Class I.] [Price 2s.

OFFICIAL

Descriptive and Illustrated

CATALOGUE.

By Authority of the Royal Commissioners.

CLASS I.

MINING AND MINERAL PRODUCTS.

LONDON:
SPICER BROTHERS, WHOLESALE STATIONERS; W. CLOWES & SONS, PRINTERS;
CONTRACTORS TO THE ROYAL COMMISSION,
29 NEW BRIDGE STREET, BLACKFRIARS, AND AT THE
EXHIBITION BUILDING.
1851.

Class I.—ALPHABETICAL LIST OF EXHIBITORS.

[*The figures annexed to the Names refer to the Numbers prefixed to the Articles exhibited; those between parentheses to the pages of the Catalogue.*]

SECT. I. CLASS 1.

MINING AND MINERAL PRODUCTS.

INTRODUCTION.

THE intention in the collection of the objects in the four Classes of the first section—Raw Materials and Produce—has been to give a practical illustration of those substances in the mineral, animal, and vegetable kingdoms, which human industry is constantly occupied in converting into the varied forms of manufactured articles, or which are themselves, as in the case of fuel, the indispensable sources of manufacturing power. If, therefore, it is desired to obtain a philosophical view of this Exhibition and its multifarious contents, it will be found useful to commence the study by the examination of those materials, which, in other departments, have been caused to assume forms so diversified. From the raw mineral it is thus possible to proceed through the various stages of its manufacture, until it is finally seen embodying the conceptions of the mechanic, the architect, or the artist. Many of the objects comprehended under these four Classes have little or no external beauty, and present, consequently, no appreciable value to the uninstructed. But if it be considered that, in the preparation of these materials for use, and in their application to the purposes of life, consists the daily toil of multitudes of the human family, then the Classes of raw materials appear to take on a new and interesting aspect.

The present Class is divisible into the following sub-classes:—A. Mining and quarrying operations. B. Geological maps, plans, and sections. C. Ores and metallurgical operations. D. Non-metallic mineral products. It comprises all that relates to the procuring of metal yielding mineral substances, to their mutual geological relations, and to the operations necessary for subduing them to the requirements of the manufacturer. It also includes the extraction of minerals used as fuel, of marine minerals used in construction, of minerals used in manufactures, for ornament and for agriculture. Specimens illustrative of each of these subjects are to be found in this Class; and if it be studied attentively it will be discovered that objects representative of all that properly belongs to the Class are contained in this collection.

CLASS 1 is partly contained within AVENUE S of the building, and extends from the western entrance to the Sculpture Room. If the study of it be commenced at the Sculpture Room and proceeded with to the western extremity of the avenue, it will be found that the metalliferous minerals and the objects illustrative of metallurgical processes generally, are first encountered, and subsequently the non-metallic minerals, fuels, stones, and geological specimens. The arrangement of the objects in the Catalogue is, however, in the opposite direction. Upon the walls of this avenue are arranged maps, plans, and geological sections, in addition to specimens of decoration belonging to Class 27, which have a certain relation with the present Class.

Among the groups of objects which present themselves most prominently on entering the avenue at the Sculpture Room are large specimens of lead ore and of lead in various stages of preparation. Specimens of silver extracted from lead by the crystallizing process of silver and gold, of iron, copper, tin, zinc, and other metals, are arranged in order along the avenue. To these succeed mining apparatus of various kinds, and models illustrative of mining processes. Mineral fuels, containing every variety of coal, with specimens of cannel coal in manufactured state, cokes, peat, and artificial fuels come next. Slates, with illustrations of their economical application, building stones, China clays, cements, and artificial stones follow these, and are succeeded by geological specimens, gems, &c., up to the western termination of the avenue.

CLASS 1 is also illustrated by several large objects placed outside the building; among these are artificial cements applied to various purposes, specimens of slate, flagstones, blocks of anthracite and other coal, pillars of coal exhibiting sections of beds of that substance, and columns formed of single blocks of granite. Several of these specimens are remarkable for their size, and furnish good illustrations of the mechanical facilities of extraction and of transport possessed by this country.

The whole of this Class may be considered well illustrative of the mineral wealth of Britain. If our supplies of the more precious metals are limited, the resources of power and wealth are given to this country in the exhaustless stores of minerals yielding the viler metals, and a fossil fuel with which it has been endowed. The ore, the fuel for its reduction, and the material for the necessary processes, are all to be found in abundance, and generally in direct geological proximity to each other. The possession of these materials, added to the development of the means of their employment, and of the applications of their products, lie at the foundation of the present commercial and productive greatness of Great Britain.—R. E.

1 ———.
Fossil fishes from the old red sandstone (*Cephalaspis*).

2 POWELL, WILLIAM JOHN, *Tisbury, near Hindon, Wilts*—Proprietor.

Varieties of hard and soft building stone, from Tisbury. The hard from Chicksgrove quarry, 20 feet below the surface, forming part of the Portland bed. The soft from Tuckermill quarry, 5 feet deep. The hard is used for steps, pavements, tablets, monuments, &c. The soft, for fronts of houses, cornices, and general building purposes. Both are adapted for resisting the influence of the weather.

Geological specimens:—A species of coral, from the sand of the upper oolite formation at Tisbury, found in a vein extending northward, and now converted into flint and chert. The hardest flints were originally manufactured into gun flints.

A fish from the oolite formation at Tisbury.

Specimen of part of a fossil tree from Tisbury, found in an excellent state of preservation in the oolite formation.

[The town of Tisbury is on the Portland stone; but the lower beds of the Purbeck series, as well as the uppermost oolites, are quarried in the neighbourhood. A continuous bed of flint, about two inches thick, is seen in one of the quarries, and from this band are obtained beautiful specimens of coral in chalcedony. Some of the oolite of the neighbourhood is very fine grained.—D. T. A.]

3 CARTER, J., *Delabole, near Camelford, Cornwall*—Proprietor.

Two specimens of rock crystals, taken from the slate quarries at Delabole, near Cornwall; used for jewellery.

4 BONITTO, J. NELSON; BALLERAS, G. E., *of London*, Exhibitors; and PARIS, E.—Producer.

Specimens of emerald in the matrix from the mine of Muso, New Granada.

5 LENTAIGNE, J., *Tallaght House, Dublin*—Proprietor.

A specimen of Limestone inclosing granite.

6 ———.
Block of carboniferous limestone containing shells of *Productus*.

7 BREADALBANE, Marquis of, *Taymouth, Aberfeldy, Perth*—Producer.

Specimens from the silver-lead mine of Corriebuie, on the south side of Loch Tay, Perthshire.

Specimens from the lead mines of Tyndrum, Perthshire.

Chromate of iron, from the mine of Corriecharmaig, in Glenlochy, Perthshire.

Hæmatitic iron, from Glenquaich, Perthshire.

Rutile, or oxide of titanium, from the north side of Loch Tay, Perthshire.

Brown quartz, from Ben-Lawers, north side of Loch Tay, Perthshire.

Granite and porphyry, from the forest of Glenorchy, in Argyllshire.

Granite, from the quarries of Barrs and Inverliver, on Loch Etive, Argyllshire.

[The mineral produce of Perthshire, illustrated above, is obtained from systems of veins, some of which, running N.W. and S.W., contain copper ores of various kinds, with some ores of iron; and others, running N.N.E. and S.S.W., contain chiefly lead ore. The veinstone is generally quartz, and the ores include several interesting minerals.—D. T. A.]

8 LEESON, Dr. H. B., *Greenwich*—Inventor.

Models, crystalline minerals, and engravings; illustrative of the exhibitor's system of crystallography.

The following are the principles upon which these models have been constructed:—

When the atoms of any description of matter have arranged themselves through the intervention of certain natural forces, in a form characterized by the evident order and angular disposition of its bounding surfaces, such solid form is termed a crystal.

Every crystal may be referred to one or other of three classes or systems.

These three classes are dependent on the relative direction of three lines not all in the same plane, indicative of the direction from a common centre of origin of the natural forces by which the crystal has been formed; such three lines are termed the gubernatorial axes.

The three classes are as follows:—

Class 1. Rectangular. All the axes at right angles to each other.

Class II. Oblique rectangular. One axis oblique to the other two, which are rectangular.

Class III. Oblique. All three axes making equal oblique angles with each other.

All the axes are of equal length, and in the second and third class the prevailing angle of obliquity is nearly (if not invariably) 101° 49′ 9·4″, and its supplement 78° 10′ 50·6″.

It is a very simple but important law, easily demonstrated, and greatly facilitating crystallographic investigations, that any plane of any crystal whatever must belong to one or other of the three following forms, which may be designated and defined as follows:—

Trisecant. Cutting all three gubernatorial axes.

Duosecant. Cutting only two axes, and therefore parallel to the third.

Ultimate. Cutting only one, and therefore parallel to the other two.

A set of fundamental forms, similarly constituted, belongs to each of the three classes.

This circumstance, viz., the existence of such a set of forms, characterizes a class or system.

Each fundamental form is produced by six similar and equal four-sided pyramids, one being placed at each end of every gubernatorial axis, so that the diameters of the base of the pyramid coincide with or bisect the other two gubernatorial axes.

When the diameters of the base of the pyramid coincide with or are parallel to the gubernatorial axes, the form produced is trisecant. When, on the contrary, the diameters of the base of the pyramid bisect or are parallel to the line of bisection of the gubernatorial axes, the form produced is duosecant.

The series of fundamental forms is produced by a successive diminution in the height of the pyramid, according to a regular law. The diameter of the base of the pyramid in the trisecant series, and the sides of the base in the duosecant series, being a multiple of its height by some integer. When the diameter of the base becomes infinitely extended, or the height of the pyramid becomes 0, we arrive at the ultimate form, which is a cube in the rectangular class, a right rhombic prism in the oblique rectangular class, and a rhombohedron in the oblique class.

The most frequent, if not the only series, is that in which the ratio of height in the pyramid to the diameters or sides of its base is as 1 to some power of 2, those actually observed being 2^1, 2^2, 2^3, 2^4, and 2^∞. In this series we may pass from the trisecant to the duosecant, and from the duosecant to the trisecant forms, by a continual replacement of edges by planes. Thus commencing with the octohedron, and replacing its edges by planes, we pass to the dodecahedron, or first duosecant form. Thence to the trapezohedron, or second trisecant form. Thence to the pyramidal hexahedron, or second duosecant form. Thence to a flatter trapezohedron, and so on, till we arrive at the ultimate form, or cube, when, by replacement of its edges, we may return to the dodecahedron, or first duosecant form.

A new set of forms is produced by rotating, inverting, or altering the position of the pyramids 45°, so as to make trisecant pyramids duosecant, and duosecant pyramids trisecant; and next, by combination of two equal and similar fundamental forms, a set of forms having an eight-sided pyramid is produced at each end of the gubernatorial axes: thus, two octohedrons joined together produce the triakis octohedron; two trapezohedrons joined together produce the hexakisoctohedron, and so on.

It appears as if these forms, like macled crystals, arise from a simultaneous development of two crystals in opposite directions, and then what would be re-entering angles are filled up, so that only the edges of the two crystals remain. Thus each eight-sided pyramid consists of planes joining the four lateral edges of one pyramid with those of the four lateral edges of another equal and similar pyramid. Lastly, from the forms thus described an infinite variety of others are obtained, first by the unequal development of particular planes, and next by composition of two or more forms.

In natural crystals, it is frequently observed that certain planes are extended more than others; indeed it will be found that unequal development is the rule, and perfect forms are the exception. In the case of the diamond, which very commonly crystallizes in the regular octohedral form, the octohedron is constantly unequally developed, giving rise to the various forms exhibited in the drawing.

When unequal development does not occasion the loss of any plane, the form is termed simply imperfect; but when, as in the passage of the octohedron into the tetrahedron, or into the rhombohedron, certain planes are obliterated, the form is termed defective.

The law of unequal development shows that whatever forms can be produced thereby from the series of forms already described, they may possibly have existence without any dimorphism in the substance examined. Proceeding on this basis, the exhibitor has discovered that all the unequal-axed crystals are merely unequal developments which have concealed the true character of the crystals, but which have been abundantly and conclusively explained by the small remnants of planes to which little attention has been heretofore directed, but which become of great significancy in relation to the law in question.

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9 MITCHELL, Rev. WALTER, *St. Bartholomew's Hospital*—Designer and Inventor.

Series of models in paper, representing all the primary and secondary forms of crystals, and the most important combinations of these forms.

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10 DYER, WILLIAM, *Little Hampton, near Arundel*—Proprietor and Inventor.

Sussex coast agates, found on the sea-beach; many containing specimens of petrified sponges, sea anemones (*Choanites Königii*), and other zoophytes. Specimens fashioned and polished for ornaments.

Model of a mechanical contrivance for ventilating rooms and public buildings.

[The agates on the Sussex coast are, to a great extent, if not entirely, chalk flints in a peculiar state; and they frequently exhibit very beautiful indications of organic structure. The definition of agate generally in mineralogy has reference to an apparently banded structure, or concentric arrangement of siliceous matter, often showing different tints of colour. When of considerable size, the central part is generally clear. The essential material is, in all cases, silica, and the colour is, no doubt, due to metallic oxides, chiefly of iron and manganese.—D. T. A.]

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11 SLATER & WRIGHT, *Whitby*—Manufacturers.

Specimens of rough jet, and articles manufactured from jet for ornamental purposes.

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12 SCHOMBURGK, Sir ROBERT—Proprietor.

Specimens of fossil wood.

13 ELLIS, R., *Harrowgate*.

Collection of the different mineral waters of Harrowgate, and their analyses.

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14 TENNANT, J., 149 *Strand*.

Four cases of minerals and fossils for educational, scientific, and ornamental purposes.

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15 NELIS, JOHN, *Omagh, County Tyrone, Ireland*—Proprietor.

Pearls, with specimens of the shells in which they are formed; found in the deepest parts of the river Strule (fresh water), at the town of Omagh, county Tyrone.

[The shell fish from which these specimens of native pearl are derived is the *Unio margaritifera*, and the pearls are second only in quality to those obtained from the true pearl-oyster, *Meleagrina margaritifera*. Pearl consists of concentric layers of membrane and carbonate of lime, and is partially soluble in acid.—E. F.]

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16 COWIE, A., & RAE, W., *Ellon, Scotland*—Proprietors.

Pearls from the river Ythan, Aberdeenshire.

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19 COOK, A.—Proprietor.

A large crystal of black quartz. (Batten, A., Agent.)

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20 MACDONALD, Major C.—Proprietor.

A large series of turquoises in the matrix, in unpolished fragments, and manufactured into various ornaments.

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21 OLDFIELD, Rev. —, *Dublin*—Proprietor.

A mass of crystalline quartz adapted for various useful and ornamental purposes.

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22 TOLAN, W.

A collection of polished agates from the Isle of Wight.

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23 HIGHLEY, SAMUEL, jun., 32 *Fleet Street*—Collector and Preparer.

Sulphur Minerals.

1. Native sulphur in rhombic crystals, from Sicily.
2. Native massive sulphur.
3. Native earthy sulphur.
4. Iron pyrites, or sulphuret of iron, from Cornwall, &c.
5. White iron pyrites, from Littmitz, near Carlsbad.
6. Radiated pyrites, from the chalk of Surrey and Isle of Wight.
7. Cockscomb pyrites, from Derbyshire.
8. Copper pyrites in crystals, from the Banat, &c.
9. Copper pyrites massive, from Staffordshire, &c.

Crude Sulphur of Commerce.

10. Crude Sicilian sulphur.
11. Crude drop sulphur.

Refined Sulphur.

12. Lump sulphur.
13. Roll sulphur.
14. Sublimed sulphur.
15. Sulphur vivum.

16 and 17. Sulphur precipitation, pure and (17) adulterated.

Crystallized Sulphur.

18. Crystals of sulphur from its solution in bi-sulphide of carbon.
19. Crystals from solutions of sulphur in camphine, made at temperatures varying from 77° cent. = 170·6° Faht. to 138° cent. = 280·4° Faht.
20. Crystals of sulphur deposited from sulpho-penta-chloride of phosphorus.
21. Crystals obtained by the fusion of sulphur.

[Sulphur occurs native, in rhombic crystals; also massive with earthy and bituminous impurities, and occasionally with arsenic and selenium. It is generally found in volcanic districts and near hot springs in formations of various geological date. It occurs abundantly with iron and copper (iron and copper pyrites), and also with the common ores of lead, &c. It is used in chemical manufactures and in medicine; also for matches and gunpowder; and in preparing vermilion, sulphuric acid, vulcanised caoutchouc, &c. About 80,000 tons of crude sulphur are annually furnished from Sicily.—D. T. A.]

24 THISTLETHWAYTE, HENRY F., *The Vine House, Sevenoaks, Kent.*

A collection of gems and precious stones, chiefly illustrative of such as are used for personal ornament. The principal part of this collection was formed by Mr. Hertz, with a view to show the great variety of shades of colour in each species of stone, and to prove the connection of some classes; such as the corundum, where the tints of the ruby, sapphire, and topaz, are distinctly seen in the same stone. In the class of zircons and jargoons, the same connection of colours is exhibited. The specimens of diamond are interesting in point of crystallization as well as colour. The collection of pearls exhibit many varieties of colour both in the margarita and conch-shell specimens.

[The colours of certain minerals are extremely useful to the mineralogist in the determination of species, and are presented in great varieties in distinct series, but sometimes in very unconnected order. The most striking examples of series are found amongst gems, and are well illustrated in the collection described above, which is worthy of very careful observation and study.

The gems which best exhibit series of colours are diamond, corundum (oriental ruby and sapphire), topaz, emerald, garnet, and tourmaline. The zircons and jargoons are also remarkable, and highly interesting.

In most cases, minerals that are nearly allied, and are homomorphic, present similar series of colour; but in other cases, as in the diamond, the usual crystalline forms exhibit a more or less complex series in themselves. The principal colours of the gems are white, as opal, which is milk white; grey; black; blue, as some sapphires, which are Prussian blue, or the variety corundum, called ceylonite, which is indigo blue; green, as emerald; yellow, as topaz; red, as some zircons, garnets, ruby, &c.; and brown, as zircons.

The varieties of colour in pearls, extend from white and lead grey, through yellowish and pink, to black; the latter being, however, remarkable and rare exceptions, and the bluish or lead grey, being less valuable than more distinct tints. Some pearls exhibit much play of colour.—D. T. A.]

25 JAMIESON, GEORGE, 107 *Union Street, Aberdeen*—Proprietor.

Cairngorm stones from Cairngorm, Aberdeenshire, in the natural state, and cut into gems for jewellery.

Aberdeen and Peterhead granite, cut and mounted in brooches and other fancy articles, as buttons, studs, desk seals, pen-holders, &c.

A ram's head mounted in silver, as a snuff-box.

Scotch pearls found in the rivers Don, Ythan, and Ugie, Aberdeenshire. The shell from which the pearls are obtained.

[The Cairngorm mountain, one of those forming the granite nucleus of the Grampians, and rising to the height of 4,080 feet, is well known, and has been long celebrated for the fine quartz crystals of white, pink, dark brown, and black colours which take their name from it, and are found either in the cavities in the rock or the debris of rivers. Of these crystals, the deep yellow varieties, when well cut and set, are sold as topazes, and sometimes called Scotch topaz, while the darker varieties are called smoke topaz.—D. T. A.]

26 CASSELS, ALEXANDER, *Edinburgh*—Proprietor.

Two curling stones used in Scotland in the national game of curling, made of the rock of Ailsa Craig, in the Firth of Clyde.

A specimen of the rock in the rough state.

The game of curling is practised upon ice during the winter. The Royal Caledonian Curling Club, of which His Royal Highness Prince Albert is patron, is composed of above 10,000 members.

[Ailsa Craig consists of a single rock of grayish compact felspar, with small grains of quartz, and very minute particles of hornblende. The height is stated to be 1100 feet, its length 3300, and its breadth 2200. On the east it rises by steps, but from the south, round by the west to the north, it is more perpendicular, and divided into columns. It rises abruptly from deep water, about 10 miles west of the coast of Ayrshire, and 15 miles south of the Isle of Arran.—D. T. A.]

27 KAY, J., *Hayhill, Ochiltree*—Manufacturer.

Curling stone, made of greenstone trap.

28 MAJENDIE, ——.

White topaz from Van Diemen's Land. Rough and cut.

29 HOWARD, THOMAS C. E., *Bristol.*

Specimens of building stones, marbles, &c., in six-inch cubes.

Oolite.

Upper oolites, from the neighbourhood of Bath.
Inferior oolite, from Dundry Hill, near Bristol.

Lias.

Blue lias (hydraulic lime when burnt), from Keynsham, near Bristol.
White lias, from Radstock and Poulton, Somerset.
"Landscape" lias, from Cotham, Bristol.

New Red Sandstone and Calcareo-Magnesian Conglomerates.

New red sandstone, found at Bristol.
Coarse sandstone, from Easton, Bristol.
Indurated red sandy marl, from Chew Magna, Somerset.
Fine-grained yellow conglomerate, found near Harley Place, Clifton.
Fine-grained crystalline calcareous conglomerate, found near Durham Down.
Indurated red sandstone with calc spar.
Re-cemented magnesian conglomerate, from Clevedon, Somerset.
Conglomerate with quartz, limestone, &c., from Sea Mills, below Bristol.
Conglomerates from Clifton, Bristol; and from the tunnel of the Bristol Waterworks, Harptree, Somerset.
Silicious conglomerate with jaspery iron-stone, from Brandon Hill, Bristol.
Conglomerate, from the Mendip Hills.
Gypsum (sulphate of lime), from Windford, Somerset.

Coal Measures.

Pennant sandstones, from the middle part of the coal series.
Fine silicious grit (millstone grit, or miner's "farewell rock"), from Bristol.

Carboniferous or Mountain Limestone.

Series of limestones and marbles from the defile of the river Avon, Clifton, Bristol.

Old Red Sandstone, Silurian, &c.

Old red sandstone, from the banks of the Avon, below Bristol.
Grey sandstone, from Tortworth, Gloucestershire.
Red silicious conglomerate, from Markham Bottom, near Bristol.

Transition limestone and sandstone, from Tortworth and Charfield, Gloucestershire.

Amygdaloidal trap rock, from Damory, Gloucestershire.

Samples of the brick and pottery clays, with specimens of the manufacture.

Samples of sands, used for commercial purposes, and of the deposit from which the "Bath scouring brick" is made. This brick is manufactured by Messrs. Ford & Son, Bridgewater.

Samples of ochre, reddle (oxide of iron), fullers' earth, &c.

Samples of strontian, massive and fibrous; gypsum, massive and fibrous; barytes (sulphate of); lime, white and the brown, or hydraulic.

Iron ores — hæmatite, compact, silicious, stalactitic, reniform, &c.

Ores of zinc: Blende (sulphuret); calamine (carbonate).

Ores of lead: Galena (sulphuret); white lead ore (carbonate).

Phosphate and muriate of lead. Manganese ore (black antimony ore, sulphuret).

Specimens of quartz crystals (Bristol diamonds); crystals of calc spar; geodes (locally, potato-stones), containing various crystals, agates, &c.

Series of the various seams of coal, worked in the Bristol coal basin, showing the cleavage, fracture, &c.

Maps and sections illustrative of the position and localities of the specimens are exhibited with them.

