and soon afterwards the process was further simplified, so that the cop machine was arranged with hank stands, to wind directly from the hank to the cop, with greater accuracy and increased yield of cloth.

Linen fabrics are of great variety, from the most delicate lawns to the rough sacking and sail canvas, the flax fibre being adapted from its fineness and strength to produce either the very finest or the strongest cloth. The finest goods are produced in Ulster and Scotland. Leeds is the centre of the linen trade in England, producing a heavier class of goods.

The manufacturers at present engaged in the linen trade of Leeds are :—

Messrs. R. Buckton & Sons.
„ C. Dovener.
„ G. & R. Robinson.
„ C. Fox & Son.
„ T. Leuty & Co.
„ T. F. Stead & Co.
„ T. B. Cumpston & Co.
„ W. Place & Co.

These have about 1,300 looms and 1,700 workpeople, and produce weekly upwards of 200,000 yards of linen goods. The women and girls employed in weaving earn from 9s. to 12s. weekly, and in the preparing department 7s. to 10s. weekly.

The finishing of the goods which were formerly sent out to the calenderer, is now in almost every instance done by the manufacturer himself.

Several firms in the neighbourhood do a large trade in the bleaching of linen yarns and linen piece goods, the principal being Messrs. J. Gill & Sons, of Horsforth.

THE LEATHER MANUFACTURE.

By W. Beckworth.

Fifty years ago the Tanning trade of Leeds was confined to a few old-fashioned open tan-yards, and one or two of a larger type, which were already beginning to develop the modern methods of manipulating leather.

As a centre for the sale of leather, the Leeds leather fairs, held eight times a year, and attended by tanners and buyers from all parts of the North of England, had existed for many years, and had no doubt much to do with rooting the leather trade in Leeds. These fairs are still attended by buyers and sellers from all parts of the country, who meet in the leather market in Meadow Lane, as upon a modern exchange.

Formerly, each district had its little tan-yard to deal with the hides and skins of the animals slaughtered in the neighbourhood; but the modern facilities of transit by railway have led to the concentration of the trade in suitable places, and a gradual extinction of the small country tan-yards.

This change was aided by the establishment in large towns of a weekly market, where the whole produce of hides and skins in the district was classified and sold by auction.

The leather manufacture has three chief branches—tanning, currying, and leather dressing—each of which is carried on extensively in the town. Some firms only pursue one branch, others combine different branches in the same establishment.

Tanning embraces the stripping of hides of hair and other extraneous matter, and the process by which their substance is converted into leather. The tanning of light or upper leather requires different treatment from the heavy or sole leather.

Though more leather is now tanned in Leeds than in any other town in the kingdom, it is almost exclusively of the light leather description, only one tannery being engaged in the manufacture of sole leather.

There are twenty-one tanneries within the borough, giving employment to thirteen hundred men, and able to turn out one hundred and fifty tons of rough leather per week.

The hides are derived in part from the surrounding district, and from other parts of the kingdom, but chiefly from foreign sources, especially India.

For the tanning of East India Kips Leeds has been famous for the last fifty years. The first hides imported from India were tanned here by the late Mr. Richard Nickols; and the steady and large supplies available, with their suitability, have enabled them to retain a foremost place.

Oak-bark, once the principal tanning material, is now only used to a small extent, as, though cheap, it requires a length of time to do its work.

For the staple manufacture here, mixed tannage is found more suitable, the materials used being gambier, valonia, sumach, myrobalans, and mimosa bark; also oak, chestnut, hemlock, and quebracho extracts obtained from the bark and wood of these trees.

As regards foreign competition, the position of the trade here is particularly unfavourable; other countries have cheap and abundant tanning materials, which in England have to be imported at an increased cost of carriage.

The chief material used by the Leeds tanners is gambier extract, made from the leaves and twigs of the shrub *Uncaria gambir*, grown in the Straits settlements, and first used sixty-five years ago by Mr. Edmondson, of Sale, and Messrs. Rhodes, in Leeds; its introduction was mainly owing to the skill of Mr. Richard Nickols, who, against prejudice and opposition, established its position as the best and richest tanning material known to the trade.

In 1889, the imports of gambier into England were of the value of £513,000. The foreign demand for the article, and the limited supply, have caused its value to increase from £18 per ton in 1879, to £28 in 1889-90. Its cultivation is now, however, being extended, and the Director of the Kew Gardens offers to supply cuttings to those wishing to cultivate it in such parts of the Empire as may be found suitable to its growth.

Currying.

This is a process quite distinct from tanning, and used to be carried on as a separate business. In large businesses it is now the exception to find tanning or currying carried on alone.

Great improvements have been made in the art of finishing leather, making it more attractive and better fitted for its many different uses.

In the United States the art of currying has received the greatest attention, and with the help of the best skilled labour drawn from Germany and France the American currier has obtained the lead in this branch of the trade. Our Leeds curriers have therefore been led to introduce machinery chiefly after American patterns for the different processes of splitting, scouring, stuffing, levanting, glazing, embossing, &c., by means of which production has been both cheapened and improved. Leeds can boast of one of the largest and most complete currying establishments in the world, fitted with all the best and most recent machinery.