[This series of rocks, illustrating the economic geology of the Bristol district, is of considerable interest, as showing a large succession of beds, and the result, in some measure, of their close association at the surface. Of the substances used economically, the sands for Bath bricks, ochres, quartz crystals, and geodes, are worthy of notice. Of the ochres, the red and yellow are found in considerable quantities and of very good quality. They are friable, and stain the finger. The red is of deep colour, between crimson and purple, and of strong body; the yellow of fine gold colour. They are dry and mix well. The Bristol diamonds are clear quartz crystals, chiefly found near Clifton.—D. T. A.]

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30 FAHIE, JAMES K., *Tipperary, Ireland*—Producer.

Copper ore, found on Lord Stanley's property, near Tipperary, and from Hollyford.

Lead ore, found at Oola, near Tipperary.

Minerals from several parts of the country.

Anthracite coal, from Killanaule.

Building limestone, found near Tipperary.

Black and white marble, found at Mitchelstown, county Cork. Red and grey marble, found at Cloyne.

Hydraulic limestone, found near Tipperary; a natural cement, produced in powder and biscuit.

Artificial cement, prepared from chalk, alluvium, and pit clay; and stucco, for interior work; prepared from gypsum found in a limestone quarry near Tipperary.

White clay, in its rough state, found near Caher, and prepared in biscuit and small bricks, used for stone ware and pottery. Black clay, in its rough state, found at Killanaule. Black fullers' clay, found near Caher, in a stratum over white clay.

Felspar, from Lord Kingston's cave, county Cork.

Draining tiles and pipes, made on Lord Stanley's property, near Tipperary.

Sands, white silica, found at Killonan, useful for heavy iron castings and other purposes. White silica, found near Caher, used for pottery, &c. Manganese, found at Springhouse.

Inorganic vitreous matter, the produce of green ash and elm, calcined in a brick-kiln by the exhibitor.

Water, from a well in the rock of Cashel, lately discovered, about 150 feet above the general level of the surrounding surface.

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31 ———.

A collection of Labrador felspar.

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32 ———.

A collection of minerals from the Mendip Hills, Somersetshire.

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33 TALLING, —, *Truro.*

Sundry minerals from Truro.

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34 ———.

Minerals from Liskeard, Cornwall.

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35 IPSWICH MUSEUM COMMITTEE, by the Rev. J. HENSLOW, President.

Sundry minerals obtained from the neighbourhood of Ipswich, and used in the arts, as manure, for cement, and for some other purposes.

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36 PAINE, JOHN M., *Farnham*—Producer.

Phosphoric fossils and marls from the upper greensand, the gault, and the upper part of the lower greensand formations. These fossils are stated to contain as high a per centage of phosphate of lime as ordinary bones; and they have been proved to be useful in fertilizing land. They are easily converted into superphosphate of lime, by the agency of sulphuric acid. The clean fossils contain from 50 to 70 per cent. of bone-earth phosphate; the green marl (without fossils) contains from 4 to 15 per cent. The substances found are characterized by the almost total absence of carbonic acid, and are, therefore, the more valuable as a material for forming superphosphate of lime. These phosphoric fossils are to be found in greater or less quantities at the bottom of the chalk range of hills throughout England. The fossils and marls are chiefly dug from the lands of the exhibitor at Farnham, in Surrey.

Transverse section of pocket of hops of the choicest "Golding" variety, grown upon the phosphoric marl of the "upper greensand."

Entire pocket of the same as prepared for sale.

[The concretions of phosphate of lime, which were discovered by Mr. Paine in the cretaceous rocks near Farnham, in a state well adapted for economic use, and which were much employed for agricultural purposes, appear to exist in two or three bands in the upper greensand and gault, not extending into the true lower greensand. The concretions are occasionally formed about an organic centre, and appear to be instances of segregations of a mineral substance at one time generally distributed in a bed while being deposited at the bottom of a sea. The phosphoritic nodules are everywhere found with green earth.—D. T. A.]

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37 LANCE, EDWARD JARMAN, *Frimley, Bagshot, Surrey.*

Specimens of minerals, in their raw state, as used in the arts (as iron from the Wealden formation, and the coal measures, &c.), arranged in trays, and named.

Specimens of minerals, used as manures, as phosphate of lime and magnesia; sulphate of lime and alumina; Cornwall sand, shell marl, &c.

Specimens of cultivated soils or earths, arranged as they occur from London to Cornwall, being the abrasions of minerals.

Specimens of corn produce; the effect of the admixture of fertilizing minerals and culture on siliceous sand, in illustration of the preceding collection.

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38 GILL, WILLIAM EATHORNE, *Truro*—Inventor.

Normal guano, a manure: prepared from the refuse of the fisheries, as a superior fertilizer.

[The large quantities of fish, particularly pilchards, mackerel, and hake, which are caught around the coast of Cornwall, renders the preparation of a manure from the refuse, on most occasions, a comparatively easy undertaking. The value of fish manure has been long known, and it is not at all uncommon for farmers to go to considerable expense to obtain the offal from the nearest fishing towns; and they value highly the refuse salt, which they obtain after the pilchard season, from the curing-houses, on account of the great quantity of pot-oil it contains.—R. H.]

39 ———.
Clay and chalk.

40 SWEETMAN, JOHN, *Sutton County, Ireland*—Proprietor.
Blue limestone, containing about 90 per cent. of carbonate of lime. Dolomite, containing about 40 per cent. of carbonate of magnesia. Cement made with dolomite. Quartz rock for road metal. Steatite, for pottery or silicated soap. Brown hæmatite iron ore. Black oxide of manganese, containing about 55 per cent. of oxygen. Umber. Yellow and brown ochre. White sand, for manufacture of glass.

[Dolomite occurs in various places in Ireland, in veins in the limestone districts, particularly where intruded rocks are near. On the south side of Belfast Lough, at Holywood, it appears also as a distinct rock in a stratum about 60 feet thick. The best kinds contain from 18 to about 22 per cent. of magnesia.—D. T. A.]

41 TESCHEMACHER, E. F., 4 *Park Terrace, Highbury*—Exhibitor.
Collection of mineral and other manures.

42 HARRIS, J., 2 *Hart Street, Mark Lane*—Inventor and Manufacturer.
Fæcal manure, deodorised, containing the fertilizing properties essential to vegetation, and suitable for every description of soil and climate.

43 ———.
Silt, sand, turf, &c., from the Isle of Ely.

44 RAMSEY, A., 65 *Mark Lane.*
Artificial manure, bone dust, and superphosphate of lime.

45 MITCHELL, W. B., *Sheffield.*
Sandstones, for purposes of construction, and grindstones.

1. Millstone grit—Bull Hill Quarry. 2. Millstone grit—Reeves' Edge Quarry. 3. Blue sandstone—Green Moor Quarry. 4. Brown sandstone—Green Moor Quarry. 5. Blue sandstone—Brinkcliffe Edge Quarry. 6. Brown sandstone—Grenoside Quarry. 7. Brown sandstone—Wickersley Quarry. 8. Magnesian limestone—Steetley Quarry.

Clay.

9. Fire clay and brick—Dore Moor Mine. 10. Fire clay, for crucibles—Storr's Mine. 11. Balbro brick clay; pressed brick.

Coals.

12. From Soap House Colliery—Sheffield Bed. 13. From Birley Vale Colliery—Sheffield Bed. 14. From Mortomley Colliery—Sheffield Bed. 15. Handsworth converting coal. 16. Tinsley Park high hazel coal. 17. Tinsley Park furnace coal.

46 NESBITT, J. C., *Kennington.*
Phosphate fossils for manure.

47 CAWLEY, JAMES, *Pendell, Blechingley*—Producer and Manufacturer.
Stone from the surface of fuller's earth, used for building purposes.
Fuller's earth in the raw state, blue and yellow.
Fuller's earth, blue and yellow, dried and prepared for use in the manufacture of woollen cloths, flannels, blankets, Scotch tweeds, and tartan shawls.
Specimen of the spar found in the strata of the fuller's earth.
All the above specimens were found and dug at the "Cockley pits" at Nutfield, Surrey.

[The fuller's earth pits of Nutfield, near Reigate, are extensively worked, and supply large quantities of this substance to the clothing districts. There are two kinds, one greener than the other, owing to the presence of silicate of iron; but both exist under the same geological conditions, occurring in the lower cretaceous series, and differing little in chemical condition.

Fuller's earth consists of about 45 silica, 20 alumina, and 25 water. When placed in water it almost dissolves, and when exposed to great heat it melts. It combines readily with grease, forming a kind of earthy soap, and for this reason is valuable in the manufacture of cloth made of animal fibre.—D. T. A.]

48 GAWKROGER & HYNAM, 7 *Princes Square, Finsbury*—Manufacturers.
Fuller's earth, and purified dried fuller's earth, from Chart Lodge, Reigate, Surrey, and Cormonger's Pits, Nutfield, Surrey.

[Fuller's earth, and its localities in England, are elsewhere described. The following is the mode of purifying and preparing the raw material for use:—

The fuller's earth, after it comes from the pit, is baked or dried by exposure to the sun, and then thrown into cold water, where it falls into a powder, and the finer parts are separated from the coarser by a method of washing in several tubs, through which the water is conducted, and where it deposits the different kinds in succession. These are used for different kinds of cloth, the coarser part for the inferior and the fine for the better kinds of cloth. The soapy combinations formed by fuller's earth with the greasy portions of cloth during the process of fulling, are supposed to serve the purpose of mordants in some measure.—D. T. A.]

49 WILSON, Sir THOMAS MARYON, *Charlton, Kent.*
Sands and loams for casting, from Charlton, next Woolwich; sands used for glass and house purposes from Hampstead.

50 ROCK, JAMES, jun., *Hastings.*
Lignite found in the summit tunnel of the Hastings and Ashford railway, 1½ miles to the N.N.E. of Hastings, about 90 feet from the surface, and 300 feet above the sea level. The strata dip from N.W. to S.E. at an angle of about 65 degrees.
Clinker, containing a considerable quantity of iron, from an ancient cinder-bank on the property of Hercules Sharpe, Esq., Sedlescomb, Sussex.
Claystone, said to contain oxide of chromium.
Fine white sand, from Hastings cliffs.

[The lignite of the Hastings sand formation, near Hastings, has been long known, and corresponds in every particular with other lignites from Tilgate Forest. It occurs in nearly horizontal bands, thinning out into a mere film, and the largest masses do not exceed a few inches in thickness. It is very brittle, and burns with a bright flame; resembles jet, and contains included fragments of ligneous character. It is not unlike the Bovey coal.

Ironstone was formerly extracted from some of the ferruginous sands of the Wealden, either in irregular concretions, hard, compact, and of steel-grey colour inside, or laminated, and often concentric. In some places it is of excellent quality, and when the country was covered with forest was much used in the manufacture of charcoal iron.—D. T. A.]

51 ROSS, THOMAS, *Claremont, Hastings.*

Iron ore from the neighbourhood of Hastings.
Tilgate stone from the East Cliff, Hastings.
Hastings "granite" (locally so called).
Clay, from a large bed lying under the sand cliffs to the eastward of Hastings.
Hastings hone-stone, rough and prepared.

[The clay near Hastings underlies a thick deposit of white sand and friable sandstone, called the "Worth beds." The clay itself contains undulating seams of lignite. It overlies another bed also including lignite.—D. T. A.]

53 WHITTAKER, JAMES, *Worksworth, Derbyshire*—Proprietor.

Specimens of marble, and vase made of the same.
Specimens of grit sand, used for fine castings.
White sand, used for scouring, &c.
White lead ore, and stalactite.

54 BRODIE, PETER B., F.G.S., *Down Hatherley, Gloucester*—Producer.

1. Limestone, from the Purbeck strata in the Vale of Wardour, Wiltshire, applicable to purposes of lithography.
2. Ironstone, from the top beds of the lower lias, Robinswood Hill, near Gloucester, Hewlett's Hill, near Cheltenham, and Chipping Campden, Gloucestershire; it occurs in beds, and occupies a considerable area in the Cotswold hills.
3. Septaria, found in the upper beds of the lower lias, Robinswood Hill, near Gloucester, in sufficient quantities to be used for cement.
4. Iron pyrites, or sulphuret of iron, found in digging a well in the lias at Gloucester.
5. Limestone, forming an extensive bed in the lower lias near its base, and extending through Gloucestershire and Somersetshire.
6. Hard limestone of the lower lias, near Bidford, in Warwickshire. This stone takes a polish, and could be used as a marble.
7. Bone bed, a thin but extensive band at the base of the lower lias, charged with fragments of bones, teeth, and coprolites, which might be beneficial as a manure. It occurs at Wainlode Cliff, Coombe Hill, near Gloucester, Westbury-on-Severn, Somersetshire, and Wales.

[All the above specimens, except the first, are from the lias, a deposit of calcareous clay widely distributed in the west of England, and ranging from the coast of Dorsetshire, at Lyme Regis, to the coast of Yorkshire, at Whitby. The upper and lower beds are often shaly, and yield materials for the manufacture of alum and other substances. The middle portion is more calcareous, and includes some bands of compact limestone. Where the carbonate of lime forms into nodules somewhat argillaceous, there are found septaria well adapted to the making of cement. In many places, the iron disseminated through the clay has collected into bands of impure ironstone, which, however, is not likely to come into successful competition with other ores. The bone-bed may, if the expenses of transport be inconsiderable, be worth working as a cheap and effective mineral manure.—D. T. A.]

55 RIDDELL, Sir JAMES MILES, Bart., *Strontian*—Proprietor.

Various specimens of minerals.
Harmotome, in large crystals, on calcareous spar.
Morvenite, a variety of harmotome, on calcareous spar, amber colour.
Crystallized calcareous spar, with annular iron pyrites, enclosing radiated sulphate of barytes.
Brown calcareous spar.
Crystallized calcareous spar, of a pink colour.
Calcareous spar, on hexahedral tables enclosing icositetral crystals.
Hexahedral prismatic calcareous spar, penetrated with crystals of the same, of a different form, the obtuse solid angle of which partly protrudes from the terminal plane of the prism.
Brewsterite, discovered near Strontian.
Crystallized carbonate of strontian.
Massive fibrous carbonate of strontian, with heavy spar.
Sulphate of barytes with phosphate of lead.
Sulphuret of iron.
Gneiss. Gneiss passing into granite. Gneiss with red felspar.
Junction of gneiss with granite, intersected by a vein of felspar.
Fine-grained granites. Syenites.
Porphyritic granite.
Syenite, with a vein of felspar.
Rock, of carbonate of lime and serpentine.
Granite studded with garnets, from the summit of Ben Resipole, a mountain above 3,000 feet in height.
A very large specimen of the same.
Quartz rock.
Sulphuret of lead, in a matrix of calcareous spar, from the Smithy Vein (Feedonald district).
Sulphuret of lead with calcareous spar, a continuous string of lead ore, from the red vein of Feedonald.
Crystallized sulphuret of lead (the primary cube), from the same vein.
Sulphuret of lead, with sulphuret of zinc and crystallized calcareous spar in the cavities.
Sulphuret of zinc and calcareous spar, from Corantee.
Cubic sulphuret of lead with calcareous spar.
Sulphuret of lead in calcareous spar, from Clashgoram mine (middle district).
Sulphuret of lead; sulphuret of lead, embedded in calcareous spar; and sulphuret of lead, partly crystallized with calcareous spar—from Belsgrove Mine.
Junction of granite and mica slate.
Lias limestone; from the north side of the promontory of Ardnamurchan.
Lias limestone, from the south side of the promontory.
A large mass of sulphate of barytes, a substance constituting much of the matrix or veinstone of lead ore.

[At Strontian, in the western part of Argyllshire, a boss of granite is seen penetrating the gneiss, which abounds in the district; and a little further to the west, a large quantity of porphyry and trap occurs, covered, in two or three places near Ardnamurchan, by deposits of the oolitic and liassic period. In the granite, and near its junction with the gneiss, mineral veins are found, containing lead and copper; and in one of these was first observed the mineral thence called *strontianite*, or *strontites*, a carbonate of strontide, usually associated with calc-spar, sulphate of barytes, and galena. The metal called *strontian*, obtained from this mineral, was first described by Sir H. Davy, and resembles barium in its properties and appearance. Carbonate of strontia is chiefly used in the production of the nitrate employed in giving a red colour to fireworks.

Harmotome and morvenite are hydrous silicates of alumina and barytes. Brewsterite is also hydrous silicate of alumina, but contains strontia, as well as barytes. The other minerals are well known. The lias is one of several small patches round the trap rocks of Ardnamurchan, Morven, and the Isle of Mull, and contains numerous organic remains.—D. T. A.]

56 DANN, THOMAS, *Reigate*—Producer.

Greystone lime, from the lime-works, at Reigate Hill, on the estate of the Countess of Warwick.

57 WORTHINGTON, WILLIAM, *Northwich, Cheshire*—Proprietor.

Specimens of rock salt, as produced from the mines, near Northwich, Cheshire.

Specimen of refined salt, for curing fish.
Fine high-dried table salt.
Malvern salt, much esteemed for table use.
Large-grained bay salt, used for various purposes.

[The salt-mines of Cheshire are worked in the new red sandstone of that county, the salt being in large masses of irregular form associated with marl and gypsum. In its natural state it is of dull red colour, semi-transparent, and though sometimes cubical in crystal, more usually massive. The number of saliferous beds in the district is five, the thinnest of them being 6 inches, but thickest nearly 40 feet thick, and they are worked at a depth of from 50 to 150 yards below the surface.

The mode of working the thick bed is not much unlike that adopted in South Staffordshire for coal; but the roof being generally uniform and tolerably tough, and the mine without noxious gases, the works are more simple. The salt is blasted, and large pillars are left to support the roof. Upwards of 60,000 tons of salt are obtained from the Cheshire mines, and a large quantity is also manufactured from brine-springs and other similar sources, in Cheshire and Worcestershire. The greater part is exported from Liverpool.—D. T. A.]

58 HILL, JOHN, *Ringsend, Dublin*—Manufacturer.
Basket and pink salt for table use; Irish fine, or butter salt, and coarse or provision salt.

[There are no natural deposits of salt in Ireland, and the various kinds exhibited by and prepared in that country are generally procured from the English salt mines.—D. T. A.]

59 ———.
Wad and white-lead ore.

60 ROAKE, JAMES WHITE, *Newbury, Berkshire.*
Specimens of soils which surround Newbury, Berks, and the uses to which they are applied.

Nos. 1 to 4. Various clays. 5. White. 6. Red. 7. Yellow ochre. 8. Fine white sand. 9. Coarse sand. 10. Ferruginous sand. 11. Ochreous sand, used by iron founders. 12. Green sand, with oysters embedded. 13. Gravel, rough and pebbly. 14. Calcined pebbles, reduced to coarse and medium grit. 15. Fine pebbles, with stucco made from it, to compare with a coloured fragment and tessera from Herculaneum. 16. Chalk from Kintbury, with shells peculiar to that deposit. 17. Whiting. 18. Limestone. 19. Stone lime. 20. Chalk lime, through which gas has passed. 21. Peat from the Kennet valley. 22. Peat, condensed by Cobbold's patent process. 23. Peat, pulverised for horticultural uses, and disinfecting purposes. 24. Peat ashes, for the agriculturist.
Samples of bricks, tiles, and pottery.

[Newbury is situated on the lower tertiary beds immediately overlying the chalk, which crops out at a short distance from London to the north, south, and west. The river Kennet crosses the chalk from the west, runs through the town towards the east, and enters the Thames near Reading. The tertiary deposits here include a moderate thickness of the London clay overlying the mottled clays and sands of the lower or plastic clay series, including a pebble bed, mottled red clays and sands, and the whole covered up with a little gravel.—D. T. A.]

61 COWPER, JOHN, *Alston, Cumberland*—Proprietor.
Sulphate of barytes, a large crystal from Dunfell, Cumberland.

Witherite (carbonate of barytes) from Fallowfield, Northumberland.

Sulphate of barytes, found in witherite.
Bromlite (baryto-calcite) on bitterspar and pseudomorphous quartz; from Brownley Hill, Alton, Cumberland.

Carbonate of barytes, from Fallowfield, Northumberland; used in the manufacture of plate, crown, sheet, and bottle glass, chemical works, &c.
Barytes and galena, from the same quarter.
Coal, galena, shale, &c.
Carbonate of lime, from Alton, Cumberland.

62 DYER, WILLIAM BUNT, *Mold*—Proprietor.
White lead ore, carbonate of lead ore, from Jamaica mine. Assay, 60 per cent. for lead, and four ounces of silver per ton of lead.

62 ———.
White carbonate of barytes, from South Barrule, Isle of Man.

63 CAIRNS, J., 9 *Charlotte Street, Manchester.*
Carbonate of barytes, with specimens of lead ore, from Anglezark Moors, near Chorley, Lancashire.

64 BROOKMAN & LANGDON, 28 *Great Russell Street*—Proprietors.
Specimens of black lead from Cumberland, in the raw state, and as hardened for use.

[The Cumberland graphite is obtained from a large and very irregular vein cutting through the green slate and porphyry, and the mineral occurs in large lumps, found here and there expanding and thinning out with no apparent order. About 50 years ago, one of the largest masses ever discovered was suddenly met with, and yielded about 70,000 lbs. of the purer kind of black lead. Since then there has been nothing found of any value. The mines are near the head of Borrowdale, the entrance being about 1,000 feet above the sea, and as much below the summit of the mountain.—D. T. A.]

65 BROCKEDON, W., 29 *Devonshire Street, Queen Square*—Patentee and Manufacturer.
Native plumbago:—Samples from the mines of Borrowdale in Cumberland, fine and crude: from Ceylon, Davis' Straits, Spain, Bohemia (called Mexican), Greenland, California, France (Poligny): nodules from India, &c.
Samples of Cumberland black lead, prepared for condensing into blocks by patent process.
Specimens in powder, purified from grit, and in fine powder, ready for condensing, which has passed through apertures $\frac{1}{50000}$th of an inch in diameter.
Blocks which have been condensed by a pressure of 5000 tons.
Slices of the blocks for pencil-makers; points for Mordan's ever-pointed pencils; cedar pencils, by various makers, of Brockedon's patent Cumberland lead.
Blocks made of Ceylon and other plumbagos, &c.
The plumbagos exhibited in their natural state, are—Three very fine samples of the old black-lead, formerly found in Cumberland. The only native plumbago which could be cut into slices, and used in its natural state; the miners have long failed to supply such specimens. Two samples of Cumberland lead, containing too much grit to be used without purification. Samples of plumbago from Ceylon, crystalline and fibrous: this is the purest plumbago known, being 98·55 pure carbon; but it is too fragile for use in cedar. Two samples from Davis's Straits and Greenland. One from California. Others from Spain and Bohemia (called Mexican), of these two the common pencils are made, when hardened by sulphur. From none of these can a fine pencil be made, but the Cumberland.
The manufactured blocks are from the second variety of the Cumberland, freed from grit, and reduced to an impalpable powder, of which a quantity is shown to form one of the blocks. From this powder the air is exhausted, when it is condensed in a dry state by an enormous pressure, which consolidates a mass weighing seven ounces under a force, in two blows, with a force of 5,000 tons, leaving it as compact as the natural; and from these blocks slices are cut, as shown: these are inserted in

channels in the cedar. It is also cut into the lengths of the block as square threads; these are rounded, then cut to the proper lengths for the ever-pointed pencils.

For the process by which the Cumberland lead can be freed from grit, and then solidified, the exhibitor obtained a patent, and pencil manufacturers use it only for their finest drawing pencils.

[Graphite or Plumbago, a form of carbon commonly called *black-lead*, and sometimes, but incorrectly, regarded as a carburet of iron, is a well-known soft mineral, crystallized in small hexagonal plates of laminated structure, infusible, burning with great difficulty under the blowpipe; consisting of from 85 to 8·35 per cent. of carbon, and having a specific gravity of 2·09 to 2·25; the purest being the lightest. It is found in metamorphic, generally in schistose, rocks, of various geological age, in masses or veins parallel to the lamination or stratification. The pure and valuable kinds are very rare, and have been obtained almost exclusively from the localities mentioned above. The variety from Ceylon is remarkably pure but soft; that from Greenland is also pure, but very hard. The latter, according to an analysis recently made by T. H. Henry, Esq., yields carbon 96·6, ash 3·4; but does not seem adapted for use in pencil-making, owing to its hardness and paleness. It appears that the presence of a certain quantity of iron is favourable for its use in the arts.

The method by which Mr. Brockedon has rendered several of the softer and less compact graphites available, and has also brought into use the fragments formerly too small for pencils, is by enormous compression, produced by powerful machinery, on the finely-levigated powder in a pure state, after a certain amount of preparation.—D. T. A.]

66 REEVES & SONS, 113 *Cheapside*—Inventors and Manufacturers.

Cumberland lead and cedar wood, in the different forms in which they are used in the manufacture of drawing pencils.

67 ADAIR, R., *Maryport*—Manufacturer.

Various materials used in black-lead pencil making; with specimens of pencil manufacture, in its different stages.

The cedar used is imported into London and Liverpool chiefly from South America. The foreign plumbago, of which common pencils are manufactured, is imported from Germany, the East Indies, Spain, and Mexico. The Cumberland black-lead is found only in Borrowdale, and is used only for the best pencils.

68 WOLFF, E., & SONS, *Cumberland*—Manufacturers.

East India and Spanish black lead and manufactured pencils.

69 BANKS, SON, & CO., *Greta Bridge, Keswick.*

Black-lead and other manufactured pencils.

70 ROGERS, SAMUEL SANDILANDS, *Douglas, Isle of Man.*

Specimens of the earths and sands of the Isle of Man.

71 TENNANTS, CLOW, & CO., *Manchester*—Manufacturers.

Large groups of crystals of sulphate of copper.

72 THOMPSON, J., *Northwich.*

Crystalline block of rock salt.

73 CLAXTON, J.

Sands from Alum Bay, Isle of Wight.

74 SQUIRE, JOHN & WILLIAM, *Tamworth, Isle of Wight, Hampshire.*

Specimen of pure white sand, used in the manufacture of best flint glass, taken from horizontal and vertical beds in the cliffs in Alum Bay, near the Needles, on the estate of William George Ward, Esq. It is exported from Tamworth, and is extensively used by glass-makers, for its siliceous properties.

75 COLLINSON, CHARLES, *Mansfield*—Proprietor.

Red casting sand, found only at Mansfield, and of value in the production of fine castings. Its qualities are fineness of grain, porosity, great purity and smoothness, which latter property contributes to give a high face to castings.

76 RELF, S., *Reigate, Surrey*—Producer.

White sand, from the Tunnel Caves at Reigate (called in use "silver sand"), dug from the rock.

77 MORRISON, GEORGE, Agent of EARL SOMERS, *Reigate.*

Sand from the common, named Reigate Heath, valued for its grit, and used in the manufacture of glass.

[This sand is from certain beds of the lower greensand series much developed in Surrey, and frequently exhibiting extensive tracts of sand, often without admixture of any argillaceous or calcareous matter.—D. T. A.]

78 LONG, J., *Limerick.*

Sands and earths from the river Shannon.

79 ROUSE, Capt., & WHITLEY, N., *Truro.*

Specimens of sands, from various parts of Cornwall, used for agricultural and building purposes: the agricultural sands from Gwithian, Falmouth harbour, and Perran Porth; the others used for building purposes.

80 FLATHER & HADEN, 1 *Castle Mills, and* 2 *Broad Lane, Sheffield.*

Prepared Trent sand, or wharpe, used for buffing up, or bringing to a surface, German silver, Britannia metal, brass, copper, &c.

Prepared Welsh rotten-stone, used for producing the fine polish on silver, Britannia metal goods, &c.; when mixed with one-sixth its weight, of rape or sweet oil, it forms the polishing paste used for cleaning Britannia metal, brasses, tin ware, and other bright metal goods.

[Most substances employed under the name of rotten-stone, or Tripoli, are essentially composed of silica in a peculiar state of subdivision, the actual particles of which the whole is made up being crystalline, but the mass earthy, and often reduced by compression to a solid state, having a slaty fracture. In most cases, the origin may be traced to the remains of infusorial animalcules, and occasionally the presence of carbon, and a little resinous organic matter which shows this still more clearly. The name Tripoli is generally understood to apply to all the earthy varieties (of which there are several) in which silica exists nearly pure, but in a very minute state of subdivision. Rotten-stone is limited to those which are light and friable, and of very fine grain. It occurs rather abundantly near Bakewell, in Derbyshire, amongst the carboniferous limestones, but is often met with in other rocks.—D. T. A.]

Prepared lime, used for producing the bright black polish upon German silver, electro-plated, and silver goods.

81 SOLOMON, THOMAS, *Truro.*

Varieties of hone-stones, used for sharpening edge-tools, from Perran Porth, near Truro; Lostwithiel; Feock, near Truro; Kenwyn, near Truro; and other localities.

Wolfram, from various tin-mines in Cornwall, used as a mordant in dying calicoes.

Varieties of rarer minerals, from various parts of Cornwall.

84 Meinig, C. 103 *Leadenhall Street*—Manufacturer.
Circular grindstones for glass, mineral teeth, fine tools, &c. Grinding lathe, &c. Circular and flat oilstones.

85 Walton, J., *Greenends, Alston*—Proprietor.
Various specimens of crystals and minerals:—
Pyramidal quartz; ruby blende or limestone; stalactitical drusy quartz; amber fluor spar, with pearl spar and copper pyrites; dodecahedral galena and blend on quartz; carbonate of lime on amber fluor, quartz spar, and pearl spar on sulphate of zinc, from Bromley Hill, Alston.
Carbonate of lead, from Thorngill Alston.
Lead ores from Greensides.

87 Potter, William, & Co., 87 *Aldgate, and Cromford, Derbyshire*—Proprietors and Manufacturers.
Specimens of fluor spar, calcareous spar, calamine, white-lead ore, lead ore, sulphate of barytes, and sulphate of barytes manufactured as a pigment. From the Dinah, Goodluck, and other mines in the vicinity of Cromford, Derbyshire.

88 Falmouth Local Committee.
Quartz, pebbles, and sand, from Swan Pool, near Falmouth.

89 Nicholls, J., *Truro*,
Fire-clay, used for stopping furnaces.

90 Whiteway, Watts, & Co., *Wareham, Dorsetshire, also of Kingsteignton, Devonshire*—Producers.
Blue clay, used in potteries, raised from the pits called Furzebrook, near Wareham, Dorsetshire.
Black clay, for pottery purposes.
Pipe clay, for making tobacco pipes.
Top clay, for brown stone-ware purposes.
Draining clay, for draining tiles, from the pits of Kingsteignton.

91 King & Co., *Stourbridge*.
Stourbridge fire-clay, and various raw and burnt articles manufactured from it.
Model of a glass-house in Stourbridge.

92 Jenkins & Beer, *Truro*—Producers.
Ochres, three in a powdered state, of different shades of colour, and one in lumps of two shades of colour; produced at Kea, near Truro; used in the manufacture of paints, paper-hangings, &c. Exhibited on account of their clearness, fulness of colour, body, and cheapness.

93 Jenkins & Courtney, *Truro*—Producers.
Specimens of Cornish china-stone, exhibiting its natural fracture: raised in the Great Bodilla China-stone quarries, St. Stephen's, Cornwall, and largely used in the potteries for the manufacture of the finer descriptions of china and earthenware.

[China-stone and china-clay, both of which are most extensively used in the potteries, are produced in the neighbourhood of the great granite ranges of Cornwall and Devonshire: in the former county chiefly from the St. Austell granite, and also from Tregorming Hill to the south of Helstone, and from the southern granite of Dartmoor in the latter county. The decomposed granite of St. Stephen's, and the uses to which it and the clay produced from it could be applied, were discovered in 1768 by Cookworthy of Plymouth, who was the first person who made hard porcelain in this kingdom. To this discovery is due entirely the manufacture of porcelain, similar to that of China.

The composition of this kaolin, or porcelain clay, varies in different localities, the average of the best Cornish clay giving an analysis—alumina, 24·6; silica, 44·30; lime, magnesia, and potash, 1·60; water, 8·74. The pure kaolin of Dartmoor being, alumina, 36·81; silica, 44·25; lime, magnesia, and potash, 2·20; water, 12·7.

With the increase of our porcelains and fine earthenware manufacture, the demand for these clays has largely increased; and to this must be added a large trade in the china-stone itself, which is used principally for glazing fine ware, the ordinary glaze being composed of decomposed granite, lime, flint, litharge, and borax.

A large quantity of this clay of an inferior quality is used by the paper-makers and calico-dressers, for the purpose of giving weight and body to their fabrics.

Men, women, and children are largely employed on these clay-works, which, when the clay is being dressed, present a scene of active and curious industry.—R. H.]

94 Thriscutt, C., *St. Austell*.
China-clay as dug out of the earth, from Caudle Down Clay-works; prepared, burned, and calcined.

95 Whitley, N., *Truro*.
Clays of the district of Truro.

97 Minton, H. & Co.
Raw materials used in the manufacture of porcelain.

98 Highley, Samuel, jun., 32 *Fleet Street*—Importer.
Collection of rocks and fossils, stratagraphically arranged, to illustrate modern works on geology; from Dr. Krantz's establishment at Bonn.

99 Greaves, R., *Warwick*—Proprietor and Producer.
Two busts of Shakspeare, in cement.
Blue lias limestone, with samples of the lime in the lump and ground.
Models in lias, Portland, and improved Roman cement.
Blocks of concrete, made in lias, Portland, and Roman cement, and ground-lias lime.
Brick-work cut from the Copenhagen tunnel in the Great Northern Railway, and set in lias lime. Ornaments cut and set in the same, to show the adhesiveness of the mortar.
Lias flag-stone, adopted for hall, church, and house-floors, being hard and dry.
Lithographic stones.
Floors in lias stone and lias cements.

[The beds of lias in many parts of England, consisting of carbonate of lime mixed with from 20 to 35 per cent. of alumina, are well adapted for the manufacture of hydraulic cements, and the nature of the clay greatly affects the value of the cement. Samples of the raw material, with various applications of it, are, therefore, of great practical importance. The lithographic stones from the lias are not unlike those from Germany, but they have hitherto been little used.—D. T. A.]

100 Fayle, Benjamin, & Co., *Old Swan Lane, Upper Thames Street*—Proprietors.
Specimen of blue potters' clay, as dug from the pits at Norden, Isle of Purbeck, county of Dorset; used for the manufacture of earthenware; said to possess greater strength of body, and to shrink less than many other clays when exposed to high heat.

101 Phillips, William, *Morley Works, near Plympton*—Producer and Proprietor.
1. Specimen of disintegrated granite from Morley Works, Devon, in which the felspar is in a decomposed state, pure, and in a large proportion, compared with the quartz, schorl, and mica.
2 and 3. Prepared china clay, or decomposed felspar, the result of washing; used chiefly in porcelain, fine and common pottery, calico-dressing, and paper-making.
4. Specimen of clay for fire-bricks and crucibles.

5. Plymouth porcelain, made by Cookworthy, the discoverer of china clay in this country.
6 and 7. Porcelain made from Morley clay.
8 and 9. Pottery from this clay, made of 80 per cent. of clay, with flint and china-stone.

[A large quantity of china clay is found on the south side of the Dartmoor granite, the quality of the clay being excellent, and the position exceedingly favourable for the supply of the Staffordshire potteries by railway carriage. The china clay of Devonshire possesses much interest, not only by its excellent quality, but also as the material from which Mr. Cookworthy, the first manufacturer of porcelain in England, probably obtained his material. The process of purifying china clay is at present simply mechanical, but is capable of much improvement, and the coarse parts of the clay are well adapted to the manufacture of brick of various kinds. The china clay is obtained from the decomposition of particular varieties of granite.—D. T. A.]

10 and 11. Pottery of ordinary manufacture, with small proportions of china clay, flint, and stone.
12 and 13. Bricks made from clay.
14, 15, and 16. Pottery and china, illustrative of the application and uses of this china clay, which has a larger proportion of alumina than other china clays, and is free from metallic oxides.

[The china clay and china stone used in the manufacture of the finer kinds of porcelain are chiefly obtained from decomposed granite; the felspar of the granite, under certain circumstances, yielding to the action of the weather, and parting with its alkaline earths, and the harder, heavier, and coarser parts of the granite removed by mechanical washing, either naturally or artificially. The purified material thus obtained is called *kaolin*, its specific gravity is from 2·21 to 2·26. Some of the finer kinds contain, when boiled for a short time in a solution of potash, about equal parts of silica and alumina, upwards of 10 per cent. water, and from 2 to 10 per cent. of free silica, the mineral being therefore represented by the formula $A : S : + 2 Aq$.

The formula for felspar is $3 A : Si^3 + K : Si^3$, the potash being often replaced by soda, and the nature of the change may thus be understood. The best china clay in England is obtained from Cornwall and Devonshire.—D. T. A.]

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102 PIKE, WILLIAM & JOHN, *Wareham*—Producers.

Potters' or blue clay, from the island of Purbeck, Dorsetshire, used in the British potteries.
Stoneware clay, used in the London and Bristol potteries for the manufacture of stoneware and drain pipes.
Pipe clay, for the manufacture of tobacco pipes.
Alum clay, for the manufacture of alum.

[A considerable quantity of clay fit for ordinary potters' work, and for the manufacture of tobacco-pipes, besides some alum schist, is obtained in the small peninsula called the isle of Purbeck, on the Dorsetshire coast. This little tract of land contains a curious series of cretaceous, Wealden, and oolitic deposits; among the latter is the Kimmeridge coal elsewhere described, and above the whole series are clays of the Hampshire basin, in the manufacture of which the coal is used. These plastic clays belong to the lowest tertiary deposits.—D. T. A.]

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103 WEST OF ENGLAND CHINA STONE & CLAY CO.—*St. Austell, Cornwall.*

China stone and china clay.

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104 ———

China stone and china clay.

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105 GRIMSLEY, HENRY, *Oxford*—Designer and Modeller.

Terra-cotta statue of a female figure holding a dial, made in clay obtained from Shotover Hill, near Oxford. Clay, sand, and ochre, from the same place, showing fourteen different strata, to the depth of 25 feet.

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106 BURNETT, NICHOLAS, *Black Hedley, Gateshead, Newcastle-upon-Tyne*—Producer.

Specimen of clay, found near Black Hedley.
Articles manufactured from the clay, by Messrs. Thos. Fell and Co., Newcastle.

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107 MARTYN, ELIAS, *St. Austell*—Producer and Manufacturer.

Specimens of China clay, or kaolin, used in the Staffordshire potteries, in bleaching, and in paper making.
China stone.

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108 WHEELER, PHILIP, & CO., *St. Austell*—Proprietors.

China clay, or "kaolin," for the manufacture of earthen and china ware.
Bleaching clay (*terre blanche*), used in the cotton and paper manufactures.
Clay, exported to France, &c., for the extraction and manufacture of alum (*alumine*).
China stone from quarries in the parish of Germoe, Cornwall.

[The china clay quarries in the adjoining parishes of Germoe and Breage, were the first worked in this country; and from this clay the earliest Plymouth china was made. —R. H.]

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109 BROWNE, WILLIAM, *St. Austell*—Proprietor.

Specimen of china clay, derived from the decomposition of felspar, extensively used in the manufacture of china, porcelain, and Parian, for ornamental vases, busts, and all articles that require particular care and delicacy in moulding, and employed in the patent manufacture of ornamental stone, facing, flooring, and tiling, various articles of furniture, &c.

[A very large quantity of valuable china clay and china stone are found naturally, and prepared artificially in Cornwall and Devon, chiefly from the St. Austell decomposing granite, and the southern granite of Dartmoor. About 14,000 tons of prepared and 30,000 tons of natural china clay are annually exported, chiefly to the potteries. —D. T. A.]

One of a series of reports published monthly, containing a description of the duty performed by the steam-engines used in the mines of Cornwall and Devon.
The various engineering details of the engine and its work are given in these reports on a new method.

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110 MICHELL, SARAH, *St. Austell.*

White china clay, for manufacturing china and earthenware, also for bleaching paper, calico, &c.

111 WANDESFORDE, HON. CHARLES, *Castlecomer*—Proprietor.

Specimens of anthracite coal. Iron-stone. Fire-clay for fire-bricks. Slate-clay, for flooring-tiles, milk-pans, flower-pots, &c. Clay for making draining-tiles. Sand, for fire-bricks and moulding.

112 BEAMISH.

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113 PHIPPARD, THOMAS, *Wareham*—Proprietor.

Potters', and pipe or brown clay, from Carey pits, with ware and tobacco pipes made from them; also silicious sand, for the manufacture of glass.

114 SIMONS, THOMAS, *Birmingham*—Manufacturer.
Specimens of raw and burnt clay:—Lumps of glass-house pot, rough, and fit for use. Lump of coke and finer. Casting pot, &c., in different stages, and finished. Muffles, &c. Portable furnaces for chemists and others. Glass-house pot. Stove liners. Retorts. Crucibles.

115 KING, GEORGE, *Demidge Lodge, Gazeley, near Newmarket*—Manufacturer.
Red brick earth as dug from the pit. Red building bricks, pamment bricks, and coping bricks made from the earth.

116 ENNISKILLEN, the Earl of, *Florence Court*.
Two kinds of clay, and drain pipes and tiles made of them.

118 ANSTEY, S., 10 *Devonshire Street, Hoxton Fields*.
Casting pots for brass.

119 FISHER, FREDERICK, *Woolpit, Suffolk*—Manufacturer.
Specimens of Woolpit brick-earth.
White building bricks.
Pamment bricks and draining pipes.

120 WALKER, R., *Victoria Works, Beverley*.
Paris white.

121 DEERING, JAMES, *Middleton, Cork, Ireland*—Producer.
Various materials obtained at Rostellan, county of Cork, Ireland, adapted for use in the manufacture of the better kinds of porcelain and earthenware. These include samples as raised from the mine, which was opened in 1850, and the different substances as used in the arts, and articles of earthenware and glass, manufactured from them.

122 PEASE, JOSEPH, *Darlington*.
Coal, from Pease's West Collieries, used for general purposes.
Coke manufactured from the coal.
Fire-clay, from above and below the coal. The same material in different stages of manufacture.
Ware produced from the fire-clay.
Fire-bricks, pipes for sewerage and agricultural drains, coping ridge-tiles, paving quarries, &c.

123 HODGSON, Sir G., Bart., *Hollybrooke Bay, County Wicklow, Ireland*—Proprietor.
Specimens of porcelain clay, from Sugarloaf Mountain.

125 LEE, JOHN, LL.D., *Hartwell, near Aylesbury*—Proprietor.
Samples of fine washed sand, from a sand-hill in the parish of Stone, near Aylesbury.
White, yellow, blue, and green glass prisms, made from the same.
Two spheres of white glass, made from the same sand.

[These sands are from soft beds of the Lowes green-sand series, of which there is a considerable thickness, forming a knoll at Stone. There is about 8 feet of whitish sand below 7 feet of sand and sandy clay, containing impure fuller's earth. The lower green-sand terminates a little to the west, and is succeeded by the beds of Portland stone, forming a distinct ridge near Hartwell, but covered and obscured by beds of gravel.—D. T. A.]

126 WHITE, HENRY, *Dunstable, Bedfordshire*.
Chalk, from the Downs of Dunstable.
Whiting, or chalk in a refined state.

127 NORTH DEVON POTTERY COMPANY, *Annery, near Bideford*—Manufacturers.
Raw clay, as raised from the pit. Gravel or sand, from the River Torridge. Sewerage pipes, hollow brick, ornamental ridge and garden tiles, &c., made from the same.

128 BULLER, T. W., *Bovey Tracey Pottery, Devon*.
Specimens of lignite or Bovey coal.
Specimens of earthenware fired with Bovey coal, and showing the colour of the Kingsteignton clays. This is the only instance in which lignite has been successfully applied to the firing of earthenware in England. Extensive deposits of lignite exist both in France and Germany; but De Brogniart (Traitè des Arts Ceramiques, vol. i., p. 222) says, that no one has yet succeeded in the manufacture of earthenware with this fuel except at Elbogen, where it is used mixed with other coal.
Patent stilts and cockspurs used in the manufacture of earthenware.

129 FAHIE, J. K., *Tipperary, Ireland*—Producer.
White and black clay. Draining tiles and pipes. Felspar, from Cork.

130 WHITE, JOHN BAZLEY, & SONS, *Westminster*—Manufacturers.
Case, containing specimens of cement stones and those producing plaster of Paris, as used in England for building purposes; showing the raw stone, the powder calcined and ground, and cubes of cement in a set state. There are two kinds of cement stones; of each kind, as well as the gypsums, it may be well to say a few words.

1st, Natural cement stones. These include the Sheppey stone (Kent), and the Harwich stone (Essex), which produce different varieties of the cement known as Roman cement, introduced by Dr. Parker about 50 years ago. These are both from the older tertiary deposits, and so also are the Hampshire cement stones found at Christchurch, Romsey, &c., which produce the Medina cement. The Whitby stone (Yorkshire), is found in the lias formation, the cement produced being known as Atkinson's cement. At Wolverhampton and in Derbyshire cement stones occur in connection with iron-stone, which imparts to them a strong ferruginous tint. At Weymouth (Dorsetshire) similar materials are obtained from the Kimmeridge clay, but these are not extensively used for building purposes. Other districts yield natural cement stones, but the above mentioned are those most known in commerce: they are used very largely, both as mortars and stuccoes.

2nd. Artificial cements:—Portland cement is composed of carbonate of lime and the argillaceous deposit of the Medway and other rivers. These materials produce a cement of superior quality, both as to strength and colour. A large panel on a wall, representing a Roman Doric window opening, shows the colour of this cement, and its adaptation for external stucco. In illustration of its strength as a connecting material between bricks, stone, &c., are shown:—a beam of brickwork, loaded with a heavy weight, indicating the value of bond courses of brickwork in cement, and the resistance they oppose to superincumbent weight and cross strain. A beam of tiles bedded in Portland cement, adapted for flooring purposes. Cubes of stone connected by Portland cement, showing its adhesive power as great in stone as in brick. Bricks made of Portland cement, to test its resistance to tensile force. Blocks of Portland cement which have been subjected to hydraulic pressure, to prove its resistance to compression. Portland cement combines with gravel, rubble-stone, &c., to form excellent concrete or beton; specimens are to be seen in parts of a block in concrete stone made at the Digue of Cherbourg, under the direction of Mons. l'Ingénieur Reibell; size of blocks, 15ft. by 8ft. by 6ft.; weight, 45 tons; specimen two years old. Part of a block made at Dover Harbour works, under the direction of James Walker, Esq., which has been exposed during three years in an isolated position to the action of the sea and shingle. Part of a block of concrete stone, made at Alderney harbour works; composition, 1 part cement to 10 parts gravel; weight of blocks 4 to 6 tons. Part of a block of concrete stone, 2 years old; the cement was used in a liquid state.