The total number of firms engaged in currying within the borough is thirty employing about one thousand workmen.

Leather Dressing.

This is also an important industry, though less so than tanning and currying. It deals only with light skins, such as calf, sheep, lamb, goat, kid, and sealskins, and the imitations of lizard, crocodile, and similar skins, which have of late become popular. In the manufacture of calf-kid, made by

treating calf skins with alum, salt, flour, and yolk of egg, several Leeds firms have taken a leading place.

The splitting, tanning, dyeing, and finishing of sheep and lamb skins is generally carried on by the same firms who manufacture calf-kid.

In all these branches of leather dressing, our manufacturers have had to meet the keen competition of Germany and France, and in spite of advantages in favour of these countries, they have maintained their position with spirit and success.

The number of firms in this branch of the trade is ten, employing one thousand hands. Thus we have, operatives employed in :—

Tanning	1,300
Currying	1,000
Leather Dressing	1,000
Total	3,300

The leather manufactured in the district finds a market chiefly in Great Britain, the foreign tariffs being more or less prohibitive.

The application of machinery which has been made in the currying and finishing of leather, has not yet been successful in the tanning industry, in which so far hand labour prevails. As regards chemical methods, a local company formed in Leeds for the manufacture of chrome leather, after putting down costly plant, has ended in disastrous failure.

An attempt is now being made by a company in London to apply electric currents to quicken the tanning process.

Though the whole manufacture is a series of chemical processes, yet the chemistry of tanning is anything but simple, and much patient research of the highest order is required, before the industry can hope to receive the benefits already won in other branches of industry by the application of science.

The following are some of the principal firms engaged in the leather industry :—

Messrs. Appleyard & Sons.
„ Conyers & Sons.
„ Dixon & Walker.
„ J. J. Flitch & Son.
„ R. Gallsworthy & Son.
„ Horsfield & Son.
„ W. L. Jackson & Co.
„ Kitchen & Co.
„ H. Nichols.
„ R. Nickols & Beckworth.
Mr. W. Paul.
Messrs. J. S. Stocks & Co.
Mr. S. Smith.
Messrs. Stead & Simpson.

BOOTS AND SHOES.

By W. Beckworth.

A SURVEY of the Leather trade of the town which did not embrace the important department of the Boot and Shoe manufacture would be very incomplete. At first sight it appears natural that this branch of industry should flourish in any neighbourhood where leather is so largely produced. It happens, however, that a comparatively small part of the leather manufactured in Leeds is suitable for the particular branch of the boot trade which is carried on here, and hence another reason must be sought to account for the enormous development which has taken place in this branch of business during recent years. It will probably be found in the class of labour which is here available, and also in the natural advantages which Leeds possesses, not only as a place of manufacture, but also as a convenient centre of distribution.

There are at present no less than eighty-five boot manufacturers engaged in the wholesale trade in Leeds, and they give employment to about 8,000 persons. The estimated production of these firms amounts to a total of over 5,000,000 pairs of boots and shoes yearly.

The whole of this important trade may be said to be the product of the last thirty years. The introduction of machinery into the manufacture marks the period of its first development, the sewing machine especially having led the way in revolutionising the old methods of hand work. About the same time the process of rivetting was introduced, superseding the ancient mode of sewing on the sole by hand, these radical changes at once proved beneficial to employers and workmen alike—for by means of them unskilled labour could be utilised and employed to greater advantage, whilst healthier conditions of labour together with shorter hours of work became possible to the workmen. Production was cheapened, and the natural result of cheaper production followed in a largely increased demand. Thus stimulated, the ingenuity of inventors produced new machines for the different stages of manufacture until now the whole process can be carried through by mechanical means.

In this matter of machinery Americans have usually led the way. In the United States the boot manufacture is the leading industry, and the dearness of labour has supplied the necessary stimulus to invention. Our home manufacturers have not been slow to avail themselves of the facilities thus afforded, but have also themselves brought out several original inventions, the latest of which, the lasting machine, has only recently been introduced.

A portion of the labour in certain branches of the business is still done in the separate homes of the workpeople, but the tendency of the times is undoubtedly to drive the whole of the work inside the factories, where already the great bulk of it is performed.

The goods produced are chiefly of the strong, heavy kind of men's and boys' boots for which this district has become

noted, just as Leicester is noted for women's and children's, and Northampton for men's higher-class goods.

For the class of work peculiar to this district American hemlock-tanned leather is very largely used, affording as it does a raw material rough, strong, and cheap. The trade has been largely built up upon it, and so far the home tanner has been unable to supplant it.

The goods when manufactured find a market throughout the United Kingdom, Ireland taking its full share, but an increasing export trade is also being done, principally with the Colonies.

The drawback from which the trade suffers is found in the fact that it is largely a "season" trade, causing the manufacturers to be exceedingly busy in the later months of the year, and correspondingly slack in the spring and early summer time. To meet this, attempts are being made to develop a trade in lighter classes of goods, and if they meet with a fair amount of success there is no doubt a new impulse will be given to the business, and its continued development and prosperity will be assured.

FLOUR MILLING.

By Israel Rishworth.

Flour Milling has always held an important position in the industries of the town. The "Soke," dating from the time of the Crusades, made a monoply of all custom grinding in the borough, while the miller had to grind all grain for a fixed charge in kind, called monterage. This monoply, bought in 1815 by Mr. Robert Hudson, together with the King's Old Mills, was purchased by the Corporation in 1839.

Save that steam power came in place of wind and water, the corn mill till recent years received but little improvement.

The stones were universally used to grind the grain at one operation, and the material was afterwards sifted into flour, fine sharps, and bran. The new roller system, introduced in Leeds about ten years ago, has completely revolutionized the manufacture. The rollers are of the hardest steel or chilled iron with spiral flutes on the surface. The gradual reduction of the grain to flour requires at least six break rolls, and fifteen smooth roller machines, besides the purifying and dressing operations carried on in centrifugal dressing machines with silk screens. The husk, the outside gritty portion of the grain, and the germ (whose presence in the old stone-ground flour tended to darken the colour) are each perfectly eliminated, and the maximum quantity of fine white flour obtained. All the local mills are now worked on this system, being obliged to comply with the popular demand for a fine white flour.

The roller system, requiring so many machines subject to great wear and tear, and liable to be superseded by improvements, is much more costly than the stone system, and therefore many of the old firms of the district have retired from the business. The mills remaining have a capacity of over 9,000 sacks of 18 stone each per week. They are :—

Messrs. C. Copping, King's Old Mills, Leeds.
„ Gaunt and Bellwood, City Mills, Mabgate.
„ W. Hudson, Ivory Mills, Horsforth.
The Leeds Co-operative Industrial Society, Marshall Street, Leeds.
Messrs. Midgley and Bairstow, Globe Mills, Holbeck.
„ Rishworth Bros., Albert Mills, York Street, and Union Mills, Holbeck.
„ Henry Rishworth, King's Mills, Swinegate.
„ R. Shackleton & Sons, Victoria Mills, Swinegate.
„ Wilson, Crosby & Co., Marshall Street, Holbeck.
„ Wilson, Son & Co., Queen's Mills, East Street.
„ Wright Bros., Fletland Mills, The Calls.

OIL AND SOAP INDUSTRIES.

By Dr. J. Lewkowitsch.

The extensive seed-crushing and oil-refining trade of Leeds, employing eighteen firms thirty years ago, has now been completely transferred to Hull and Grimsby. During that time cotton seed oil has come largely into use. The first batch of cotton seed sent to this country was crushed in Leeds and the oil refined by Messrs. Lomas Joy & Sons.

The manufacturers of the district require large quantities of oils, fats, soaps, &c., and a number of firms are engaged as importers of oils, &c., in the trade in recovered grease and the products therefrom, and in the soap and candle manufacture. The chief firms are :—

Messrs. Lomas Joy & Sons.
„ E. Joy & Sons.
„ A. Hess & Brother.
„ Vickers & Sons.
„ Briscall & Co.
„ J. Grisdale & Co.
„ Joseph Watson & Sons.

Messrs. Hess & Brother prepare the fatty acids, especially oleic acid from tallow, palm oil, &c.; they also distil the grease recovered from the woollen and worsted mills and obtain a "cloth oil," which is used again in the woollen manufacture. Messrs. Hess also refine lubricating oils, and prepare a white odourless, hydrocarbon oil.

The tallow and stearine candle trade has been much reduced by the competition of petroleum and paraffin.

The soap manufacture carried on by Messrs. Watson & Sons is very extensive, employing 500 hands, and producing 600 tons of soap per week. This firm also carry on successfully the recovery of the glycerine from the spent soap leys, producing large quantities of "best refined dynamite glycerine."

CHEMICAL MANUFACTURES OF LEEDS AND DISTRICT.

By G. Ward, F.I.C., F.C.S.

Though Leeds is not an important centre of chemical industry, yet several substances are manufactured in considerable quantity, chiefly for use in local industries.

Sulphuric Acid, first made in Leeds by Messrs. Bower about 1817, is now manufactured by at least six firms in the district. The total quantity produced per week is estimated at 750 tons. It is used in dyeing operations, in the manufacture of other chemicals and dyeing materials, in the recovery of oils and fats from scouring liquors, and in dissolving cotton from mixed rags.

It is made from native sulphur in small quantity, but chiefly from pyrites and from "spent oxide," *i.e.*, the oxide of iron that has been used in gas purification, which contains about 50 per cent. of sulphur. The larger works have had Gay-Lussac and Glover's towers erected during the last twenty years.

Messrs. Nicholson, of Hunslet, the largest makers of sulphuric acid, use Spanish pyrites chiefly, and extract from the burnt pyrites 3 to 5 per cent. of copper, beside silver an ounce and a half, and gold 3 grains to the ton, by Claudet's process. Messrs. Nicholson were the first to use spent oxide in the manufacture, 22 years ago.

Messrs. G. J. Crowther use native sulphur for the manufacture of strong and pure acid for dissolving indigo.