GYPSUMS, or sulphates of lime, are found in many parts of England, particularly Derbyshire, Nottinghamshire, and Cumberland; and when calcined and ground they produce the material known in commerce as plaster of Paris, and in combination with alum they produce the hard artificial cements known as Keene's, Martin's, and Parian patent cements. Keene's cement is composed of sulphate of lime and alum; the intimate chemical combination of these materials effected by calcination imparts to the stuccoes made from them, extreme hardness, by which they are adapted for use in those parts of buildings where strength and durability are required, such as skirtings, columns, pilasters, and mouldings of all sorts; and they are not liable to be injured by fire, vermin, &c. As specimens of Keene's cement are shown — a skirting moulding, worked in the common quality of Keene's cement; two pavements, of which the ground is the common quality, and the inlaid borders of the finer quality; large panel on wall, second quality, adapted for painting. Specimens, showing that in combination with colours, brilliant and forcible imitations of marbles, granites, &c., may be produced, the effect being aided by gilding and inlaying; large panel on wall, and pavement, illustrating the effect of colouring in this material, and its applicability to inlaid work, after the style of Florentine mosaic, at a cost not much exceeding the price of polished vein marble.

[There are three very different processes of manufacture in the case of hydraulic cements and artificial stone, the one consisting of an admixture of caustic lime (with or without magnesia) with silica in a gelatinous state, thus producing in the final result a hydrous silicate of lime; a second, consisting of sulphates of lime burnt with alum; and the other, composed entirely of silica, and forming, in fact, a kind of glass. Each class of artificial stones will be found noted in describing the objects exhibited by different persons. The hydrous silicates of lime manufactured artificially, consist, as noticed above, of carbonate of lime mixed with agillaceous earth, and calcined with sand or powdered flint, when the alkali, acting on the silica at a bright red heat, produces a mass which, with the subsequent addition of water, becomes permanently solid. —D. T. A.]

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131 Blyth & Jacobs, 44 *Baldwin's Gardens, Gray's Inn Lane, Holborn*—Manufacturers.

Gypsum dug from the pits; calcined, and prepared for manure. Specimens of plaster of Paris, with a collection of articles in the same.

[Gypsum (hydrous sulphate of lime) occurs in various ways and various places very abundantly. In a semi-crystalline form it is called *alabaster*, and in crystals *selenite*. In the same combination without water, it is called *anhydrite*.

Most of the gypsum used in the manufacture of plaster of Paris is obtained from tertiary deposits, of which enormous masses exist in the neighbourhood of Paris, especially at the heights of Montmartre. This stone contains above 7½ per cent. carbonate of lime, and 3 per cent. clay, which greatly improves the strength of the cement made from it. It lies between marly beds, and is of fresh-water origin; but other beds equally extensive are of the triassic series occurring with common salt, and others again in the oolites of the Alps.

The gypsum, heated from 250° to 270° Faht., parts with the whole of its water, and is changed into an anhydrous sulphate. In this state it is reduced to a fine powder, and then, on being again mixed with water, becomes warm, and rapidly solidifies. This is not the case, however, if the temperature of calcination has been too high, since if it reaches 320° the water is absorbed very slowly. The mode of calcining varies with the object required, the plaster used in constructions being less carefully burnt than that intended for fine casts. A harder and more perfect plaster than the common kind is sometimes made by adding alum during the process of calcination. This material dries more slowly, but is smoother than the ordinary plaster, and has a certain degree of transparency. The use of gypsum as manure depends on its supplying to certain soils lime and sulphuric acid.— D. T. A.]

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132 Gowans, James, *Edinburgh*—Proprietor.

Group in freestone, designed and executed by A. Handyside Ritchie, 92 Princes Street, Edinburgh.

This stone is from Redhall quarry. According to the analysis of Dr. George Wilson, of Edinburgh, the average percentage of peroxide of iron is not more than ·052. It is said to possess the property of hardening by exposure to the weather, and of retaining its primitive surface.

Specimen of freestone, from Binny quarry, forming the plinth of the group.

Dr. Wilson, in his analysis, says, "This building stone which has been in use for many years in Edinburgh, has been analysed by me, and found to contain the same percentage of peroxide of iron as the Redhall freestone, and I find that it exhibits the peculiarity of having diffused through it a quantity of native bitumen or asphaltum which acts as a protective varnish to the stone, and defends it from the action of the atmosphere."

Specimen of Binny quarry bitumen candles, made from the nearly solid bitumen or mineral wax, which is diffused through the stone, and exudes in considerable quantity between its layers. Owing to its abundance, the workmen use it for domestic purposes.

Specimen of bitumen from Binny quarry, in its natural state. It has been found by Dr. Wilson to yield, on distillation, paraffine, and a liquid hydro-carbon analogous to naphtha.

Model of a steam crane, with travelling gear, worked from a horizontal shaft, and capable of raising 20 tons.

Drawing of a steam crane, worked by crab gearing, attached to a horizontal steam-engine, and capable of raising 50 tons.

Drawing of a boring machine, capable of boring holes to a depth of 40 or 50 feet, from 3 to 6 inches in diameter; used in conjunction with a galvanic battery for separating the large masses of rock in the quarry. It is stated that masses weighing upwards of 6,000 tons have been dislodged by this operation from their beds. It is proposed to apply the same method to the working of coal-mines, blasting of submarine rocks, &c.

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133 Freston, William, *Hawthorn Cottage, Stroud.*

Building-stone from Painswick Quarries; from Sheepscombe, and from Nailsworth Quarries.

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134 Maxwell, Wellwood, *Munches, Dalbeattie, Scotland*—Proprietor.

Slab of granite from Craignair quarry, near Dalbeattie, Stewartry of Kirkcudbright, showing some of the styles in which that stone may be dressed and polished. The value of this granite has been tried in the Liverpool docks and similar works; it is adapted for ornamental architecture.

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135 Voss, James, *Woodyhide, Corfe Castle*—Proprietor.

Purbeck marble, from quarries at Woody-hide, Corfe Castle, used in decorating the interior of the Temple Church, London; also used for dairies, hall tables, mantelpieces, &c.

[The Purbeck series of beds occurs at the base of the Wealden formation, and immediately overlies the Portland series. It is best developed in the Isle of Purbeck, where it has a thickness of 275 feet, 55 feet of the upper part of which is useful stone. The beds called Purbeck marble consist, for the most part, of small *paludinæ*, cemented by carbonate of lime with much green matter. Other beds are composed of bi-valves of the genus *Cyclas*. They are all used for building purposes.—D. T. A.]

136 KING, THOMAS, *Morpeth*.
Block of free stone, from a quarry at Hartford Bridge, Northumberland, belonging to the Earl of Carlisle, with the proprietor's coat of arms cut thereon.

137 SIM, WILLIAM, *Inverary, Scotland*—Manuf.
Inverary granite paving, with kerb, gutter-stone, and causeway stones, all in their respective positions; extensively used in paving the streets of Glasgow.

Granite ballusters of fine-grained granite, from Bonan, Argyleshire. One cubic foot of Inverary granite. Bonan granite, coarse-grained and fine-grained, showing the various descriptions of work generally put on this stone.

Specimens of the form and size of granite causeway stones used for paving. Hand specimens of Inverary granite, Bonan, fine and coarse-grained.

Marquis of Breadalbane's Loch Etive, and Duke of Argyll's Mull granite. The Inverary and Bonan fine-grained granite are chiefly used for paving purposes; the others are used in immense blocks for the heavy masonry of harbours, lighthouses, &c.

[The granite of Inverary consists of distinct patches, protruding through the gneiss. The granite is of fine quality, and much used. It is of two kinds, the one containing mica and red felspar, and the other hornblende and white felspar with the quartz.—D. T. A.]

138 LENTAIGNE, JOHN, *Tallaght House, Dublin*—Proprietor.
Specimens of iron pyrites, from the great sulphur lode, Ballygahan mine, Wicklow; exported to Liverpool, &c. Sulphuret of copper, from same place. Sulphuret of lead, or galena; white carbonate of lead; sulphate of barytes, with crystals of phosphate of lead; all from Glenmolure mine, county Wicklow.

Native gold, and imitation of a large piece (found some years ago), from the gold mines, county Wicklow. Silver (the property of Mr. Donegan, Dublin), from the Irish Mining Company's lead mines.

Specimens of stratified breccia, composed of angular fragments of granite embedded in calp or impure limestone, and of granite, from Crumlin quarry, near Tallaght, county Dublin. Limestone from Sutton, same county, and from Clane, county Kildare. Porphyry, from Lambay Island, county Dublin.

Sulphuret of lead, from Killing mine, county Dublin; from Clontarf mine; from Lyrus, county Kildare; and other counties. Black oxide and other copper ores from Ballystein, county Limerick. Sulphurets of lead and copper, in fluate of lime, from Inveran, near Galway. Peacock copper ore, from Killarney mines. Oxide of manganese, from Glandore, county Cork. Bog iron ore, from Howth, county Dublin. Crystals of quartz, weighing 84 lbs., from Donegal.

[The iron pyrites of Wicklow is used in the chemical works of St. Helen's and other places near Liverpool, for various processes where sulphur is required. It contains, when pure, iron 46·67, sulphur 53·33.

This material is associated with the copper ores of Wicklow, and occurs in a vein traversing the copper lodes in a north-eastern and south-western direction. It is found at the surface, and is raised in large quantities, down to the depth of 50 feet, the lode varying in width from 4 to 36 feet.

The native gold of Wicklow is remarkable for the comparatively large quantities in which it has been found. Some of the lumps weighed from 18 to 22 ounces, and 945 ounces were collected during some operations carried on by Government some years ago. The gold is associated with iron and quartz, in a bed of detritus varying from 20 to 50 feet deep.

Considerable quantities of silver, as well as gold, have been found in Ireland at various periods in the history of the country.—D. T. A.]

139 GELLING, FREDERICK LAMOTHE, *Castletown, Isle of Man*—Producer.
Marble, obtained from Coshnahawin and Skillicore, in the parish of Malew, Isle of Man, exhibited in several forms, to show its capabilities—in the rough, with one face polished; table in five pieces; turned specimens; a vase, &c. It can be raised of large size, and of great variety.

Red porphyry, and agate or pebble, with polished faces.

[The limestone of Skillicore and Coshnahawin is of the carboniferous period, and is broken up into rhomboidal blocks, the intervals being often filled with quartz. The rock exhibits a beautiful variegated appearance, but is too much fractured, and appears to be too hard to be worked with profit as a marble.—D. T. A.]

140 COLLES, A., *Marble Works, Kilkenny, Ireland*—Manufacturer.
Bust pedestal of Kilkenny marble, from the Black Quarry.

141 MEREDITH, JAMES HENRY, *Fowey, Cornwall*—Proprietor.
Slab of black porphyry, polished on both sides.
Slab of red porphyry, polished on both sides.
Slab of green porphyry, polished on one side, and partly polished on the other.
Tessellated porphyry table, containing 54 specimens of indigenous stones raised in the parish of Withiel, in the county of Cornwall, from a porphyry quarry, which has been worked for fourteen or fifteen years; it was polished in the mills at Fowey Castle Mine, in the parish of Tywardreath.

Porphyries are principally used for ornamental architecture, such as floorings, ceilings, and sides of rooms, passages, porches, and entrances of various descriptions; tables, recesses, tessellated pavements, monuments, columns, &c.

142 ROSSMORE, Lord, *Rossmore Park, Monaghan, Ireland*—Proprietor.
Specimen of green granite from Rossmore Park, county Monaghan.

143 COURTOWN, Lord.
Block of jasper.

144 FRANKLIN, PLIMEAS LEWIS, *Galway, Ireland*—Proprietor.
Block of black marble, with polished surface. Black marble columns for statues, from quarries on the banks of Lough Corrib, near Galway; used also for ornamental marble works, monuments, tombs, &c.

145 MALAHIDE, Lord TALBOT DE, *Malahide Castle, Londonderry*.
Specimens of Irish verd antique.

146 HALL, JOSEPH & THOMAS, *Marble Works, Derby*—Manufacturers.
Specimens of articles, manufactured by aid of steam machinery, at the Derby Marble and Spar Works.

Chimney-piece of black marble, from the quarries of the Duke of Devonshire. Exhibited in connection with a stove-grate of Mr. Haywood, Derby.

Fallow-deer, with antlers sculptured in Derbyshire mottled alabaster, the natural colour of the stone. The plinth is of black marble.

Model of an Egyptian obelisk, in black marble, the hieroglyphics and Greek inscription copied from the original brought from the Island of Philœ by Belzoni.

Tripod, carved in black marble.

Vases in black marble, copied from Greek terra cotta vases found near Naples, and brought to England by

Lord Western; the figures and ornaments produced by extracting the colouring matter of the marble, without injuring the polish.

Vases, Grecian form, in plain black marble.

Vases, Etruscan form, ornamented with flowers, by extraction of the colour from the black marble; vases, Medicis form, ornamented with various figures.

Tazza of Derbyshire rosewood marble; black marble, with handles; stalactite (Oriental alabaster); and variegated alabaster (gypsum).

Cups, lotus form, with fluted stem.

Chalice, with coronated cover; chalice, plain black, called "Newburgh," and "Wescomb."

Candelabra, ornamented with Thorwaldsen's Night and Morning, scrolls, &c., with fluted shafts on pedestals, and with fluor spar middles.

Candlesticks, various patterns, in black marble, alabaster and fluor spar.

Vase of Derbyshire alabaster on pedestal.

Series of pieces of Derbyshire black marble, arranged in a columnar form, showing the process of turning, polishing, &c., from the rough block to the finished article. Similar series in Derbyshire alabaster.

Slab of white marble, exhibiting T. Hall's new method of ornamenting, by depositing on the surface, malachite or green carbonate of copper.

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147 LONG, J. C. E.

Building of ornamental stones, from Ireland.

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148 MANDERSON, W.

Marbles of Ireland.

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149 DAMON, R., *Weymouth*—Proprietor.

Polished slabs of septaria, or Turtle stone, from the Oxford clay formation, Weymouth, Dorset.

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150 MONTEIRO, LUIS ANTONIO, 13 *Claremont Terrace, Pentonville.*

Specimen of pure stalagmite, or Oriental alabaster, veined in colours, from Granada.

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151 QUILLIAM & CREER, *Castletown, Isle of Man*—Producers.

Slabs of Poolvash black marble, inlaid with red and yellow composition, to imitate encaustic tiles.

Plain polished slab of Poolvash black marble.

Table of Poolvash grey shelly marble, with encrinital column.

National tile one foot square. Poolvash black marble, with the arms of England, Scotland, Ireland, Wales, and the Isle of Man, in figures inlaid in red.

Slab of black marble, for chess table, inlaid with various marbles of the Isle of Man.

Marble candlesticks.

Wreath of flowers in Poolvash black marble.

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152 ———.

Building material found in Sussex.

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153 GUILLAUME, GEORGE, *Southampton.*

Specimen of stone found in Hampshire, adapted for ornamental use.

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154 ———.

Building material from Dorsetshire and Somersetshire.

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155 ———.

Slab of green Connemara marble from the D'Arcy estate.

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156 ———.

Mountain limestone from Weardale.

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157 CUMMING, Rev. J. G., Producer.

Carboniferous limestone, from the Isle of Man.

159 TENNANT, J., *Strand.*

The maps of the Ordnance Survey, geologically coloured by the officers of the Geological Survey of the United Kingdom.

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160 FREEMAN, WILLIAM & JOHN, *Millbank Street, Westminster*—Producers.

Several varieties of material used for constructions, namely:—

GRANITES from Lamorna, near Penzance; from Constantine, near Helston; from Carnsew, Mabe parish, and Polkanago, Stithian's parish, near Penryn; from Zennor, near St. Ives; and from Rosemorran, Gulval, Cornwall. Foggintor granite, county Devon; Aberdeen granite, and Peterhead granite, from Stirling Hill quarries, Aberdeenshire; Dalkey or Dunleary granite, county Dublin; Ireland, and Guernsey and Herm granite used for macadamising roads. Polyphant stone from Lewannick, near Launceston.

LIMESTONES.—*Purbeck marble,* from Swanage, Dorset; the top vein in the quarry, used anciently in churches and cathedrals. *Purbeck stone,* called Laning vein, the second stratum from the top, used chiefly for door steps and street curbs; freestone, third vein, used chiefly for building; stone, from Down's Vein, fourth from the top of the quarry, used for footway paving; stone, called feather, fifth vein, used in church building; stone, five bed and cap used for carriage-way paving and building purposes; Portland. *Portland Stone,* from West Cliff and from Bill quarries; from the Waycroft quarries; from the Trade quarry, and from the Vera Street quarry, all in the isle of Portland. *Portland Roach,* the upper part of the regular stone beds; the lowest bed, used for troughs, sinks, &c. *Bath stone,* from the Farleigh Down quarries; from the Box quarries, and from Coombe Down quarries. Limestone, from Hooe lake, Plymstock; used for agricultural purposes, for footway pavements, and building. *Caen stone,* from the quarries of M. Jobert.

MAGNESIAN LIMESTONE, from the estate of the Misses Gascoigne; Huddlestone stone, near Sherburne, Yorkshire.

SANDSTONES.—Darley Dale stone, from Stancliff quarry, near Bakewell, Derbyshire; Cromwell bottom stone, from the estate of Samuel Freeman, Esq., Southowram, near Halifax, Yorkshire. Bradford stone, from the quarries at Heaton. Potter Newton stone, and Gipton wood stone, from the neighbourhood of Leeds. Bramley Fall stone, from Meanwood quarries, near Leeds; and from Horsforth quarries, near Leeds. Gazby stone, from quarries near Bradford.

Kentish rag, from the quarries of Mr. Bousted and Mr. Seager, near Maidstone.

Fire stone, from the quarries of Mr. Stedall, Godstone, Surrey.

SLATES and SCHISTS.—Caithness slabs, used very extensively for paving.

Valentia slate stone, from the island of Valentia, Kerry, Ireland: the slate is non-absorbent; experiments made by Messrs. Bramah showed that inch cubes required nearly six tons to crush them.

MARBLE.—Green, and black marble, from the estate of Mr. Martin, county Galway, Ireland.

[Most of the materials commonly used in construction in London are illustrated in the above collection. The Cornish granites and the Portland stones may, however, be selected as requiring notice here. Of the former, those shipped from Penryn are the best known, but the quantity annually exported varies very greatly, and the qualities are also variable. The different kinds exhibited will give some idea of their appearance. The Portland stone is well known, and very excellent, but costly, and rather heavy; it contains 95 per cent. carbonate of lime, 1 silica, and 1 carbonate of magnesia: specific gravity = 2·145, and cohesive power moderate. The upper beds above the freestone are the *top-cap, skull-cap,* and *roach,* the latter forming a good stone; the next bed is the best or *top-bed,* from 3 to 8 ft.

thick, and this is succeeded by the middle or *curf-bed,* and an inferior bottom bed. The position of the Portland stone is in the upper part of the upper oolites.—D.T.A.]

161 Hutchison, John, *Monyruy, near Peterhead*—Proprietor.
Bust and pedestal in blue Peterhead granite.

162 Nicholls, John, *Trekenning, St. Colomb*—Proprietor.
Block of porphyry or elvan stone, raised near Newquay, Cornwall; it is said to resist the action of the weather.

163 Local Committee, Falmouth and Penryn.
Stone, from Porkellis, Wendron, suitable for building, roads, chimney-pieces, or tables. Stone from Forest-gate, Stithians; and from Church Town, about two miles distant; from Mylor, near Penryn; and from Wendron.
Granite, from Wendron.
Stone, for road-making, extensively used on the Truro, Penryn, and Redruth trusts, from Pasko and Treluswell quarries, Gluvias. Stone, from Steven's quarry, Higher Treluswell, Gluvias; and from Newham, Kea.
Specimen of porphyry, found near Swan Pool, Falmouth, containing crystals of rhomboidal quartz.
Quartz pebbles and sand, from Swan Pool beach.
Magnetic iron ore, from Treluswell, near Penryn.

[A large quantity of excellent road stuff is obtained in Cornwall from the *"elvans,"* or porphyritic dykes, which traverse many parts of the county; these elvans also supply the chief building stones of the district. They are, however, not unfrequently met with in a decomposing state, and are then quite unfit for use. The stones obtained from Porkellis, near Wendron, sometimes nearly resemble sandstones. Many excellent stones, both granite and elvan, are obtained near Penryn. The decomposing porphyries and elvans yield occasionally a valuable fire-clay.—D. T. A.]

164 Hicks, Thomas, *Truro.*
Varieties of porphyry, for various purposes.

[The porphyries of Cornwall and other districts, where the primary and protrusive rocks prevail, have been neglected up to the present time. In the decoration of Osborne, and some other of the royal residences, ornamental stones of British porphyries, and other ornamental stones, have been used. Many of them are of a beautiful description, susceptible of the highest polish, and all very durable. The greenstones, or as they are sometimes called ironstone porphyries, are now being introduced into London for road-making, and it appears to prove an exceedingly good material for that purpose. —R. H.]

165 Whitley, Nicholas, *Truro.*
Varieties of porphyry.

166 St. Austell Committee.
Specimens of building material.

167 Liskeard Committee.
Specimens of building material.

168 Clugas, T., jun., 8 *L'Hyvreuse Terrace, Guernsey*—Proprietor.
Specimens of granite, porphyry, and pot-stone from Guernsey, Herm, and Sark, used for building and macadamizing.

169 Rodd, T. H., Esq., *Trebartha Hall, near Launceston*—Proprietor.
Varieties of porphyry, for ornamental and building purposes.

170 Jenkins & Stick, *Truro*—Proprietors.
Varieties of porphyry, from Tremone in Withiel.

171 Sowden, Matthew, *Burley, near Leeds*—Producer.
Hard delf-stone grit, from a quarry at Burley, near Leeds, close-grained, strong, and durable; suitable for headstones, steps, &c., and generally for erections exposed to the weather.

172 Freeman, Samuel, *Cromweld Bottom, near Halifax*—Producer.
Laminated flagstone, from Pearson Brow Quarry, in Hipperholme, Yorkshire, and from Northowram, near Halifax, from Cromweld Bottom and Southowram, and from Hove Edge and Elland Edge, Yorkshire.
Blackstone, from Ringby, near Halifax, and from the Elland Edge Quarry, a bed free from laminæ.
All these stones lie above the two known lowest beds of coal in England, and below the level of the other beds. The laminated stones are split into flags for paving, &c.
Sandstone from the quarries at Greetland, near Halifax, Yorkshire; it lies below the level of any of the known beds of coal.

[The lower coal measures of Yorkshire contain some excellent grits, well adapted for building and paving. Some of the latter are well known and very widely used throughout England.—D. T. A.]

174 Haigh, John, *Godley Cottage, near Halifax*—Producer.
Specimens of freestone from Northowram quarries, near Halifax. Block, in its natural state; block, variously dressed.
Flag, for causeways and floors of buildings.
Millstone grit, from Halifax.

175 Johnstone, George, *Craigleith, Edinburgh*—Producer.
Stone from Carlingnose quarry, North Queensferry, Scotland. This stone has been extensively used in Scotland, England, and Wales; more especially at Her Majesty's dockyards at Woolwich, Sheerness, and Chatham; for the breakwater at Warkworth (Northumberland); at Newcastle, Sunderland, and Hartlepool; and in paving the Imperial Museum at St. Petersburg.
Stone from Barnton Mount quarry, near Edinburgh: this stone can be procured in large blocks, and in any quantity. Specimen of paving stones from the same granite quarry.
Specimen of stone from Craigleith quarry, near Edinburgh; much used for stairs, landings, and fine pavings; may be seen applied to those purposes at the British Museum, Royal Exchange, Custom House, &c., London.