Messrs. Hunt, of Castleford, using at present French pyrites containing practically no copper, have therefore discontinued the Claudet process. Salt cake and hydrochloric acid are made in quantity by Messrs. Hunt. The former is sold chiefly to the local glass works, and only a small proportion of it is converted into soda ash. The hydrochloric acid is made into bleaching powder, the Weldon recovery process

being used for the manganese. Recently a large and improved condenser has been erected. The capacity of the "bleach" plant is equal to the production of 60 tons of bleaching powder per week.

Hydrochloric and *Nitric Acids* are also specially prepared in some quantity by Messrs. Nicholson, Horatio Crowther & Co., and others, for the use of dyers, in the manufacture of the *single* and *double* muriates of tin and for other purposes.

Ammonia Compounds.—Messrs. Dyson, Son, & Brotherton distil gas-tar, and make sulphate of ammonia from gas liquor. Liquid ammonia is prepared by a number of firms chiefly for scouring purposes.

Prussiate of Potash, formerly made in Leeds by many firms, is now made only by Messrs. B. Foster & Sons.

Orchil or *Cudbear*, was first made in Leeds by Mr. John Carr, in 1809, from the Orchella weed (*Roccella tinctoria*), and other lichens imported from America, India, and Africa. These lichens contain orcin, which in the presence of ammonia and air, changes into the beautiful maroon colouring matter orcein. This is the active principle in cudbear, orchil paste, and orchil liquid, used for dyeing wools, silks, leather, &c. These dyes, and also indigo extracts, refined indigo, &c., are prepared by the following firms :—

Messrs. John Marshall, Son & Co., began in 1820 to make them in Norwich, then a centre of the woollen industry. In 1843 they removed to Leeds, where they now cut dyewoods on a large scale.

Messrs. Wood and Bedford have manufactured these dyestuffs since 1828, and recently have patented a process for the application of oxygen in their manufacture in place of air. This oxygen they obtain by Brin's process. Their plant is the first erected by a private firm for the use of oxygen in a chemical industry. Patent fustin, discovered by this firm in 1887 has valuable dyeing properties, and is the first of a new class of colouring matters.

Messrs. Watson, Walker, and Quickfall, of the Albert Chemical Works, began the manufacture of orchil in 1864.

The late Mr. Wm. Watson of this firm invented the process of manufacture of indigo extracts still in use. These contain the colouring matter in a soluble form in combination as indigo-sulphonic acids. Their valuable dyeing properties have led to the greatly increased use of indigo, and a diminution in its cost. In 1825, before Mr. Watson's invention, finest Bengal Indigo cost 16s. per lb.; in 1830 it had fallen to 8s., and is now, in 1890, about 6s. 2d. per lb.

Indigo extracts are also prepared by Messrs. James Richardson and Co., along with other dyers' solutions. The distillation of coal tar for benzol, &c., is conducted by Messrs. Tunstall, at Newlay.

The distillation of wood for acetic acid is carried on in Leeds by Messrs. S. Warburton & Sons; Hirst, Brooke and Hirst; W. North & Co. The wood spirit (crude methyl alcohol) is sent out as miscible and solvent naphtha. The crude acetic acid is largely manufactured into iron liquor or 'pyrolignate' of iron for mordanting and dyeing purposes. Acetates of lime and soda are also manufactured.

THE GLASS BOTTLE INDUSTRY OF LEEDS & DISTRICT

By W. Breffitt.

During the last half century this industry has developed rapidly in the district, stimulated by the abolition of the excise duty and other causes. In 1800 a bottle works was erected at Hunslet, and another in 1832 at Castleford. Now there are over twenty large and small factories employing several thousand hands and producing about 144,000,000 bottles annually, about one-fifth for exportation. Besides Leeds and Castleford, the chief centres, factories exist at Wakefield, Knottingley, Thornhill, near Dewsbury, Barnsley, Swinton and Mexborough.

Except as regards furnaces, scientific methods have not been much applied to the industry. The mixing of the materials used has been mainly under the "rule of thumb," but the application of the Siemens' regenerative gas furnace marks an era in the trade. The glass made in the old coal-fired furnaces was very inferior in colour and quality, while the quantity in a pot of glass only was about 30 cwts. In the new furnaces a tank may contain as much as 120 tons of molten glass, the process goes on continuously, and the product is greatly improved in colour.

In making the bottles, five men and boys work together and produce an average of about 1,000 to 2,000 per day according to size and quality. The bottles are of all sizes and shapes, and one firm possess over 6,000 different moulds.

Machines to supersede hand-labour in the making of bottles have been patented by Mr. Ashley and by Mr. D. Rylands, and they have so far succeeded in overcoming the difficulties of a very complex problem, but it is not yet possible to state what commercial success may reward their efforts.

The following are the chief firms :—

Messrs. W. Brooke, Hunslet, Leeds.
„ Alexander & Austin, Hunslet, Leeds.
„ Peter Gilston & Co. Hunslet, Leeds.
„ E. Breffitt & Co., Ltd., Castleford.
„ J. Lumb & Co., Ltd., Castleford.
The Ashley Patent Machine Made Bottle Co., Castleford.
Messrs. W. Bayley & Co., Knottingley.
„ J. Kilner & Sons, Wakefield.
„ Kilner Bros., Thornhill Lees, Dewsbury.
„ Dan Rylands & Co., Ltd., Barnsley.
„ T. Barron's Exors., Mexbro'.
The South Yorkshire Bottle Co., Swinton.

PAPER MANUFACTURE, PRINTING TRADES, &c.

THERE are in Leeds at present two Paper Mills, capable of turning out about 100 tons per week, chiefly coarse paper, for packing purposes; these are Messrs. T. H. Bracken & Co. Limited, and Messrs. John Neill & Co. The raw materials are old baggings from wool and cotton bales, jute ends from Calcutta, old ropes, and wood pulp.

The printing of decorative wall paper is carried on by Messrs. Cooke & Co. and Messrs. Trumble & Sons, on a very large scale. They supply both high-class papers of the most expensive kind, and also cheap wall papers. A marked improvement has taken place in the designing and colouring of such papers, and in many cases they are sent out with a guarantee that they do not contain arsenic.

Ordinary printing, colour printing, &c., are carried on by a number of firms.

BREWING AND MALTING INDUSTRIES OF THE LEEDS DISTRICT.

BY W. BARWELL TURNER, F.C.S.

YORKSHIRE possesses two districts which produce excellent grain for malting. One is a narrow band chiefly over magnesian limestone, stretching from Ripon to Doncaster, the other lies in the chalk district of the East Riding. Grain is also obtained from Lincolnshire, East Anglia, and foreign countries. Excellent waters for the manufacture are found in the district, chiefly from artesian wells, which contain the chief mineral constituents of the Burton waters.

The process of malting consists essentially in causing the grain to germinate under the influence of heat and moisture. When the chemical changes accompanying the germination,

such as the conversion of starch into sugar, have reached a certain point, the process is checked. Much skill and care are required, but so far no mechanical or other appliances that have been devised to facilitate the process have been successful.

The malting trade of the district (within a radius of twenty miles) amounts to about 260,000 quarters of malt yearly, costing for barley at least £442,000, and employing about 2,000 persons.

As a Brewing centre, Leeds is comparatively modern. The old system of home brewing still prevails to a large extent, but, with the development of the district, many local breweries have become known beyond Yorkshire. In these brewing is carried on as elsewhere in England, with the exception of the "stone square" system of fermentation, invented by the late Mr. Timothy Bentley, of Oulton, which is much used in Yorkshire and Lancashire. Mr. Charles Clinch, of the Brunswick Brewery, has also successfully devised a process of "grist-heating," to prevent injury from defective albuminoids, caused by careless storage or drying of the malt.

The chief breweries in the district are—

Messrs. Joshua Tetley & Son, Leeds.
The Brunswick Brewery Co., Leeds.
The Kirkstall Brewery Co., Leeds.
The Tadcaster Tower Brewery.
Messrs. J. Young & Co., Leeds.
„ H. Bentley & Co. Limited, Oulton.
„ Messrs. Kirk, Matthews & Co.
„ John Smith & Co., Tadcaster.

About 285,000 quarters of malt are used annually in wholesale and retail brewing, yielding about 1,200,000 barrels, and giving employment to several thousand persons. The value of the annual production may be estimated at £2,040,000.

THE MANUFACTURE OF COAL-GAS; WATER SUPPLY, SEWAGE WORKS, AND DESTRUCTORS.

By T. Fairley.

The first Act of Parliament for lighting Leeds with coal-gas was obtained in 1818. Other Acts relating to extensions of the supply followed, and in 1870 the works were bought by the Corporation.

There are at present three large works in the borough, in Meadow Lane, New Wortley, and York Street, each under separate gas engineers, and fitted with the best plant and apparatus for the manufacture, purification, and storage of coal-gas. In winter about 11,000,000 cubic feet of gas per day are supplied, and over 1,200 men are employed at the works.

At Meadow Lane a very complete model gas plant has been erected for the purpose of testing practically all coals supplied for the manufacture. The apparatus for the revivification of gas-lime under Hislop's patent, erected at these works, is not at present in use.

At New Wortley, the regenerative system of heating the retorts is in use, chiefly under the Siemens system. Perret's mode of boiler firing with the lowest class of fuel is applied to the utilisation of unsaleable breeze and coke from certain cannel coals.

The illuminating power of the gas averages over 19 candles, when tested under the conditions of the Metropolitan Gas Acts. The gas is carefully purified by means of lime, so that the sulphur averages under 16 grains of sulphur per 100 cubic feet.

The gas is extensively used for heating purposes and for gas engines, and, with a view to the abatement of smoke, the Corporation encourage these applications by selling the gas as nearly as possible at cost price; the price charged to consumers being lower than in the great majority of towns throughout the kingdom.