[The Craigleith stone is a sandstone of the carboniferous series, consisting of fine quartz grains with a siliceous cement, and occasional plates of mica. It is obtainable of any practicable length and breadth, and up to 10 feet thick. Weight, per cubic foot, 146 lbs. It consists of more than 98 per cent. of silica, and 1 per cent. carbonate of lime.—D. T. A.]

176 Luard, Beedham, & Co., *Caen, Normandy, and Caen Sufferance Wharf, Rotherhithe*—Proprietors.
A specimen of Caen stone, wrought on face.
Four specimens of ancient Caen stone, from St. Stephen's Chapel, Westminster, 16th century; St. Stephen's Church, Caen, 11th century; and Kingston Church, Sussex, 14th century; all in good preservation.
Four specimens of Aubigny stone, wrought.
Three specimens of ancient Aubigny stone from churches at Calvados department, and from the old castle of William the Norman, of the 12th, 16th, and 17th centuries.
A specimen of Ranville stone, from quarries near Caen.
Three specimens of Scotch granite, of which blocks of 30 tons can be obtained.

[The Caen stone, obtained in large quantities and of the finest quality from the quarries at Allemagne, has been long worked, and is well known in all parts of England

and France, being used in many of our cathedrals and other public buildings. The quarries are entered by narrow galleries opening from the steep banks of the river Orme, and thus have the advantage of direct water communication at very small cost.

The stone is soft in the quarry, of very beautiful rich cream colour and very even texture. It stands exposure well in France, but is better adapted for internal work in the climate of England. Several very beautiful works in this material will be found amongst the mineral manufactures (Class 27), and other parts of the building.—D. T. A.]

177 SMITH, TILDEN, *Vine Hall, Hurst Green*—Proprietor.

Limestone, raised from a quarry on the property of Samuel John Nicoll, Esq., in the parish of Mountfield, Sussex.

Two blocks of concrete, formed with the Mountfield stone lime. One block has been kept in a damp place since 1850; the other has been kept dry. The Mountfield lime is especially adapted for submarine works, as it possesses the valuable property of hardening under water.

[The limestones of the middle part of the Wealden formation occur in the lower or Ashburnham group, and include a series of shelly limestones and shale resembling the Sussex marble. Extensive lime-works have been long carried on near Battle, and the rocks are found to be much disturbed with faults.—D. T. A.]

178 BARRY & BARRY, THOMAS and JACOB, *Mawgan St. Columb*—Producers.

Firestone, a soft-grained elvan or porphyry, from quarries near Newquay, used for lining limekilns and furnaces.

[The elvans (porphyritic dykes) of Cornwall are used for various purposes of construction, but it is only occasionally that they yield firestones.—D. T. A.]

179 KIRK & PARRY, *Sleaford, Lincolnshire*—Proprietors.

Specimen of Ancaster stone, of the lower oolite formation, from the quarry at Wilsford, near Sleaford, Lincolnshire. It is said to be a durable building material, used chiefly for dressings and architectural decorations, and adapted for sculpture and ornaments of various kinds. It rises in beds, varying from 10 to 24 inches in thickness: the texture is close and uniform; and it is stated that although it can be cut with an ordinary peg-tooth saw, like the Bath oolite, it will carry an arris equal to that of Portland stone.

[Ancaster stone is a fine cream-coloured oolite, cemented by compact, and, often, crystalline carbonate of lime. There are numerous beds, the entire depth of workable stone being 13 feet, and blocks of 3 to 5 tons being obtainable. The stone weighs 139 lbs. 4 ozs. per cubic foot; absorbs very little water; cohesive power tolerably high; composition—carbonate of lime 93·6, carbonate of magnesia 2·9, with a little iron and alumina, and a trace of bitumen. Belvoir Castle, Belton House, and numerous mansions and churches in Lincolnshire are constructed of this stone.—D. T. A.]

180 FOOT, JOHN, *Abingdon Street, Westminster*—Proprietor.

Specimens of Best Bed Portland stone, and Whit Bed Portland stone, showing different samples of workmanship.

Specimens of Roach Portland stone. The backs show natural fractures.

[1.]

181 STAPLE, THOMAS, *Stoke-under-Hamdon, near Yeovil*—Producer.

Blocks of Ham-hill stone (oolite), partially prepared to show the quality of the stone.

182 RUTHERFORD, JESSE, Stone Merchant, *Wingerworth, near Chesterfield*—Producer.

Stone from Wingerworth quarry, near Chesterfield, Derbyshire.

Stone from Lion quarry, Wooley Moor, near Wingerworth, Chesterfield.

Stone from Bramley Fall quarry, Wingerworth, near Chesterfield: this stone is generally used in heavy works such as docks, bridges, &c.; the quarry has been known upwards of 500 years; the stone is obtained in blocks 45 feet long, 20 feet broad, and 16 feet thick, each block weighing about 1000 tons.

[The Bramley Fall stone is a light ferruginous brown sandstone, with an argillo-calcareous cement and very little mica. It weighs 142 lbs. 3 oz. to the cubic foot.—D. T. A.]

183 WALSH, JOHN, Executors of, *Leeds*—Proprietors.

Sandstone, from the millstone grit series, used for docks, bridges, locks, engine beds, &c.

Potternewton stone, used for landings, sills, &c.

184 PRICE, J., *High Street, Gateshead, Newcastle-upon Tyne*—Inventor.

Freestone, from a quarry in Gateshead, used for building furnaces for glass-houses.

185 GRISSELL, THOMAS, 11 *New Palace Yard, Westminster*—Producer.

1. Specimen of magnesian lime stone, used in the construction of the New Houses of Parliament, Westminster, from quarries at Anston, in Yorkshire, belonging to the exhibitor, on the estate of the Duke of Leeds.

2. Specimen of this stone, dressed and polished.

Specimen of the same stone, forming part of an enriched parapet, at the New Houses of Parliament, Westminster.

[The magnesian limestone used in the outside work of the Houses of Parliament was selected on the recommendation of a Royal Commission, and after careful examination, as the finest available material to be obtained. It is a compact semi-crystalline rock, consisting of nearly equal proportions of carbonate of lime and carbonate of magnesia. It is of uniform and elaborate hardness; not very costly, either to obtain or work; weathers well, and of good colour, and is remarkable for its power of resisting compression. It is much heavier than most limestones, weighing upwards of 150 lbs. to the cubic foot.—D. T. A.]

186 TOWNSEND, RICHARD, *Clearwell, near Monmouth.*

Forest stone for steps, coping, &c.

Ashlar blocks for paving, grave stones, wharf walls, and all kinds of buildings; from the Forest of Dean.

187 LINDLEY, CHARLES, *Mansfield*—Proprietor.

Twelve-inch cube of magnesian limestone, or dolomite from the Mansfield Woodhouse Quarries, re-opened 1840, after a lapse of several centuries, to obtain the supply of stones for the erection of the new Houses of Parliament at Westminster. Chemical analysis:—Carbonate of lime, 51·65; carbonate of magnesia, 42·60; silica, 3·70; water and loss, 2·05. The débris is largely used for the production of carbonic acid gas and Epsom salts.

White calcareous sandstone. Chemical analysis:—Silica, 51·40; carbonate of lime, 26·50; carbonate of magnesia, 17·98; iron alumina, 1·32; water and loss, 2·08.

Red calcareous sandstone. Chemical analysis:—Silica, 49·4; carbonate of lime, 26·5; carbonate of magnesia, 16·1;

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iron alumina, 5·2; water and loss, 2·8. From quarries which have been in work for four hundred years.

These two sandstones are the connecting link between the magnesian limestone and the new red sandstone formations, partaking of the characters of both.

[The magnesian limestones, valuable for building purposes, are chiefly or entirely those which present equal proportions of carbonate of lime and carbonate of magnesia in a semi-crystalline state. Such stone has a peculiarly pearly lustre when broken, but its colour, when worked, is light yellowish brown, not changing by exposure. Its specific gravity is very high, the stone weighing upwards of 150 lbs. the cubic foot. The cohesive power is very great, and hardly rivalled by any limestone.—D. T. A.]

188 STOCKS, MICHAEL, *Shebden Hall, near Halifax*—Proprietor.

Specimens of ashlar building stone, from the Shebdenhead quarries, near Halifax. The seam from which the specimens are obtained is between the lowest, or "Halifax beds," and the "Lowmoor beds" of coal; and between the lowest of the latter, or "better bed" coal, and the Northowram flag-stone. The Halifax beds of coal immediately overly the millstone grit.

[The coal grits of Yorkshire supply a very good building material, well adapted for local purposes. Where there is not too large a proportion of organic impurities, the sandstones of the coal measures may often be depended on, but there is apt to be a want of cementing ingredients binding the sand and gritty particles together.—D. T. A.]

189 BELL, JOHN, 25 *Buckingham Place, Fitzroy Square*—Designer and Manufacturer.

Specimen of oolitic limestone, from the Oreton Bank Works, Stottesden, Cleobury Mortimer, Shropshire.

Chiselled, sanded, grounded, and polished marble, adapted for columns, pedestals, &c.

A pair of obelisks in oolitic limestone.

[It is rarely that the oolites are sufficiently uniform in texture, and sufficiently hard, to take a good polish. Specimens, however, occur, chiefly from particular parts of the series, and in limited localities, which may be made ornamental, as in the case exhibited.—D. T. A.]

190 CLARK, GEORGE HOUSTOUN, *Rotherhithe*—Agent.

Specimen of Devon Haytor granite, from the quarries of the Duke of Somerset, Haytor Rocks, South Devon. Blocks of the largest dimensions can be produced from these quarries. London Bridge, Fishmongers' Hall, the columns in George IV.'s Library, British Museum, part of Tothill Fields Prison, and the pillars to the gates of Christ's Hospital, are all of this granite.

Specimens of Bramley Fall stone, from the Fair Head quarries, Yorkshire, and from the quarries at Marshall Meadows, Berwick-on-Tweed.

191 WILLIAMS, WILLIAM, 1 *Wellington Street, Cardiff, Wales*—Proprietor.

Freestone from the Quarrella quarry, near Bridgend, Glamorganshire. It contains 99 per cent. of silica. Specific gravity, 2·288.

192 SEYMOUR, ZECHARIAH, *Shut, near Glastonbury*—Producer.

Model of a flight of stone steps cut from the blue lias tone, and specimens of workmanship.

193 SPARKS, W., *Crewkerne*—Collector.

Specimens of stone from the counties of Dorset, Somerset, and Devon:—

Greensand, a siliceous stone, from Blackdown Hills, Devon, used as a whetstone for scythes, &c.

Purbeck marble; Purbeck stone; Portland stone. Building stone from Ridgway; and limestone from Langton Herring, near Weymouth.

Building stones, white and calcareous, from Bothenhampton, near Bridport, and Beaminster, Dorset; also from Bath, Doulting, near Wells, and Crewkerne, Somerset.

Ferruginous stone, for public buildings, mill-dams, &c., from Hamdon Hill, Somerset.

Blue lias limestone, for docks, railways, &c., from Lyme Regis, Dorset, from Curry Rivell, near Langport, and from Keinton, Somerset.

White lias, from Beer Crowcombe, and from Tiverton, Somerset. Gypsum, from the former place.

New red sandstone, from Bishop's Lydiard, near Taunton, Somerset.

Millstone grit, for paving, &c., from the Pennant quarries, Hanham, near Bath.

Carboniferous limestone, from St. Vincent's rocks, Clifton; from the Breakwater quarries, Plymouth, from Newton-Abbott; and from Kingskerswell, near Torquay, Devon.

Granite, from Dartmouth, Devon, used for Government works, Stonehouse.

[Many of the stones referred to in the above list are of considerable value and interest. The whetstones first alluded to are manufactured from hard sand concretions, found in the lower cretaceous rocks on the west part of the Blackdown hills, and quarried from galleries driven as much as 300 yards into the hill side. These concretions vary from 6 to 18 inches in diameter, and form a bed about 4 feet thick, available for scythe-stones. The beds above and below are employed for building purposes.

The inferior oolites, worked at Crewkerne as building stones, are not specially remarkable for excellence, but the Ham hill stone is durable and valuable. The Pennant grit is a rock much employed for building and engineering purposes, and belongs to the coal measures.

The granite of Stonehouse and Dartmoor is a valuable and durable material.—D. T. A.]

194 JENNINGS, BENJAMIN, *Hereford*—Proprietor.

Specimen of sandstone, from the Three Elms quarries, near Hereford. Exhibited on account of its strength and durability; it is said to stand equally well on its edge or on its bed; and to be suitable for cider mills, sea walls, railway purposes, &c.

195 CUMMING, Rev. JOSEPH GEORGE, *Castletown, Isle of Man.*

Black flagstone (Posidonia schist), from Poolvash, Isle of Man. Exported from Castletown. The quarries have been wrought upwards of 200 years. The steps of St. Paul's Cathedral are from these quarries; they were presented by Bishop Thomas Wilson. Used largely for flooring, chimney-pieces, tomb-stones, and, as suggested by the exhibitor, inlaid with a red composition to imitate encaustic tiles. Easily and economically wrought.

Grey marble (encrinital and shelly limestone), from Poolvash. Exported from Castletown. Used for tables and chimney ornaments.

Black marble (lower carboniferous limestone), from Port St. Mary, Isle of Man. It is hard and durable, and takes a good natural polish; raised in blocks and flags of great size. Used for piers, floorings, tomb-stones, and burnt into a strong lime.

Pale marble (carboniferous limestone), from Scarlett, Isle of Man. Exported from Castletown. Castle Rushen (900 years old), King William's College, St. Thomas's church, Douglas, and Castletown pier are built from these quarries. It is durable, and easily raised.

Spanish-head flagstone (clay schist). It is exported from Port St. Mary, used for lintels and gate-posts, and in ancient times for Runic monuments, and is durable and slightly elastic in thin flags, and can be raised in squares of 16 feet each way.

Peel freestone (old red sandstone), from Craig Mallin, Isle of Man. Exported from Peel. A large portion of Peel Cathedral was built of it in 1226.

Granite, from South Barrule, Isle of Man. Quarries lately opened, and the church of St. John built from them. Old fonts on the island, were formed from boulders of this granite. Exported from Douglas, Peel, and Castletown.

Porphyritic greenstone, from Langness, Isle of Man. Good road material. May be obtained and shipped in any quantity at Derby haven.

Hæmatite. Iron ore from the glebe vein, Maughold, Isle of Man. Exported from Ramsey.

White carbonate of barytes, from the Cross vein, South Barrule. A vein 5 feet thick, but not raised for the market.

All the quarries on the island belong to the Crown.

[The different building and road materials, above referred to, will be found to present some rocks of considerable interest, hitherto little used for economic purposes. The marbles and other calcareous rocks are all from the carboniferous limestone, and entirely confined to the southern extremity of the island, near Castletown, where they occupy about 16 square miles, for the most part covered by tertiary gravel. The sandstones, schists, and granites are more abundant, but less valuable.

Of the calcareous rocks, the black flagstones of Poolvash contain much carbon and some argillaceous matter, and are very durable. The different marbles have the same properties as the carboniferous limestones of Derbyshire; and the porphyritic rocks are generally of good quality.—D. T. A.]

196 ———.
Stones used at Liverpool for building purposes.

197 POWELL, FREDERICK, *Knaresborough, Yorkshire*—Collector.
Building stones, from quarries in the immediate vicinity of Knaresborough.

198 CARNEGIE, W. F. L., *Kinblethmont, Arbroath, Scotland*—Proprietor and Manufacturer.
Flag-stones, rough and planed, from Leysmill Quarries, Forfarshire, and freestone from Border Quarries, the property of the exhibitor.

Flag-stone, rough and planed, from Lord Panmure's quarries at Carmyllie, and freestone from Lochee Quarries, belonging to the Harbour Commissioners of Dundee, of which the harbour and dock are constructed.

Flag-stone from Balgavies Quarries, belonging to Mr. Baxter, of Ellangowan. Flag-stone, rough and planed, from Balmashanner Quarries, belonging to Mr. Watson Carnegy, of Lowee.

Old red sandstone shale, or stone-clay, and brick and tile from the same, manufactured by the exhibitor.

Flag-stone from Guynel Quarries, belonging to Mr. Previor.

All these flag-stones are generally exported from Arbroath, and are known as "Arbroath Pavement."

199 LONG, W.
Flags from County Clare.

200 HILL, J., C.E.
Building material from Kilrush.

201 TAYLOR, JOHN, *Stamford.*
Marble, sandstones, slate, limestone, &c., all obtained within six or seven miles of Stamford.

202 POWELL, W. J., *Tisbury, near Hindon, Wilts*—Producer.
Hard and soft varieties of building stone, flint, and chert. A fossil fish and tree from the oolite formations at Tisbury.

203 DRIVER, WILLIAM, 4 *Lyon's Inn, Strand, Middlesex*—Producer.
Specimens from the Chevin stone quarry, Otley, Yorkshire.

204 THE LESSEES OF THE STANHOPE LIMESTONE QUARRIES—Proprietors.
Polished specimens of the cockle strata in the carboniferous limestone; from Weardale in the county of Durham.

Specimen of the same in the rough state.

The lime manufactured from this stone is valuable as an agricultural manure. It is used as a flux in smelting iron ore; also for purifying gas; for tanning and for other chemical purposes. The analysis is as follows, viz.:—

Carbonate of lime . .	95·1
Carbonate of magnesia	2·5
Earthy matter . . .	1·3
Residuum	1·1
	100·0

206 SINCLAIR, J., *Forss, Thurso, Scotland*—Manufacturer.
A cistern or bath of Forse-Rockhill flag. Samples of the stone, showing the natural surface, the half-rubbed, and the full-rubbed surface. Three portions of a passage of twenty-four feet long by six feet broad each, laid with the same pavement, showing the three different kinds of surface.

The principal uses of the article are laying footways, courts, railway stations, floors of manufactories and warehouses, kitchens, cellars, cottages, entrance halls, churches, &c. When used with iron girders, it renders mills, &c., fireproof, and is useful for farm buildings, and for cisterns, baths, manure tanks, troughs in chemical works, coping, for garden walls, &c. The pavement is found at the Forse-Rockhill quarries, four miles west from Thurso, Caithness, and it is there manufactured chiefly by machinery. It is said to be of a hard, close, strong, and uniform quality, and impervious to wet. It occurs in beds of various thickness, from one inch to three or four inches, and from one foot to eighty or a hundred feet superficial. The stone has been worked for more than twelve years, and is sent in large quantities to London, Glasgow, and other towns.

[The Caithness flags are well known and much used for various economic purposes, chiefly paving. They are quarried from the middle division of the old red sandstone (Devonian) series, as developed in the north of Scotland. The schists yielding them are often dark coloured and highly bituminous, slightly micaceous and calcareous, and often resembling rocks of much greater geological antiquity. Obscure vegetable impressions, and the remains of extinct fishes, are very frequently found in them, and these are often of considerable interest in the natural history of the ancient inhabitants of our globe.—D. T. A.]

207 ROYAL DUBLIN SOCIETY.
Specimens of Valencia flags.

208 DAWBARN & CO.
Manufactured slate.

209 STIRLING, THOMAS, jun., *Belvidere Road, Lambeth*—Designer, Inventor, and Manufacturer.
Slate cabinet, illustrating the applicability of slate to the formation of strong-rooms, powder-magazines, larders, venison-houses, partitions to rooms, water-closets, &c. The covering of the cabinet is formed by

the bottom of a slate cistern, consisting of slabs of slate secured together in panels by a method invented by the exhibitor. The same method is also applicable to the covering of the roofs of mansions with slate.

Slate is adapted for use in fitting up the floors and compartments of public baths and wash-houses: and for stables, being applicable to mangers, stall divisions, linings, floors, and drains. It is also adapted for balconies, larders, wine-cellars, dairies, and various other purposes.

Articles exhibited in the cabinet, &c., and in general use:—

Patent self-acting filter on stand. Filter, which can be supplied by hand or made self-acting. Small slate cistern. Pickling trough. Samples of slate roll ridge; common saddle-back slate ridge. Sunk channel in slate. Solid slate sink. Slate sink constructed of five pieces. Washing-basin for water-closet, &c. Ornamental loo-table top. Sofa and side-table ornamental tops. Chess, or ladies' work-table tops. Inkstand. Water-closet supply box for slate cistern. Waste, union screw, and drawing-off tap for slate cistern. Samples of various nails and screws used in slate work. Half of roof covered with Delabole slab slates. Specimen of Bangor slab slating.

Specimens of roofs covered with imperial slates from the Bangor quarries; rag slates from the old Delabole quarry; rag slates and green rag slates from Llanberis quarry; red duchess slates with three green slate diamonds; slates from Festiniog quarries, as cut by Mathews' patent cutting machine; open space new quarry duchess slates from Llanberis quarry; imperial slates from Aberdovey quarries, near Machynlleth.

Slate bed-room and dining-room chimney-pieces, from old Delabole quarries—in imitation of marble.

Carved head-stone; cut clock face.

[The collection of slates referred to in the above description is calculated to give an idea of the best qualities introduced into the London market, with the kind of use to which most of them are applied. The chief localities are Cornwall (Delabole), Wales (Festiniog, Penrhyn, Llanberis, &c.), Lancashire, and Westmoreland. The Delabole is especially adapted for church and other roofs, and has been much used for this purpose.

The slates, lettered A, are from the great quarries at Penrhyn, and shipped at Bangor. These quarries have as many as 10 levels, and employ upwards of 2,000 persons. Those marked B, are from Llanberis; C, from the Dorothea Slate Company's quarries, near Carnarvon; D, E, from quarries at Festiniog, shipped at Port Madoc; F, G, from near Machynlleth, North Wales, shipped at Aberdovey; H, from Delabole, Cornwall, shipped at Padstow; I, K, L, M, from near Ulverstone, in Lancashire, including some of the Westmoreland quarries, and shipped at Ulverstone.

The present consumption of slate in London is to the extent of from 30,000 to 40,000 tons per annum. One third of this quantity is in slabs, and the rest in roofing-slates, which are in nine sizes, called respectively "ladies," "countesses" (3 sizes), "duchesses" (2 sizes), "queens," "rags," and "imperials." From "ladies" (16 inches by 8) to "duchesses" (24 by 12), the slates are sold per thousand (of 1,200 slates), but above that size by the ton. The "ladies" weigh 25 cwts. the 1,200 slates, and the "duchesses" 3 tons. The regular-sized slabs vary from 1 to 6 feet in length, and 1 to 3 feet in breadth. A large quantity of slate slabs is now used for ornamental purposes.—D. T. A.]

210 GREAVES, JOHN W., *Port Madoc, Carnarvon, Wales*—Proprietor.

Slabs and slates from the quarry at Festiniog, with tools used in manufacturing the same. Blue lias lime.

[Slate is extensively used in slabs for water cisterns and for covering roofs of slight inclination. For both these purposes it is jointed, and the joints are made with a cement, aided, as roof covering, by tongues in the joints and by covering fillets. But the most extensive employment of slate is for roof covering, in the form known familiarly as *slates*. Slates are rent and dressed to sizes, and laid to lap and bond. Jointed slating is apt to fail from the expansion and contraction of the material, whilst lapped and bonded slating adapts itself to movement from changes of temperature or otherwise, without any derangement that can lead to failure.—W. H.]