Before 1837, the water supply of the town was very unsatisfactory—being derived from wells, the river Aire, adjacent streams, or the storage of rain water. In that year, a company obtained an Act of Parliament authorizing the supply of water from the river Wharfe. In 1852, the works were transferred to the Corporation, and in 1865-6 the present scheme was begun, by which the borough is supplied with excellent soft water, gathered in the valley of the Washburn (a tributary stream which joins the Wharfe near Otley), about 15 miles from the Leeds Town Hall. The water, from a drainage area of over 22,000 acres, which is underlain by the millstone grit, and receives an annual rainfall of 36 inches, is collected in three large reservoirs. Two of these, having a capacity of over 1,800,000,000 gallons, are used as supply reservoirs, while the third, holding about 750,000,000 gallons, serves as a compensation reservoir. Below this last reservoir, at Washburn foot, the Corporation have power to take, when necessary, 6,000,000 gallons per day by pumping.

In addition to these reservoirs, there is also a large storage reservoir at Eccup, capable of holding when full about 1,400,000,000 gallons, and a number of small service reservoirs at different levels in various parts of the borough. The Corporation are now improving the embankment of Eccup reservoir and driving a new and enlarged tunnel to connect this reservoir with the town. The water is filtered at Far Headingley, through seven filter beds, of which six are in use at one time.

The following is the analysis of the water, taken July 1st, 1890:—

IN GRAINS PER GALLON.

Chlorides (equal to Common Salt)	1·31	Containing Chlorine	0·79
Nitrate of Calcium	none	,, Nitric Acid,	none
Sulphate of Calcium	2·61	,, Lead,	none
Carbs. of Calcium, Magnesium, &c.	1·15		
Volatile and Organic Matter ...	0·36	Saline Ammonia,	0·0008
		Organic Ammonia,	0·0036
Total Dissolved Solids,	5·43		

Oxygen required to oxidise organic matter in fifteen minutes, 0·028.
Sediment deposited on standing :—minute quantity.
Colour of column, 2 feet in depth :—faint yellowish tint.
Smell when warmed to 100° Fahrenheit :—no distinct smell.
Hardness in Clark's degrees, total, 3°·7 (before boiling).
,, ,, ,, Permanent :—2°·8 after boiling.
,, ,, ,, Temporary :—0°·9 lost by boiling.

The erection of the works for the treatment of the Leeds sewage began in 1870. The works are situated at Knostrop, and the total volume of sewage to be treated averages about 9,000,000 gallons per day, not including storm waters, which are intercepted separately. At present, lime only is used in the treatment of the sewage, which, after treatment, passes through twelve depositing tanks. The average purity of the effluent is certainly much greater than that of the river Aire before it enters the confines of the borough. The following is the analysis of the effluent, taken on August 24th, 1889.

IN GRAINS PER GALLON.

Chlorides (equal to Common Salt)	11·89	Containing Chlorine,	7.20
Nitrate of Calcium	none	,, Nitric Acid,	none
Calcium, Magnesium, Salts, &c.,	21·64		
Volatile and Organic Matter ...	3·36	Saline Ammonia,	1·455
		Organic Ammonia,	0·416
Total Dissolved Solids,	36·89		

Sediment :—very minute.
Colour :—brownish yellow.

The solid refuse collected from ash-pits or receptacles in various parts of the borough is burnt in destructors, one set of which is located at Burmantofts, and the other

in Armley Road. About 31 men are employed, and the annual cost is about £5,000. About 120 tons of refuse are burnt daily in 26 cells. By means of the Horsfall's steam injector, the furnaces are made to act as blast furnaces, and a very high temperature is obtained.

The average temperature of the escaping gases at the bottom of the chimney-stack is about 600°F.; nearer the furnaces, it is over 900°F.

Though some complaints have been made, yet as the result of frequent testing, it is shown that the escaping gases are wonderfully free from objectionable impurity.

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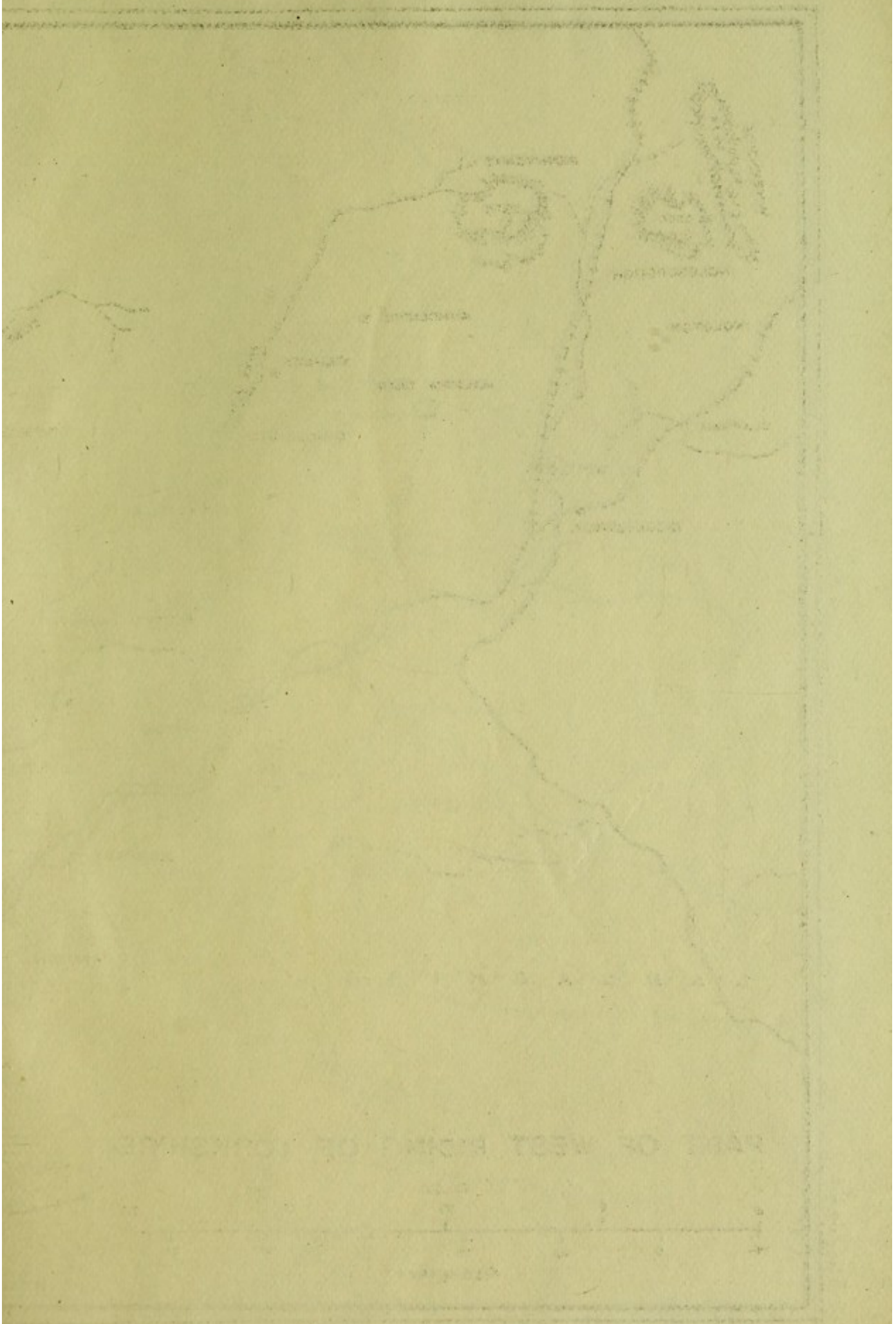