211 BREADALBANE, Marquis of, *Taymouth Aberfeldy, Perth*—Producer.

Slates from the quarries of Easdale, &c., in Argyllshire.

[The Easdale and other slate quarries of Argyllshire which have been worked for upwards of three centuries, employ about 200 men and boys, and export about 10,000,000 of slates annually, in about 300 vessels. The slates are not obtained generally in very large slabs, but most of the quarries supply a fair proportion of the larger kinds, used for roofing, and measuring 2 feet by 12 inches (Duchesses). They are worked in Easdale, Seil, and other small islands of clay slate, a little south of Oban, and near the large island of Jura. The quarries are of various dimensions; that of Ellenabeich being 300 feet long, 100 feet deep, and 150 feet broad, the quality improving in the depth. The other quarries are smaller; but those of Easdale are very valuable, and the quality excellent. The stratification of the beds of slate rocks is very much disturbed, but the cleavage is invariable, running N.E. and S.W., and dipping 50°.—D. T. A.]

212 LIMERICK LOCAL COMMITTEE.

Roofing slates.

213 GEORGE, J., 43 *Edgware Road*—Inventor, Patentee, and Manufacturer.

Model of a house, built with wrought iron and slate slabs, glass, &c., intended to secure stability, durability, and freedom from damp and vermin, to save space, and improve temperature and ventilation.

214 OLD DELABOLE SLATE COMPANY (by JAS. CARTER), *Camelford*—Proprietors.

Slate slab, as raised from the quarries at Delabole.

Slate cistern for holding water, liquid manure, oil, acids, &c., capable of containing 2,000 gallons. If used for water for domestic purposes, a self-supplying filter is attached, so that the water withdrawn at the tap passes through the filter.

Specimen of Davey's patent ridge slate.

Slate slab, used for flooring, landings, cisterns, &c.

Roofing slates.

[The magnificent quarries of Delabole have been opened for at least three centuries, and have supplied a large quantity of excellent slate. They are worked in the Devonian slates, near Tintagel, where they are chiefly shipped. The quality is good, combining lightness with strength, and resisting exposure perfectly.

This slate is used not only for roofing, but also in large slabs for various purposes.—D. T. A.]

215 WILLIAMS, D., *Bangor*.

Patent slate ridges and hip, from Bangor, Wales.

218 PENNOCK, T.

Carbonate of barytes.

219 HUNTER, L.

Model of a coal mine.

221 BITUMINOUS SHALE COMPANY, 145 *Upper Thames Street, and Wareham, Dorset*—Manufacturers and Producers.

Specimen of bituminous shale, known as the Kimmeridge coal, obtained from the cliffs at Kimmeridge, in the isle of Purbeck, in the county of Dorset. The quarries were opened in August, 1849. It is a combination of bitumen with clay, and from it are obtained, by distillation, volatile mineral oil, grease, asphaltum, and manure, specimens of each of which are exhibited.

[Bituminous schists or shale are not confined to any peculiar geological or topographical limits, and are probably, in most cases, the result of the decomposition of large quantities of animal remains.

The Kimmeridge coal is of high specific gravity (1·319), of dark-brown colour, and without lustre; it effervesces slightly with acids, and burns readily with a yellowish, rather smoky, and heavy flame. It is a very local deposit.—D. T. A.]

222 CAHILL, M.
Peat charcoal.

223 TURNER, SAMUEL, *Orchard Place, East India Docks*—Manufacturer.
Coal, and products of its distillation.
Products from caoutchouc and from wood.

[A number of highly remarkable and peculiar substances arise from the distillation of coal, caoutchouc, and wood. Coal yields, in addition to illuminative gaseous products, various volatile oils, tar, ammonia in several forms, and a complex number of singular chemical substances in a state of vapour, or fluid. Caoutchouc yields a volatile oil in which it is itself soluble, and is largely distilled for the sake of this product, which is used in caoutchouc solutions and varnishes. Wood yields an inflammable fluid called wood spirit, and an impure acetic acid, and tar.—R. E.]

224 AZULAY, BONDY, *Rotherhithe*—Producer.
Patent artificial fuel, made of coal dust by pressure, without the admixture of any other substance.
Coal-dust prepared for pressing.
Charcoal made of refuse tan, by extracting pyroligneous acid, tar, &c., from refuse matters.

[The immense compression obtained by the hydraulic press, has been employed in the arts for producing cohesion between loose particles of various substances. In the present instance, the same force is used to unite the separate particles of coal dust into a solid mass. A hard shining block of great density is the result of the pressure.—R. E.]

225 OXLAND, ROBERT, *Buckland Street, Plymouth*—Inventor and Manufacturer.
A series of specimens of sugar, produced by the patent process of refining, invented by Robert and John Oxland, in which the acetate of alumina is used as a substitute for the blood and animal charcoal usually employed for defecation and the removal of colour.
A series of specimens of Dartmoor peat, and the products obtained by its destructive distillation in cast-iron retorts. The top cut of the peat; the under cut; peat charcoal; pyroxylic spirit; chloroform made from it; peatine; heavy oil; paraffine; tar; acetate of lime; sulphate of ammonia; and solution of caoutchouc in peatine.

226 LYON & CO., *Swansea.*
Two bricks of patent fuel.

227 REES, R.
Peat and its products.

228 COBBOLD, EDWARD, 1 *High Street, Kensington*—Inventor and Producer.
Peat, condensed without pressure.

[The method adopted by the present exhibitor to prepare peat for economic use as fuel is altogether different from that adopted generally. He mixes the peat with a large quantity of water, reducing it to an impalpable mud, and then, by getting rid of the water, obtains a compact mass of considerable density. The mechanical means adopted are simple, and take advantage of centrifugal force—the water being thrown off during rapid revolution.—D. T. A.]

229 SEYSSEL ASPHALTE COMPANY.
Raw material, and various products of asphalte.

230 PATENT FUEL COMPANY, 15 *St. Mary Axe*—Manufacturers.
Specimens of Warlich's patent fuel, consisting of the following series:—Welsh steam fuel, manufactured at Swansea; North country fuel, manufactured at Middlesborough-on-Tees; household fuel, manufactured at Deptford, from North country coal; and locomotive coke fuel, manufactured at Swansea; with samples of the tar and coal used in the manufacture.

[Warlich's patent fuel consists of bricks measuring 9 inches by 6½ and 5, and weighing about 12 lbs. They are dense and well made, require breaking before use, and when burning, give off little smoke, but they take some time to light. They contain carbon 90·02, hydrogen 5·56, sulphur 1·62, ash 2·91. They are made of the dust of various kinds of coal; the above analysis having reference to those manufactured of Welsh coal.—D. T. A.]

242 THE BIDEFORD ANTHRACITE MINING COMPANY. MAXWELL, JOHN GOODMAN, Chairman, *Bideford, Devon.*
Anthracite coal, used for drying malt, lime-burning, &c.
Compressed fuel, moulded in blocks.
Mineral black paint, in powder, and mixed with oil or coal tar: mixed with the latter article, it is said to form a cheap, durable, and preservative varnish; applicable to shipping, out-buildings, &c.

[The Bideford anthracite occurs in certain rocks of the carboniferous system, occupying a considerable portion of the county of Devon, and generally called the culmiferous series. The beds have been worked for upwards of a century, producing a moderate quantity of coal, but the workings are not likely to be greatly extended. The thickness is very variable, averaging as much as seven feet, but sometimes diminishing to a few inches, and sometimes being 12 or 14 feet. To the depth of 8 or 10 fathoms it has been generally removed by old miners by means of adit levels, but shafts have been sunk more recently.

The pigment referred to is a variety of the anthracite, probably formed by decomposed parts of it, and has been much used.—D. T. A.]

244 BAGOT, CHAS., 12 *Charlemont Place, Ireland.*
Specimen of turf, or peat. The products of turf are tar and a watery liquor; the former divisible into paraffine, heavy oil and light oil; the latter containing ammonia, carbonic acid, acetic and pyroligneous acid, and pyroxylic. The gaseous products are, carbonic acid, oxygen, hydrogen, and nitrogen. 100 tons of peat are said to give 10,000 gallons of liquor, 1,000 gallons of tar, 6,269 feet of inflammable gas. The 1,000 gallons of liquor afford one ton of sulphate of ammonia, sufficient acetic acid to give 13 cwts. of grey acetate of lime, and 52 gallons of pyroxylic spirit. The tar yields 300 tons of paraffine, 200 gallons of light hydro-carbonaceous oil, and 100 gallons of more dense and heavy oil.
Anthracite, or stone coal, from the coal-fields of Kil-

kenny, county Tipperary, on the estate of Ambrose Goring, Esq., of Ballyphillip.

[The Kilkenny coal district includes a series of basins, or troughs, separated into three or four parts by carboniferous limestone. The strata are sandstones and shales, with fire-clay and several workable beds of anthracitic coal. The portion in the county of Tipperary extends for about 20 miles in length by 6 in breadth in the widest part. The beds are inclined at a high angle and undulate, the coal being worked by shafts to the centre or deepest part of the trough, and then upwards on both sides. There are only three beds in this district; two of them 2 feet each, and the other 9 inches. It is estimated by Sir R. Kane that 50,000 tons per annum are raised. The coal is considered to be of fair quality. It yields from 3 to 8 or 10 per cent. of red ash, and contains 9 or 10 per cent. of volatile matter.—D. T. A.]

245 Dalton, John, 48 *Summer Hill, Dublin.*

Mineral specimens, from Clonmore, County Mayo, Ireland, comprising:—

1. Clay iron-stone.
2. Clay iron-stone, once fluxed.
3. Bog-iron ore, analysed as containing 69·2 of oxide of iron, equivalent to about 48·2 of pure iron; it abounds in Clonmore, the estate of Mr. Phillips, and in the adjoining estate of Viscount Dillon.
4. Clay iron-stone, refined into iron in a common smith's forge, with turf.
5. Coal from one leader, 8 inches in thickness.
6. Coal from another four-feet leader, both in the same townlands.

247 Butler, Joseph Lawrence, *Liverpool*—Proprietor.

Specimens of coal, cannel-coal, and coke, from different seams, worked by the Moss Hall Coal Company, at Ince, near Wigan.

248 O'Byrne, William Charles, 7 *Montague Street, Portman Square*—Proprietor.

Specimen of Slievardagh coal.

[Slievardagh is in the county Tipperary, which contains a coal-field about 20 miles long, and 6 miles broad at the widest part; the coals lying in deep troughs, and consisting of three beds, one nine inches, and the others two feet deep. It is estimated by Sir R. Kane that 50,000 tons of coals per annum were worked from this district in 1845. —D. T. A.]

249 Russell, James, & Son, *Bathgate, Stirling.*

Specimen of cannel or gas coal, from Boghead, near Bathgate, Scotland, chiefly used for the production of gas, of which it yields 13,500 cubic feet per ton; the specific gravity being ·775.

Chips of the above coal are found to be so inflammable that, being lighted at a taper, they burn like a piece of wood.

252 Wylam's Patent Fuel Company.

Patent fuel.

253 Powell, Thomas, *Gaer, near Newport, Monmouthshire*—Proprietor.

Specimen of Duffryn steam coal, raised at Aberdare in Glamorganshire, and exported at Cardiff; stated to be well adapted for steam marine purposes.

Specimen of bituminous coal from the Monythusloyne vein, raised at Lispentwyn, Monmouthshire; adapted for household and smithy purposes.

Model of the apparatus used for the shipment of coals from boats or waggons at Cardiff dock, worked by a high-pressure steam-engine, and enabling vessels to ship 400 tons per day.

[The great coal-field of South Wales, presenting nearly 1,000 square miles of productive coal area, and divided into an anthracitic and bituminous portion, yields also, and abundantly, that intermediate semi-bituminous variety, called steam-coal, of which the above and some others are well known, and adapted for general use in the steam navy. The Duffryn steam coal is rather soft, free-burning, burns cleanly, without smoke, does not cake, and leaves a little white ash. Its specific gravity is 1·326. It yields 84·3 per cent. of coke, and contains—carbon, 88·26; hydrogen, 4·66; nitrogen, 1·45; oxygen, 0·60; sulphur, 1·77; ash, 3·26. Its relative calorific value (carbon being unity) is 87·7.—D. T. A.]

254 Buckingham, James, 13 *Judd Place East, New Road*—Producer and Importer.

Specimens of anthracite from Boniville's Court Collieries at Tenby, Pembrokeshire, South Wales, which have been worked 25 years. The anthracite is composed of—

Carbon . .	94·18	Sulphur . .	0·59
Hydrogen . .	2·99	Nitrogen . .	0·50
Oxygen . .	·76	Ash . . .	0·98

Its specific gravity is 1·4119.

255 Barrow, Richard, *Staveley Works, near Chesterfield, Derbyshire.*

Coal, from the mines at Staveley, in the county of Derby, which belong to the Duke of Devonshire. This block of coal, 17 ft. 6 in. long, 6 ft. wide and 4 ft. thick, was raised from a shaft 459 feet deep. The coal is 6 ft. thick, and is valued for its cohesive strength and power of combustion, being in general use for steam-boats.

Three small pieces of coal, cut with a saw, from the same mine, intended to exhibit its utility as ballast, or for stowage in steam ships going long voyages. It is extensively used in the manufacture of iron.

[A gigantic specimen of this coal is placed outside the Exhibition Building. The southern part of the great central coal-field of South Yorkshire and the adjoining counties of Derbyshire and Nottinghamshire, is now much worked, and contains several valuable beds of coal, and rapidly entering into general use. The pits are from 300 to 500 feet deep.—D. T. A.]

256 Cadell, Henry, *Scotland.*

Coal from Dalkeith Colliery, as a specimen of the general coal-field of Midlothian, with section showing the strata in the coal-field at a depth of 523 fathoms.

Steelyard, with improvements.

[The Midlothian coal-field is not very distinctly bounded, but contains some kinds much esteemed for household use. It is estimated that the district contains in all, 24 distinct seams, having a total thickness of 94 feet of coal.—D. T. A.]

258 Jones, Sells, & Co., 55 *Bankside, Southwark*—Agents for the Proprietors.

A block and pieces of anthracite from the Gwaun Cae Gurwen Colliery, near Llanelly, South Wales; particularly adapted for use in kilns, in the manufacture of malt, and in drying corn. It is also adapted for use in close stoves, bakehouses, and wherever charcoal is used for heating or cooking, as it burns without smoke or soot. The seam from which the block is taken is 4 feet 6 inches thick.

259 Llangennech Coal Company, *Port of Llanelly, South Wales, & 6 Coal Exchange*—Producers.

Specimens of free-burning, smokeless, steam coal, from the Llangennech colliery.

[The Llangennech coal is dull, soft, and fibrous, with irregular fracture, burning to a red ash, and weighing nearly 57 lbs. to the cubic foot. It contains, carbon, 85·46; hydrogen, 4·20; nitrogen, 1·07; sulphur, 0·29; oxygen, 2·44; and ash, 6·54. Like other semi-bituminous coals, it burns without much smoke, and is therefore adapted for use in the Steam Navy.—D. T. A.]

260 WESTERN GAS LIGHT COMPANY, 9 *Holles Street, Cavendish Square.*

Specimens of the Newcastle cannel coal, from which the gas supplied by the Western Gaslight Company to the building of the Great Exhibition is made.

Specimens of the cannel coke, produced in the manufacture.

261 ATKINSON, JOHN, *Coleford, Gloucester.*

A complete set of specimens of the workable seams of coal and veins of iron ore, from the Forest of Dean, placed in compartments, showing the name and thickness of each, and also the name of the works from which they are produced; with two sections of the mineral basin, illustrative of the same. The case which contains the minerals is a specimen of the oak of Dean Forest.

[The Forest of Dean coal-field is understood to occupy about 45 square miles; the total thickness of the deposits being about 3,000 feet, of which there is a thickness of 52 feet of coal distributed in 28 seams. It is remarkable for the great regularity of the deposits over a large part of the area, the beds dipping steadily towards the middle of the basin, and the millstone-grit rising and surrounding it. There is, however, an extensive and remarkable fault crossing the field. The workable seams of the district are in three groups, the lowest of which have not yet been much worked, except near their outcrop, where they are reached by levels driven from the hill side. Some parts of the thicker seams measure as much as 12 feet.—D. T. A.]

262 DAY & TWIBELL, *Barnsley*—Proprietors.

A column of coal, three feet square at the base, showing the entire thickness, and all the different qualities of the seams or beds which are found together, and generally known by the name of the Barnsley thick coal, from the Mount Osborne Collieries, Barnsley, Yorkshire. About two-thirds of the entire bed or stratum produces house-fire coal, and one-third, coal for steaming, iron-smelting, &c.

263 FIELD, COOPERS, & FAULDS, *Worsbro' Dale, Barnsley*—Proprietors.

Silkstone Main house coal, from the Silkstone bed—thickness of bed 5 feet 6 inches.

Worsbro' Park hard or steam coal, and soft or house coal, from the Barnsley 10 feet bed.

[The Barnsley coal is obtained from part of the great central coal-field of South Yorkshire, Nottingham, and Derbyshire, a district extending from Leeds to Nottingham, and including as much as 650,000 acres of coal-field. The qualities of coal obtained are bituminous or household coal, steam coal, cannel, and anthracite, varying much in quality in different localities. There are about 12 workable seams, the total average thickness being upwards of 30 feet, and the thickest seam is 10 feet. The total thickness of the upper carboniferous series here is estimated at about 550 yards. Much of the coal is worked on the long-wall method, and is of good quality. —D. T. A.]

264 FIRTH, BARBER, & CO., *Oaks Colliery, Barnsley*—Producers.

Coal for steam ships, for converting iron into steel, and for smelting iron.

Coal for domestic fires, from the Oaks Colliery, Barnsley, Yorkshire.

265 CORY, WILLIAM, & WILLIAM, jun., *Commercial Road*—Manufacturers.

London-burnt coke, for locomotive and foundry purposes.

[Coke is the fixed residuum obtained by burning coal in enclosed furnaces, and is generally obtained by the complete combustion of the volatile part of the coal, though large quantities are also produced by the economical distillation of coal in the manufacture of common gas. Coking on a large scale is performed in sets of ovens or furnaces of peculiar form, each charged every 48 hours with from 2 to 4 tons of fresh coal. The dome of the furnaces being heated (generally by the heat left since the previous coking), the coal is lighted from the top by a wisp of straw, all the doors and vents being open, and when in a state of combustion, the draught is so continued as to produce a gradual and slow combustion of the whole mass from above downwards, the gases being consumed. The calcination lasts about 40 hours, and the coal loses 20 to 25 per cent. of weight, but gains in about the same proportion in bulk. The texture of coke is peculiar, and determines its value.]

266 CLARKE, ROBERT COULDWELL, The Executors of, *Silkstone, near Barnsley*—Producers.

Coal, from the old Silkstone Colliery, near Barnsley, Yorkshire.

[The column of coal here exhibited is called Peacock or iridescent coal, from the peculiar tints of colour which it shows, and which appear to be generally the result of some action of water on the surface and between the natural faces. This tarnish, rare in most collieries, appears to be particularly abundant in that from which the above specimens are taken. It is not quite clear whether it arises from a very thin film of foreign matter deposited on its surface, or whether the mechanical condition of the surface itself (as in the case of mother-of-pearl) produces the appearance of iridescence. —D. T. A.]

Models of corf, and set of tools, as used by colliers at work in the mines, and in raising coal from the pits.

267 NIXON, JOHN, & CO., *Cardiff*—Producers.

Merthyr and Cardiff steam coal, obtained from the Werfa colliery near Aberdare and Merthyr Tydvil. This coal is used for steam purposes, more especially for steam-ships going long voyages. Its weight is 82·29 lbs. per cubic foot; its specific gravity 1·31. It is said to produce very little smoke. The following is the analysis of this coal as given in the Second Report of the Commissioners (Sir H. de la Beche and Dr. Lyon Playfair) appointed by Government to test the coals suited to the Steam Navy:—

Carbon	90·27
Hydrogen	4·12
Nitrogen, with traces of sulphur	1·83
Oxygen	2·53
Ash	1·25
	100·00

268 INCE HALL COAL & CANNEL COMPANY, *Wigan*—Proprietors.

Cannel coal, with various vases, manufactured of cannel coal. The cannel coal yields 11·673 feet of gas per ton, which is composed of—

Hydrogen	40·30
Light carburetted hydrogen	33·83
Carbonic acid	11·35
Olefiant gas and divers hydro-carbons	8·50
Atmospheric air	4·32
Carbonic oxide and aqueous vapour	1·53
Nitrogen	0·19
	100·02

Specific gravity of gas . . 6·20
Coke per ton produced 13 cwt. 18 lbs.

Specimens of the Arley and Pemberton coal, sent by the same exhibitors, will be found in the south enclosure, beyond the western extremity of the building.

[The Wigan coal-field is a portion of that known as the Lancashire and Cheshire, or Manchester, great coal-field, which ranges nearly fifty miles in length, with a breadth of ten miles on an average. The productive coal area is thus nearly 400,000 acres, and is divided into three principal portions, of which the middle one includes the thick coal seams, and these are worked in various places, Wigan being not the least important. The principal coals are a good caking coal (Arley main) and a very valuable bed of cannel; the former well adapted for domestic purposes, the latter yielding a large quantity of gas.

The total thickness of the carboniferous deposits is very considerable; but the number of seams of coal is large, and the thickness of many of them considerable.

The cannel is of fine quality, and takes a high polish, as seen in some of the specimens exhibited.—D. T. A.]

269 RAMSAY, G. H., *Derwent Haugh, Newcastle*—Inventor.

Cannel coal, with carved specimens.
Coke, and sample of coal from which it is made.
Samples of prepared manure, for different crops.

270 MITCHELL, REV. W., A.M., *Woolwich*—Inventor and Manufacturer.

Specimen of coal, or bituminous mineral.
Vase, from the same.
Pillars, with statues of Her Majesty and Prince Albert.
Box, for holding postage stamps. Stamp for sealing letters. Railway or sea chessboard and men. Snuff-box, as made from raw material. Snuff-boxes, polished. Box, with bracelets; another with backgammon men; and one with shirt buttons. Razor and knife hones.

The specimen of coal exhibited has recently been discovered near Edinburgh, and can be applied to the fine arts. It is of a brownish colour, and ignites with facility: it does not soil the hands: and it admits of a brilliant polish.

271 RUSSELL, JOHN, *Risca, near Newport, Monmouthshire*—Proprietor.

Specimen of black vein coal, raised at Risca, and exported at Newport: the vein ranges from 9 to 16 feet in thickness, and is worked by pits at a depth of 144 yards.

Specimen of Risca rock vien coal: the vein ranges from 4 to 5 feet in thickness, and is worked by pits at a depth of 100 yards.

Specimen of new black vein coal, raised at Cwm Tilery, and shipped at Newport; the vein is about 5 feet in thickness, and is worked by pits at a depth of 130 yards: this coal is stated to be well adapted for steam vessels.

Argillaceous iron ores from the lower coal measures of the South Welsh basin, raised at Risca.

Fire-bricks manufactured at Risca.

272 MORGAN, RICHARD, & SONS, *Llanelly, Wales*—Producers.

Stone-coal, or anthracite, from Cwm Amman, Llanelly, Gelly Ceidrim.