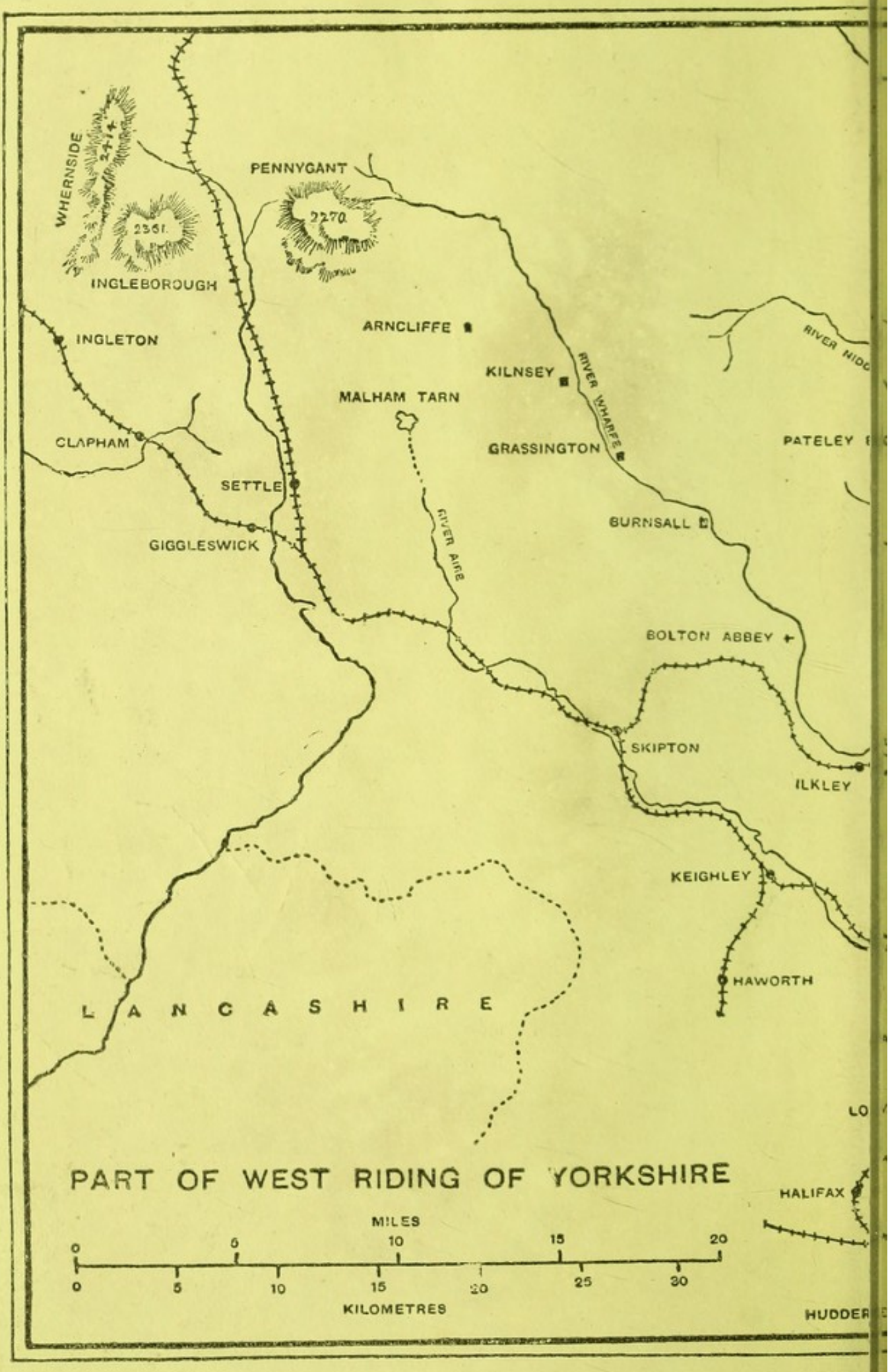
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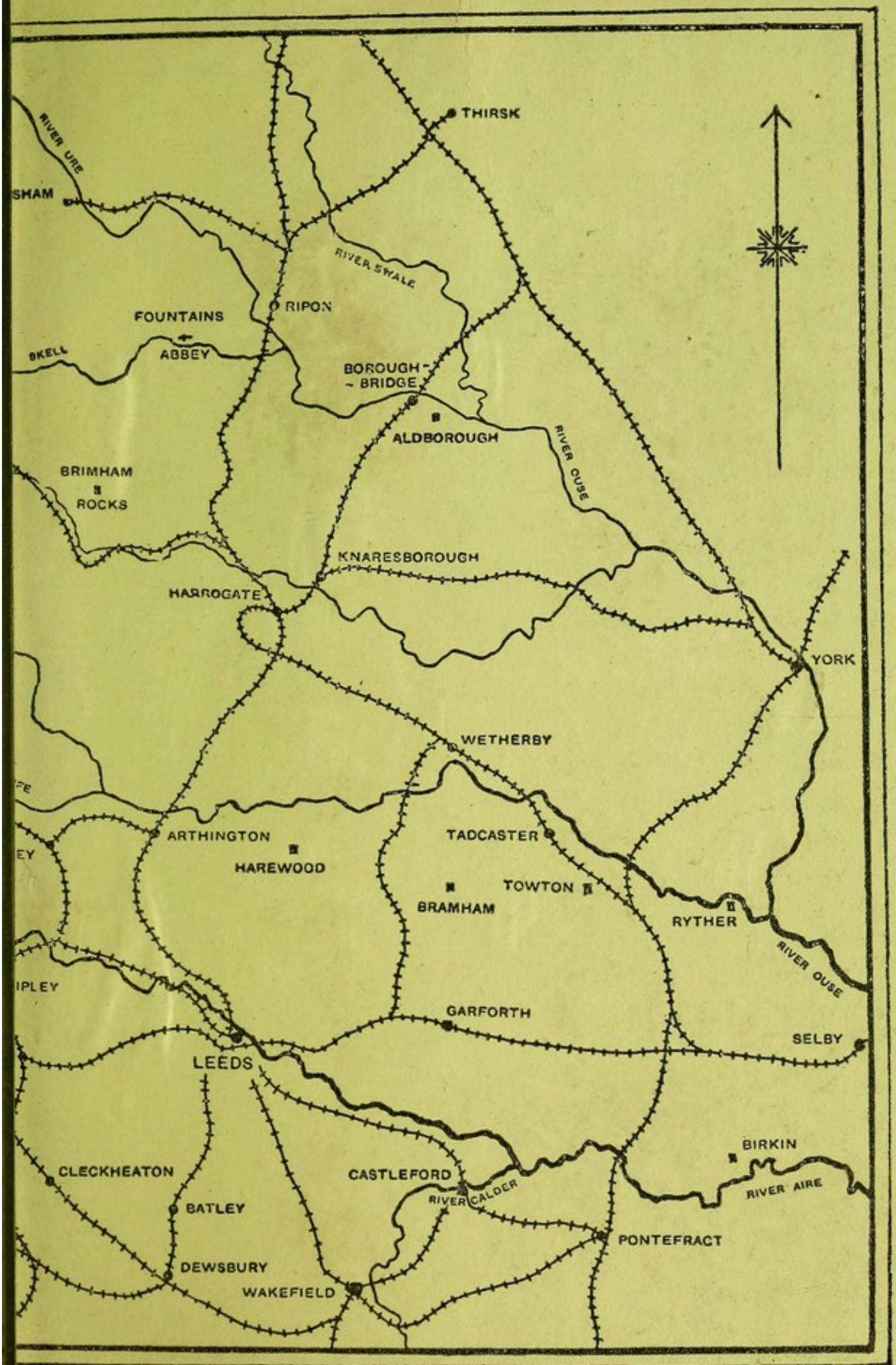
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