273 COAL TRADE OF NORTHUMBERLAND AND DURHAM, *Newcastle-upon-Tyne.*

Map of the coal-field of Durham and Northumberland, showing the pits and railways, with the faults and other remarkable interruptions.

Section of the coal-field, from and to given points, north and south; and a similar section from east to west.

Synopsis of the coal seams, in explanation of the map and section.

Working plan of a colliery, exhibiting the system of working and ventilating the coal mines.

Specimens of the fossil plants of the coal formation, all figured in Lindley and Hutton's Fossil Flora.

1. Lepidodendron Sternbergii.	19. Bothrodendron punctatum.
2. Ulodendron majus.	20. Pecopteris nervosa.
3. Ulodendron minus.	21. Asterophyllites comosa.
4. Lepidodendron gracile.	22. Lepidodendron elegans.
5. Lepidodendron selaginoides.	23. Pecopteris laciniata.
6. Sphenophyllum erosum.	24. Asterophyllites jubata,
7. Calamites nodosus.	25. Sphenopteris latifolia.
8. Bechera grandis.	26. Sphenopteris fucata.
9. Asterophyllites foliosa.	27. Neuropteris heterophylla.
10. Pecopteris adiantoides.	28. Lepidostrobus pinaster.
11. Pecopteris heterophylla	29. Sphenopteris Hœninghausi.
12. Sphenopteris crenata.	30. Sigillaria flexuosa.
13. Sphenopteris crithmifolia.	31. Lepidodendron plumarium.
14. Neuropteris gigantea.	32. Asterophyllites rigida.
15. Sigillaria pachyderma.	33. Sphenopteris cuneolata.
16. Sigillaria catenata.	34. Pecopteris Bucklandii.
17. Sigillaria oculata.	35. Sphenopteris linearis.
18. Sigillaria reniformis.	36. Stigmaria ficoides.

Various specimens of household, coking, manufacturing, and cannel coal.

Specimens of coal from the carboniferous limestone formation of Northumberland.

Specimens of the strata and rocks of the coal formation.

Specimens of the strata and rocks of the carboniferous limestone formation.

Specimens of coke.

Safety lamps, used in the Durham and Northumberland collieries.

Drawings representing sections of Walbottle Colliery engine pit, in which the engines, pumps, &c., are shown.

Model, showing the method of drawing coals from the mine, and screening the same at the surface.

Model in wood, showing the mode of ventilating coal mines.

Model, showing an underground ventilating furnace.

[The Newcastle coal field is estimated to contain upwards of 360,000 acres of productive coal area in the county of Durham, and nearly 150,000 in Northumberland. Of this 67,000 acres are now worked, and the average thickness of coal may be regarded as 12 feet. An acre contains 4,840 square yards, and each cubic yard of coal is estimated to weigh a ton; so that it may be considered that the coal field has contained more than 10,000 millions of tons of coal, of which about one-eighth part is probably consumed, and the present annual consumption may be estimated at ten millions of tons, including the quantity destroyed and rendered unserviceable.

The maps and sections exhibited illustrate the condition of the district and the details of the coal field. The qualities of coal are three: the common caking kinds, coarser kinds called splint coal, and cannel coal. They are all bituminous, but the proportions differ. The average quantity of gas from the caking coals is about 8,000 cubic feet per ton, the weight of coke being from 10 to 12 cwt.

The cannel coal has been much and profitably worked within the last few years, and yields a very much larger quantity of gas, amounting to 10,000 or 12,000 cubic feet the ton.

The coal is worked in the Newcastle coal field at a very great depth, exceeding in some cases 1,800 feet, and the areas worked from one set of pits are often very large, amounting to 500 or even 1,000 acres. The associated beds of the coal measures are grits and shales, and there are many slips and faults, some of them very considerable.

The method of extracting the coal in the Newcastle coal field is that called *pillar and stall*, which consists in first working a certain proportion of the coal by opening galleries at right angles to each other, leaving large pillars of coal to support the roof. These pillars are afterwards removed, and the roof allowed to sink down, forming what is technically called the *goaf*.

Owing to the large proportion of gas present in the coal, and the fact that such gas is given off readily from a newly-fractured surface, and on mixture with atmospheric air becomes highly explosive, it is necessary to take great care of the ventilation of the mines, and this more especially when the roof is partly fallen. The method of working has therefore reference to this, and the lights employed where any danger is supposed to exist must also be adapted to the peculiar condition of the mine. The models showing the mode of ventilation and the structure of the ventilating furnace used to produce a strong current of air to circulate through the mine, together with the safety lamps (invented by the late Sir Humphry Davy) will illustrate these methods. The mechanical contrivances for drawing and screening the coals (separating the dust and small coal) are also very important in the economy of the district.

There are nearly 200 pits or collieries worked in the district; the number of men and boys employed is about 26,000; and the average price of the coal as shipped for London is not more than 11*s*. per ton. The estimated quantity of coal, sold in the year 1847, was about 7,730,000 tons.—D. T. A.]

274 THE BRYMBO COMPANY, *Wrexham, Wales*—Producers.

Minerals, &c., found at Brymbo, near Wrexham, Denbighshire, or in the neighbourhood.

Main coal got at the Brymbo colliery.

[The Brymbo colliery is in a part of the Flintshire coal-field illustrated by the specimen of coal exhibited by Mr. Oakeley. There will be found a magnificent squared block of this coal in the enclosure beyond the western extremity of the building.—D. T. A.]

275 RANDALL, J., *Coalport, Salop*—Proprietor.

Minerals and their associated fossils, used in the manufacture of Shropshire iron. Also, specimens of clays-pottery, brick, tile, &c.

Cement from the curl-stone, manufactured by M. Brosely.

400 BUTTERLEY COMPANY, *Alfreton*—Producers.

Specimens of coal and ironstone, and of organic remains in connexion with the Derbyshire coal-field, including analyses of the different coal strata.

Iron in its different stages of manufacture, including pig-iron, refined metal, puddled, and merchant bar-iron.

[The great central coal-field of England extends into Derbyshire, and the works at Alfreton and its vicinity have been long known as exhibiting in all no less than 30 seams of coal, whose aggregate thickness is 78 feet.

The iron ore associated with the coal in this district is of excellent quality, and very abundant.—D. T. A.]

401 BAUGH-DEELEY & CO.

Iron chains used in coal mines.

Improved vice.

402 CRUTWELL, ALLIES, & CO.

Iron and iron ores.

403 CAWLEY, P., *Soho, near Birmingham*—Inventor.

Complete model and section of a Staffordshire coal-pit, with apparatus for preventing explosions in coal-mines, by exhausting the combustible gases, and supplying pure air in its place, and for enabling the workmen to ascertain in what state the air is, in the workings of the mine, before going down.

[The thick coal of Staffordshire is worked in a manner altogether different from that adopted either in Northumberland or Yorkshire, as there is constant danger of accident from the fall of the roof, besides that arising from the presence of gas which necessarily accumulates in large quantities in the upper recesses of the mine.

The usual mode of getting the coal is by sinking a pair of shafts at convenient distances, and extending a pair of levels from the shafts. On reaching the intended limit of working, the coal is removed on one or both sides of the levels, for a distance of about 20 yards wide; but pillars of 7 or 8 yards square are left at intervals for the support of the roof. Between each *side lane* of this kind a larger and more effectual barrier is left 16 or 20 yards wide, and this is called a fire-rib, and serves not only to prevent a crush of the roof, but to allow of a dam being afterwards constructed to confine the gases. A large quantity of coal is left below by this process of mining, amounting sometimes to one-half or even two-thirds of the whole. The ventilation of the thick coal mines is generally imperfect, owing to the large body of air to be moved; but more accidents occur from falls of the roof than from explosions. The workings are generally left in the care of uneducated contractors called *butty colliers*.—D. T. A.]

404 BRUNTON, W.

Model of plan proposed for ventilating mines, and diagrams.

405 HARRISON, AINSLIE, & CO., *Newland Furnace, Ulverston.*

Hæmatite iron ore, from Lindal Moor, in Furness, containing metallic iron, 66·47 per cent.; oxygen, 28·50 per cent.; silica, 3·43 per cent.; zinc, ·71; moisture and loss, ·89.

Charcoal pig-iron and furnace cinder, from Newland, Backbarrow, Duddon, and Lorn furnaces, said to be the only charcoal furnaces in Britain.

406 FARNLEY COMPANY.

Coal. Coke. Iron-stone.

407 DICKINSON, THOMAS FRIEND, *Newcastle-upon-Tyne*—Producer.

Specimen of hæmatite, or kidney ore, exported from Balcarry Bay; used to mix with poorer iron-stone.

[These peroxides of iron vary in the quantities of iron they contain. Where they are crystalline they are usually found to consist—of iron, 70, and oxygen, 30. The uncrystallized varieties are generally not so rich, yielding oxygen, 30·66, and iron, 60·34. These ores afford a considerable portion of the iron manufactured in different countries; they are also, when ground, employed for polishing metals, and used as a colouring material.—R. H.]

408 MOORE, JOSEPH, M.D., 10 *Saville Row*—Proprietor.

Iron ore, from the surface of the Arigna mines, on the western side of lake Allen, in the county of Roscommon. Calcined iron ore.

Limestone rock. Fire-clay, used for making bricks for kilns and furnaces. Fire-bricks, made from the same.

Moulding sand.

Specimens of coal found in the locality.

Peat turf, soft and hard. Charred peat for smelting.—Peat, called in Ireland turf, is used as fuel for domestic purposes; it may be used with advantage for smelting the iron ore, having all the effect of wood, and, when charred, of charcoal, which imparts to the iron the properties so highly prized in metal, prepared in wood furnaces.

Bar of iron, from the ore of Arigna. Bar of steel, converted from the same.

Crystallized rock, having a fine fracture, being the surface rock of the district.

Map of the works and section of the mine.

[The river Arigna divides the Connaught coal-field into two parts. The southern division consists of a great mountain ridge called Brahlieve, at the base of which are the Arigna iron works. The rocks within this district are similar to those of other coal-fields, consisting of sandstone, shale, clay-ironstone, and fine fire clay. The shale, which varies in thickness from 300 to 600 feet, rests on limestone rock, and is remarkable for its rich beds of ironstone.

Sir Robert Kane has given the following analysis of the clay ironstone from Arigna:—

Protoxide of iron . .	54·42
Lime	2·23
Magnesia	2·02
Alumina	1·43
Clay	8·65
Carbonic acid . . .	31·25

The mean of many analyses gives 40 per cent. of metallic iron, as the average produce of the iron ore of this district. Sir John Guest reported on the Arigna mines in 1804, and stated the cost of production to be as follows:—

	£.	s.	d.
5 tons of raw coal at 6*s*. 4*d*.	1	11	8
4 ,, ironstone, at 6*s*. .	1	4	0
1 ,, limestone . .	0	4	0
Labour	0	10	0
Rent and other charges .	1	5	4
	£4	15	0

Mr. Griffith, in his report on the Connaught coal field, estimates the cost of a ton of iron, produced in this locality, at only 3*l*. 2*s*. 5*d*. The real working cost appears, however, to be somewhat between the two. These statements are important, as directing attention to a very interesting iron-producing locality, which does not appear to have received the notice it merits.—R. H.]

409 SCHNEIDER, HENRY WILLIAM, *Ulverstone*—Producer and Manufacturer.

Red hæmatite iron ore.

Pig-iron, from Scotland, used therewith.

Bar-iron, made from the two combined.

Blister-steel, made from a mixture of iron ore and Scotch pig-iron.

Cast-steel, made direct from the iron ore and pig-iron, without being first converted into blister steel.

Shear steel, made direct from the iron ore and pig-iron, without being first converted into blister steel.

410 SOLLY & CO., *Seabrook Iron and Steel Works, Tipton, Staffordshire.*

Iron and manufactured steel.

411 BIRD, WILLIAM, & CO., 5 *Martin's Lane, Cannon Street, City*—Proprietors.

Specimens of Blaenavon, Coalbrook Vale, "Crane's" anthracite, and "Budd's" anthracite, pig, bar, and refined metal.

Specimen of Gartsherrie, Calder, Govan, and Forth Scotch pig iron.

Specimen of BBH, Lion, and JB and S, *Staffordshire bar-iron*, from 7 inches diameter, weighing 1¼ tons to the smallest size, with pieces of chain and worked iron, to show great strength and tenacity.

Specimens of "Pentwyn" rails of the ordinary quality, broken under Nasmyth's hammer.

Specimens of patent lap-welded drawer boiler tubes, enamelled and plain, of various sizes; enamelled corrugated sheets, and specimens of TD tin and term plates.

412 THE EBBW VALE COMPANY, *near Abergavenny, and* 83 *Upper Thames Street*—Producers.

Samples of coal and iron stone, with foils, from the Ebbw Vale iron works, in Wales, and the Coalbrook Dale iron works, in Shropshire.

Maps showing the strata, vertically, of the South Wales and Shropshire mineral fields. Model of the mineral workings taken both vertically and horizontally, of the Ebbw Vale estate. Working model of blast furnaces, showing the mode of using the gases and economizing fuel. Pieces of various pattern rails, bar-iron, angle-iron, &c. Samples of rails, full length, and other descriptions.

[The South Welsh coal-field has been elsewhere described. The Coalbrook Dale field contains 32 square miles of workable coal, the average number of seams being 17, and the average thickness of the principal seams three feet. The field is much faulted, some of the dislocations amounting to 600 or 700 feet. The coal is of the kind called slate coal, and contains from 1 to 3 per cent. ash. The percentage of carbon is 56 to 64. Very excellent iron is made from several seams of clay iron ore interstratified with the coal, and yielding upwards of three tons of ore per square yard.

The Ebbw Vale coal is brilliant, brittle, lights easily, and yields a clear fire. It is light, weighing 53¾ lbs. to the cube foot.

It contains 89·78 carbon; 5·15 hydrogen; 2·16 nitrogen; 1·02 sulphur; 0·39 oxygen, and 1·50 ash. The coal yielding the above analysis is that known as the "Ebbw Vale 4 feet steam coal." The mine is 400 to 500 feet deep.—D. T. A.]

413 SUTCLIFFE, JOHN CLARKSON, *Barnsley*.

Model of Honey Well Colliery, Barnsley, showing the manner in which it is worked and ventilated.

[The method of working coal, adopted in the Yorkshire mines generally, is that known as the *long wall*, and is distinguished from the Newcastle, or *pillar-and-stall* method, by extracting at once all available coal, instead of first taking a small proportion and leaving the rest in the form of pillars. The selection of the method of working should depend on the conditions of the mine; and generally the long-wall system may be considered admissible where ironstone occurs with the coal, the coal being thin or the floor and roof soft, the royalty small, the general superincumbent mass compact, and the water not very troublesome.

When, however, there is much gas, where the coal is deep and the quantity to be extracted from one set of workings very considerable, and the water troublesome, it cannot generally be recommended.

In working the long-wall method, it is usual to put a pair of levels from the shafts, and carry drifts at once to the extremity of the intended workings; and then, removing the coal from the end, the roof is allowed to fall, leaving only an air-way round the outside of the fallen mass (*gob*), cut in the solid coal. The gob is often partly filled with the rubbish removed in getting the coal.—D. T. A.]

414 DICKINSON, J., F.G.S., *Inspector of Coal Mines, Birmingham*—Producer.

Section of the strata in the coal and ironstone mines at Dowlais and Merthyr Tidvil, South Wales.

415 BEECROFT, BUTLER, & Co., *Leeds*—Manufacturers.

Pieces of best double-fagotted railway axles, in the forged state, cut to show the mode of manufacture; and broken, to show the fibre in fracture.

Pieces of best quality of railway tire-bar, in the forged state, cut to show the mode of manufacture; and broken, to show the fibre in fracture.

Railway tires, and double-fagotted railway axles, best quality, and double-fagotted cart and carriage axles, in forged state, bent cold in different forms, to exhibit the toughness, soundness, and strength of the material.

[As the speed of the locomotive steam-engine became developed, many results presented themselves which were as unlooked for by the mechanic and engineer as the speed itself had been wholly unexpected. Among these none has been the cause of more anxiety, and none perhaps of more real danger, than the change which wrought iron in axles and in the tires of wheels is found to undergo when exposed to the severe friction induced by rapid speed under heavy loads. Metal that had been deemed tough and fibrous became brittle, and broke like cast iron.

The specimens of railway tires and axles exhibited, in various conditions, and showing the structure of the metal in fracture, illustrate a method of obviating this result.—W. H.]

Double-worked cable-chain iron, bent cold.

Tension bar-end, of best Kirkstall iron, torn asunder by 135 tons, by means of hydraulic pressure.

Bar of iron in the rolled state.

Walking-sticks made from the iron.

Railway-carriage wheels of different materials and various construction.

Waggon and mail axles on various principles.

Improved Collinge's India and other axles.

Registered self-acting regulating damper for high-pressure boilers.

Registered improved moveable eccentric tumbler.

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416 WINGERWORTH IRON CO., *Chesterfield, Derbyshire*.

Iron ore.

Iron and steel manufactured.

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417 BIDDULPH, —.

Iron and tin-plate manufactures.

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418 MILLS, ROBERT, *Foxhole Colliery, near Swansea* — Inventor.

Model of an apparatus for opening and closing doors in mines, by a reversion of levers, one opening, and the other closing the door, on each side of the door; whether worked by the carriage drawn by a horse, or pushed by a man or a boy, the action is precisely the same. The principal advantage is to keep the doors regularly closed; the doors being at present attended to by boys, who are apt to fall asleep, leaving the doors open, and allowing the air to make its escape to the upcast pit; thus leaving the working part of the pit unventilated, and in many cases causes serious accidents. The Foxhole Colliery, where this method is in practice, has been worked from 80 to 100 years; and there has not been an explosion of gas in it for the last 22 years.

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419 THOMAS, JOHN TROTTER, *Coleford*.

Specimens of iron ores, from the Forest of Dean.

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420 STAINTON MINING COMPANY, *Ulverston*.

Furness iron ore (hæmatite) produced from mines belonging to the Earl of Burlington, and used in Staffordshire, Yorkshire, and South Wales, for mixing with inferior iron ores.

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421 MONTAGUE, ARTHUR, *Lydney, Gloucestershire*— Proprietor.

Specimens of the iron ore procured from the mines of the Forest of Dean Iron Company, and smelted at their iron works at Parkend, Gloucestershire, with the pig-iron, refined metal, and furnace scoria produced from it, viz.:—

Argillaceous, calcareous, and silicious hematite iron-ore.

Best forge pig-iron.

Refined metal.

Blast furnace scoria.

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422 AINSWORTH, THOMAS, *Cleator, near Whitehaven*— Proprietor and Manufacturer.

Iron ore (*Hæmatite*) from mines in Cleator. No. 1. Pig iron from hæmatite ore only.

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423 BEWICK, JOSEPH, *Grosmont, near Whitby*— Agent.

Calcareous ironstone from the iron mines of Mrs. Clark, of Hollins House, Grosmont, in the valley of the Esk.

Sandstone from the estate of Mrs. Clark, at Fairhead, near Grosmont.

Petrified shells found in the ironstone beds.

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424 BICKFORD, SMITH, & DAVEY, *Tuckingmill, Cornwall* —Inventors and Manufacturers.

Several kinds of safety fuse, adapted to convey fire to the charge in the blasting of rocks or of ice, or in submarine operations. The fuse consists of a small column of gunpowder, spun into the centre of a cord. The different kinds are made by adapting the coating to resist the pressure of water. Gunpowder not being allowed in the Exhibition, these samples are made with sand.

[The safety fuse is considered to possess three great advantages over the ordinary mode of firing a charge: first, that of certainty both as to time and resistance to damp; second, that of safety; and thirdly, that of economy.—D. T. A.]

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425 PAGE, J. R., *Athenæum Club*—Proprietor.

Specimens of ironstone, from the Leitrim coal and iron basin. Also some specimens of the same in a washed state.

Small pieces of the iron, from the same, reduced by means of peat charcoal.

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426 MONKLAND IRON AND STEEL COMPANY (WM. MURRAY, 33 *West George Street, Glasgow*)—Producers.

Specimens of the seams of coal, ironstone, limestone, freestone, fire-clay, and Roman cement, contained in the various strata of the mineral field of Lanarkshire.

Specimens showing the relative quantities of coal, raw and roasted ironstone, pig iron, refined iron, and puddled iron, required to produce malleable iron.

Specimens of white pig iron and malleable iron, square, round, flat and half round; rails, wheel-tires, angle iron, and nail-rods.

[The coal-field of Lanarkshire comprehends about 150 square miles in that county, and contains from 20 to 30 seams of coal, of which five or six are generally worked in one colliery, having an aggregate thickness of about 20 feet. None of the coals are caking, and one kind (the columnar glance coal) burns without flame or smoke.

About half the coal raised is used in the iron-works. The total consumption in 1845 was upwards of two millions of tons.—D. T. A.]

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427 BLACKWELL, S. H., *Dudley*.

A series of iron ores, illustrating the general iron-making resources of the United Kingdom. The following remarks have reference to this series:—

The gross annual production of iron in Great Britain is now upwards of 2,250,000 tons. Of this quantity South Wales furnishes 700,000 tons; South Staffordshire (including Worcestershire) 600,000 tons; and Scotland 600,000 tons. The remainder is divided amongst the various smaller districts.

One of the principal causes of the advantages possessed by Great Britain in the manufacture of iron, arises from the number and variety of the measures of argillaceous and black-band ironstones which alternate with the beds of coal in almost all its coal-fields; and in consequence of which, the same localities, and, in many instances, the same mineral workings, frequently furnish both the ore and the fuel required to smelt it.

So extensive are the ironstone beds of the coal measures, that they furnish in themselves the greater part of the iron produced in Great Britain; but the iron-making resources of the kingdom are by no means confined to them. The carboniferous, or mountain limestones of Lancashire, Cumberland, Durham, the Forest of Dean, Derbyshire, Somersetshire, and South Wales, all furnish important beds and veins of hæmatite; those of Ulverston, Whitehaven, and the Forest of Dean are the most extensively worked, and seem to be almost exhaustless. The brown hæmatites and white carbonates of Alston Moor and Weardale also exist in such large masses that they must ultimately become of great importance. In the older rocks of Devon and Cornwall are found many important veins of black hæmatite, and in the granite of Dartmoor numerous veins of magnetic oxide and specular iron ore. The new red sandstone furnishes in its lowest measures beds of hæmatitic conglomerate. In the lias and oolites are important beds of argillaceous ironstones, now becoming extensively worked; and the iron ores of the greensand of Sussex, once the seat of a considerable manufacture of iron, will, in all probability, again soon become available, by means of the facilities of railway communication.

In the following classification, the number of the blast furnaces in each district is given, and the ironstones of the coal measures are arranged in the definite order in which they occur in the different coal-fields; so that their position, in reference to the beds of coal alternating with them, is at once seen. The more important of the coal-fields are also subdivided into districts, showing the changes which occur in each, and thus giving a concise view of their general character. The other iron ores are arranged according to the geological formations in which they occur.

The produce of the manufacture of iron in Great Britain in 1750 was only about 30,000 tons; in 1800, it had increased to 180,000 tons; in 1825, to 600,000 tons; in the following year the duties upon the introduction of foreign iron were either removed or rendered nominal, since which the production of iron has nearly quadrupled itself, being now about 2,250,000 tons.

SOUTH WALES.—(Eastern Outcrop.)

General No.	No. of Series.	—	Blast Furnaces. In	Blast Furnaces. Out
		Strata.		
		PRINCIPAL WORKS:—		
		Cwm Bran	.	1
		Pontypool	2	1
		Abersychan	2	4
		Pentwyn	.	3
		Varteg	2	.
		Gelynos	3	.
		Blaenavon	3	2
		23 Furnaces	12	11
		Strata.	Ft.	In.
1	1	*Soap Vein Mine, Blaenavon.*		
		Soap Vein Coal	.	6
		Coal (not named)	2	6
2	2	*Black Pins, Bleanavon.*		
		New Vein Coal, or Elled Coal	4	0
		Droidig Coal, or Big Vein	4	0
		Red Vein Coal	3	3
3	3	*Three Quarter Balls, Blaenavon.*		
		Rock Vein, or Three Quarter Coal	8	0
		Yard Vein Coal	2	6
4	4	*Meadow Vein Mine, or Pwdlaca, Blaenavon*		
		Meadow Vein Coal	8	10
		Old Coal	5	6
5	5	*Spotted Vein Mine, Blaenavon.*		
6, 7	6	*Bottom Vein Mine, Blaenavon.*		

SOUTH WALES.—(North Eastern Outcrop.)

General No.	No. of Series.	—	Blast Furnaces. In	Blast Furnaces. Out
		PRINCIPAL WORKS:—		
		Clydach	4	.
		Nant-y-glo	7	1
		Coalbrook Vale	2	3
		Blaina	2	1
		Cwm Celyn	2	1
		Beaufort	7	.
		Ebbw Vale	4	.
		Victoria	2	2
		Sirhowey	5	.
		Tredegar	7	.
		50 Furnaces	42	8
		Strata.	Ft.	In.
13, 14	1	*Soap Vein Mine, Coalbrook Vale.*—Four courses, =7 inches. Average yield about 2,000 tons per acre.		
15	2	*Black Band, Coalbrook Vale.*—One course, not very generally worked: only very local.		
		Soap Vein Coal	1	3
16 to 18	3	*Black Pins, Coalbrook Vale.*—Ten irregular courses of nodules in about 15 feet of ground. Yield about 4,500, tons per acre.		
		Elled Coal	3	4
		Big Vein Coal	5	6
19, 20	4	*Three-quarter Balls, Coalbrook Vale.*—Worked with three-quarter coal: three courses (two irregular). Yield per acre very variable, averaging about 1,200 tons		
		Three-quarter Coal	3	.
		Bwdellog Coal	2	10
		Engine Vein Coal	3	2
		Yard Coal	3	8
21, 22	5	*Blackband, Nant-y-glo.*—Worked with the Old Coal over which it lies, very local in extent, but of very good quality, and forming an important measure at Beaufort and Nant-y-glo.		
		Old Coal	5	6
23, 24	6	*Spotted Pin, Coalbrook Vale.*—Two courses = 4½ inches in 4 feet ground. Yield per acre, about 1,200 tons.		
25, 26	7	*Little Pins, Nant-y-glo.*—Two courses = 5 inches in 3 feet ground. Yield per acre, about 1,400 tons.		
27 to 29	8	*Red Vein, Coalbrook Vale.*—Three courses = 6¼ inches. Yield per acre 1,800 tons.		
30	9	*Big Vein, Nant-y-glo.*—Worked with bottom coal. Two courses = 6 inches. Yield per acre, about 1,700 tons.		
		Bottom Coal	1	8

The beds of coal in this division of the coal-field are all bituminous. The principal coals only are given in this section. The ironstones are principally argillaceous, although some important beds of blackband or carbonaceous ironstone exist locally. The total thickness of the coal measures, in this series, from the Soap Vein Mine to the bottom coal is about 150 yards.

SOUTH WALES.—(Northern Outcrop.)

General No.	No. of Series.	—	Blast Furnaces. In	Blast Furnaces. Out
		PRINCIPAL WORKS:—		
		Rhymney	8	2
		Dowlais	11	3
		Ivor	3	1
		Penydarren	5	2
		Cytharfa	6	1
		Hirwain	4	.
		Duffryn and Furnace Ycha	8	.
		Ynysfach	4	.
		Aberdare	6	.
		Aberammon	2	1
		Gadlys	3	.
		70 Furnaces	60	10
		Strata.	Ft.	In.
32	1	*Gwrid Mine, Dowlais.*		
33, 34	2	*Soap Vein, Dowlais.*—Three courses = 6 inches, worked with Soap Vein Coal.		

SOUTH WALES.—(Northern Outcrop)—*continued.*

General No.	No. of Series.		Ft.	In.
		Soap Vein Coal.		
35, 36	3	*Upper Black Pins, Dowlais.*—Three courses = 4 inches.		
37, 38	4	*Lower Black Pins, Dowlais.*—One course = 3 inches.		
		Yard Coal	3	6
		Upper Four Feet Coal . .	3	0
		Dowlais Big Coal . . .	8	0
39, 40	5	*Black Pin Soap Vein, Dowlais.* — Five courses = 11 inches. About 17 yards beneath big coal.		
		Ras Las Coal	7	9
41	6	*Brass Vein Mine, Dowlais.*—Two courses = 3½ inches lying immediately on Brass Vein Coal.		
		Brass Vein Coal . .	2	0
42, 43	7	*Little Pins, Dowlais.*—Eight courses = 16 inches.		
		Three Coals	3	0
44	8	*Little Vein, Dowlais.*—One course = 5 inches, lying over Little Vein Coal.		
		Little Vein Coal . . .	3	0
45, 46	9	*Big Blue Vein, Dowlais.*—Three courses = 8½ inches, lying 4 feet above Lower Four Feet Coal.		
		Lower Four Feet Coal .	9	3
47	10	*Spotted Vein, Dowlais.*—Three courses = 12 inches, in 8 feet ground, lying about 5 yards below Lower Four Feet Coal.		
48, 49	11	*Red Vein, Dowlais.*—Four courses = 11½ inches in 8 feet ground, about 5 yards underneath Spotted Vein.		
50, 51	12	*Little Blue Vein, Dowlais.*—Six courses = 14 inches in about 12 feet ground.		
52, 53	13	*Jenkin Pins, Dowlais.*—Eight courses = 12 inches in about 10 feet ground.		
54, 55	14	*Lumpy Vein, Dowlais*—Three courses = 6½ inches in about 6 feet ground, worked with Lumpy Vein Coal.		
		Lumpy Vein Coal . . .	1	3
56	15	*Top Rosser Mine, Dowlais.*—One course = 5 inches.		
57	16	*Bottom Rosser Mine, Dowlais.* — Three courses = 8 inches in about 5 feet ground.		

Total average thickness of measures from Gwrid Mine to Bottom Rosser Mine about 320 yards. In the last 100 yards of this, there are five workable beds of coal varying from 2 feet to 9 feet thick: and 62 distinct courses of ironstone varying from 1 to 5 inches thick, many of which, however, are necessarily not workable.

SOUTH WALES.—(Central Anticlinal District.)

General No.	No. of Series.	—	Blast Furnaces. In	Blast Furnaces. Out
		PRINCIPAL WORKS:—		
		Cwm Avon . . .	4	2
		Oakwood	2	.
		Garth	.	3
		Maesteg	.	3
		Llynvi	4	.
		Neath Abbey . . .	.	2
		20 Furnaces . . .	10	10

General No.	No. of Series.	*Strata.*	Ft.	In.
58	1	*Upper Blackband, Llynvi.*—One course = 20 inches; worked at Llynvi, Maesteg, and Cwm Avon.		
		Albert Seam . . .	1	8
		Victoria Seam . .	3	0
59	2	*Lower Blackband, Llynvi.*—One course = 12 inches. These beds, about 22 yards apart, are perhaps, for extent of area and general quality, the most important Blackbands yet discovered in the South Wales Coal-Field, although not nearly equal in thickness to the Blackband in the parish of Gellygaer, in the central part of this coal-field.		

SOUTH WALES.—(Central Anticlinal District)—*continued.*

General No.	No. of Series.		Ft.	In.
		Yard Vein . . .	3	0
		Two and a Half Feet Vein .	2	6
		Two Feet Vein . .	2	0
		Cae David Vein . .	4	6
60 to 62	3	*Cockshut or Scwd Mine, Llynvi.*		
63, 64	4	*Fire Clay Vein, Llynvi.*		
		Fire Clay Vein . .	1	4
65 to 67	5	*Yellow Vein, Llynvi* } These three courses of mine lie in about 24 feet of ground, and are worked together in the patches or open works of this district.		
68	6	*Pin Balsog, Llynvi*		
69, 70	7	*Black Pin, Llynvi* .		
		Upper Six Feet Coal . .	6	0
71, 72, 73	8	*Double Pin, Llynvi.*		
		Truro Coal . . .	3	0
		Lower Six Feet Coal . .	6	0
74	9	*Big Vein, Llynvi* } These three courses lie in about 38 feet of ground, and are worked together in the same way as Nos. 5, 6, and 7, in patches or open works.		
75	10	*Pin Halkin, Llynvi*		
76	11	*Furnace Mine, Llynvi*		
		Furnace Vein Coal . .	3	0
		Seven Feet Coal . .	7	0
77	12	*Coal and Mine Seam, Llynvi.*		
		Coal and Mine Vein . .	2	3
		CWM AVON SERIES.		
		Wernddu Seam . .	2	0
		Wern Pistyll Seam . .	1	9
		Tor Mynydd Seam . .	2	2
		White Seam . . .	4	0
		Jonah Seam . . .	1	2
78	1	*Blackband, Cwm Avon.*—Thickness varies very much, at Cwm Avon about 7 inches, Oakwood 22 inches.		
		Cwm Bir Seam . . .	1	8
		Black Seam . . .	1	6
		Golden Seam . . .	2	2
		Cockshut Seam . .	1	6
79	2	*Big Mine, Cwm Avon.*—Lies under Upper Cockshut Rock; one course of 12 inches.		
80	3	*Middle Big Mine, Cwm Avon.*—Lies between two Cockshut rocks; one course of 6 inches.		
81	4	*Lower Big Mine, Cwm Avon.*—One course of 4 inches; sometimes worked with New Mine coal, about 2 feet under it.		
		New Mine Vein . .	2	4
		Balling Seam . . .	2	2
82, 83	5	*Balling Mine, Cwm Avon.*—Two courses.		
		Finery Seam . . .	2	0
84 to 86	6	*Sulphury Mine, Cwm Avon.*—Three courses = 7 inches.		
		Sulphury Seam . . .	2	0
		Four Feet Seam . .	4	0
87	7	*Cefn Glo Balls, Cwm Avon.*—This corresponds with the Furnace Vein at Llynvi and Maesteg, worked extensively there in patches: 16 inches worked at Cwm Avon by level.		
		Big Seam . . .	9	0
88	8	*Middle Clay Vein, Cwm Avon.*—One course.		
		Clay Seam . . .	1	9
		Coal and Mine Seam . .	6	0
89, 90	9	*Five Feet Pins, Cwm Avon.*—Two courses.		
		Five Feet Seam . .	5	0
		Lower Four Feet Seam .	4	0
91 to 93	10	*Jack Mine, Cwm Avon.*		

The total thickness of measures from Wernddu Seam to Lower Four Feet Seam is about 800 yards. The beds of coal in this division are all bituminous. Several important beds of coal and various measures of ironstone are known to exist below the Lower Four Feet Seam coal; but the entire extent of the lower beds is not yet proved in this division of the South Wales coal-field.

SOUTH WALES.—(Western or Anthracite District.)

General No.	No. of Series.	—	Blast Furnaces. In	Out
		PRINCIPAL WORKS :—	In	Out
		Venalt	.	2
		Ystalyfera	5	6
		Yniscedwin	3	4
		Banwen	.	2
		Onllwyn or Brin	2	.
		Cwm Ammon	2	.
		Trim Saren	.	3
		Gwendraith	.	3
		Branere	.	2
		34 Furnaces	12	22
		Strata.	Ft.	In.
94, 95	1	*Blackband, Ystalyfera.*—14 inches thick, very local. Yields about 2,750 tons per acre.		
96, 97	2	*Black Pins, Ystalyfera.*—Two courses = 8 inches. Yields about 2,400 tons per acre		
98	3	*Soap Vein, Ystalyfera.*—Three courses = 9 to 10 inches. Yields about 2,750 tons per acre.		
		Soft Vein Coal . . .		
99	4	*Penny Pieces, Ystalyfera.*—Three courses with scattered balls. Yields about 3,600 tons per acre.		
		Penturin Coal . . .	3	0
100	5	*White Pins, Ystalyfera.*—Sometimes called Coedfalda Mine: Four courses about 16 inches in 14 feet ground. Yields about 4,800 tons per acre.		
		White Vein Coal . .	1	6
101, 102	6	*Black Vein Mine, Ystalyfera.*—Two courses = 8 inches. Yields about 2,400 tons per acre.		
		Black Vein Coal . .	4	0
103a to 103k	7	*Little Vein Mine, Ystalyfera.*—Ten courses in 18 feet ground, got with Little Vein Coal. Yields 7,000 tons per acre. This is the most important measure of ironstone in this district.		
		Little Vein Coal . .	3	0
105	8	*Billets, Ystalyfera.*		
106	9	*Harnlo Mine, Ystalyfera.*—Two courses.		
		Harnlo Coal . . .	2	0
107	10	*Big Vein, Ystalyfera.*—Two courses = 6 inches. Yielding 1,800 tons per acre when worked by level: if worked in patches 16 feet ground, all interspersed with stone.	5	6
		Big Vein Coal . . .	2	0
		Black Vein Coal .		
108	11	*Brass Vein, Ystalyfera.*—Five courses in 13 feet of ground. Yielding 3,500 tons per acre.		
		Brass Vein Coal . .	4	0
		Three Coal Vein . .	3	0
		Bryalley Vein Coal . .	3	0
109	12	*Little Brass Mine, Yniscedwin.*		
		Little Brass Vein . .	2	0
		Middle Vein Coal . .	2	6
110, 111	13	*Cwm Fil Mine, Yniscedwin.*—Three courses.		
		Lower Vein Coal . .	3	0
112	14	*Little Blue Vein, Yniscedwin.*		
113	15	*Big Blue Vein, Yniscedwin.*		
114	16	*Gnappog Mine, Yniscedwin.*		
115	17	*Pin Mawr Mine, Yniscedwin.*		

The beds of coal in this district are all anthracite. The measures of ironstone extremely numerous and important, but principally worked in patches or open works. All the measures in this series bear the appearance of having been subjected to an extremely high temperature; which has been in all probability the cause of the conversion of its beds of coal into anthracite.

SOUTH WALES.—(Southern Outcrop.)

General No.	No. of Series.	—	Blast Furnaces. In	Out
		PRINCIPAL WORKS :—	In	Out
		Pentyrch	2	.
		Tondu	1	1
		Cefn Cwsc	1	2
		Cefn Cribbwr	.	1
		Dinas	3	.
		11 Furnaces	7	4

SOUTH WALES.—(Southern Outcrop)—*continued.*

General No.	No. of Series.	*Strata.*	Ft.	In.
		Rock Vein Coal . .	4	0
		Double Vein Coal . .	4	0
		Little Vein Coal . .	3	0
		Bridge Vein Coal . .	1	6
		Lanthern Vein Coal . .	5	0
		Small Bodur Coal . .	5	0
		Great Bodur Vein . .	8	0
		Sooty Vein . . .	5	6
		North Vawr Vein . .	12	0
		South Vawr Vein . .	4	4
		Second Vawr Vein . .	3	0
		Third Vawr Vein . .	5	6
		Slattog Vein . .	2	0
		Six Feet Vein . . .	6	0
116, 116a	1	*Six Feet Ironstone, Cefn Cwsc.* — Four courses = 9 inches.		
		South Nine Feet Coal . .	9	0
117, 117a	2	*Nine Feet Balls, Cefn Cwsc.*—Seven courses = 17 inches.		
		Fiery Vein Coal . .	4	0
118, 118a	3	*Fiery Vein Ironstone, Cefn Cwsc.* — Six courses = 14 inches.		
		Five Quarter Vein . .	4	6
		Great Gribbur Vein . .	6	0
119	4	*Gribbur Balls, Cefn Cwsc.*—Two courses = 6 inches.		
120	5	*Upper Spotted Vein, Cefn Cwsc.* — Two courses = 4 inches.		
121	6	*Spotted Balls, Cefn Cwsc.*—Two courses = 4 inches.		
122	7	*Middle Spotted Vein, Cefn Cwsc.* — Two courses = 8½ inches.		
123	8	*Lower Spotted Vein, Cefn Cwsc.* — Two courses = 4½ inches.		
124, 124a	9	*Variegated Pins, Cefn Cwsc.*—Two courses = 5½ inches.		
125, 125a	10	*Yellow Vein and Balls, Cefn Cwsc.*—Two courses = 8 inches.		
126	11	*Upper Red Vein, Cefn Cwsc.*—Two courses = 3 inches.		
126a126b	12	*Upper Red Vein Balls, Cefn Cwsc.*—Two courses = 6 inches.		
126c	13	*Lowest Red Vein, Cefn Cwsc.* — Two courses = 4 inches.		
126d	14	*Pin Rhybwr Balls, Cefn Cwsc.*—One course = 3 inches.		
126e	15	*Black Balls, Cefn Cwsc.*—Two courses = 3 inches.		
126f	16	*Double Balls, Cefn Cwsc.*—Two courses = 6 inches.		
126g	17	*Black Pins, Cefn Cwsc.*—One course = 3 inches.		
126h	18	*Upper Blue Veins, Cefn Cwsc.*—One course = 4 inches.		
126i	19	*Blue Vein Balls, Cefn Cwsc.*—Two courses = 4 inches.		
126j	20	*Lower Blue Veins, Cefn Cwsc.*—Two courses = 3 inches.		
126k	21	*Lumpy Balls, Cefn Cwsc.*—One course = 5 inches.		
126l	22	*Pin Garu Balls, Cefn Cwsc.*—Two courses = 8 inches.		
		Small Gribbur Coal	2	9

The iron ore principally used at the Pentyrch works is hæmatite, from the carboniferous limestone on the south of the South Welsh coal-field. The annual production of iron on the south outcrop is about 25,000 tons.

SOUTH WALES.—(Upper or Red Ash Series.)

126a to 126b.	..	*Blackband; Jos. Latch, & Co.* — Colfatch Colliery, Gellygaer, Glamorganshire. This Blackband lies in four courses, respectively 22, 6, 8, and 6 inches thick. Total thickness, 3 feet 6 inches. It lies in 6 feet of ground, and yields upwards of 7,000 tons per acre. Its position is very high in the coal measures above the Mynyddis-mwyn Vein of coal.		

The South Wales Coal-field extends over an area of upwards of 800 miles. Both from its extent and the varied character of its numerous beds of coal and iron, it may be considered as the most important of all our coal-fields. The upper measures furnish the best Red Ash coals for household purposes, whilst its lower measures are well adapted for iron-smelting, and for steam coal.

The number of furnaces now in blast is 143, averaging about 100 tons of iron each per week: or a gross annual production of 700,000 tons, and requiring 2,000,000 tons of ironstone, principally furnished from this coal-field. The annual production of coal is estimated at from 5 to 6,000,000 tons.

In 1796, the annual production of iron in South Wales was 34,011 tons, and in 1823, 182,325 tons; since which time the production has been nearly trebled.

In the eastern part of the district the coals are bituminous; as they approach the west they gradually become semi-anthracitic; and in the western district all the coals are anthracitic.

From the great area of this coal-field, and the great variety in character, both of its beds of coal, and its measures of ironstone and blackband, it will, in all probability, long remain the most important iron-making district in the world.

NORTH WALES.

General No.	No. of Series.	—	Blast Furnaces.	
		Principal Works:—	In	Out
		Rhuabon	2	1
		Brymbo	1	1
		5 Furnaces	3	2
		Strata.	Ft.	In.
		Three Yard Coal	9	0
		Brassey Coal	2	3
127—130	1	*Upper Yard Ironstone, Rhuabon.*—Four irregular courses (No. 1 to No. 4), averaging about 7 inches.		
		Upper Yard Coal	2	6
131—133	2	*Red Coal Ironstone Balls, Rhuabon.*		
		Red Coal	1	6
134—137	3	*Stone Coal Ironstone, Rhuabon.* — Four courses (No. 6 to No. 9).		
		Stone Coal	2	9
		Half-yard Coal	1	6
138	4	*Two Yard Coal Ironstone, Rhuabon.*		
139	5	*Lower Yard Coal Ironstone, Rhuabon.*		
		Lower Yard Coal	3	0
140—145	6	*Wall and Bench Ironstones, Rhuabon.*—6 courses = 12½ inches (No. 12 to No. 17), lying in about 7 feet of ground.		
		Wall and Bench Coals	3	0
146—160	7	*Llwynemion Ironstones, Rhuabon.* — 15 courses (No. 18 to No. 32), averaging 30 inches, all worked with the coal in three lifts. Will yield 8,000 to 9,000 tons per acre.		
		Llwynemion Coal	1	6

The production of iron in this district is very limited: the coals are principally thin, but good in quality: and the ironstones, although lean, furnish very good iron. The only important works now in blast are the Rhuabon and the Brymbo. The Brymbo series appear by themselves.

SHROPSHIRE.

General No.	No. of Series.	—	Blast Furnaces.	
		Principal Works:—	In	Out
		Madeley Wood	3	.
		Madeley Court	2	1
		The Castle	1	1
		Light Moor	2	.
		Horse-hay	2	1
		Lawley	1	.
		Hinkshay	.	2
		Stirchley	4	.
		Dark Lane	.	2
		New Lodge	1	1
		Donnington	3	.
		Sneds Hill	2	.
		Langley	1	1
		Ketley	1	1
		33 Furnaces	23	10

SHROPSHIRE—*continued.*

General No.	No. of Series.	—		
		Strata.	Ft.	In.
161	1	*Chance Pennystone, Donnington Wood.*		
		Fungous Coal	3	0
162, 163	2	*Blackstone, Donnington Wood.*		
164, 165	3	*Brick Measure, Donnington Wood.*		
166, 167	4	*Ballstone, Donnington Wood.*		
		Top Coal	5	6
		Three Quarters Coal	2	0
		Double Coal	5	10
168, 169	5	*Yellow Stone, Donnington Wood.*		
		Yard Coal	3	0
170, 171	6	*Blue Flats, Donnington Wood.*		
172	7	*White Flats, Donnington Wood.*		
173—175	8	*Main Pennystone, Donnington Wood (No. 1), Madeley Court (No. 2).*		
		Sulphur Coal	7	0
		Clunch Coal	3	0
		Two Feet Coal	2	0
		Clod Coal	2	4
		Little Flint Coal	2	0
176	9	*Crawstone, Madeley Wood.*		
177	10	*Black Flats (position not given).*		

Annual production of iron about 90,000 tons. This field was one of the first important iron-making districts of the kingdom; but from its limited extent, the production of iron in it has remained, for a considerable period, nearly stationary. The quality which it produces is very good. The coal measures of Shropshire were probably once connected with those of South Staffordshire—indeed, of the identity of some of the measures in the two districts there can be little doubt. This is especially evident in the Whitestone and Cakes of the one, and the Pennystone of the other; and a great resemblance between all the measures of the two fields may also be traced, the difference in their thickness, &c., not being greater than might be expected at such distant points, judging from actual changes that are known to occur in some of the South Staffordshire beds, over comparatively a small space of ground.

SOUTH STAFFORDSHIRE.

General No.	No. of Series.	—	Blast Furnaces.	
			In	Out
		148 Furnaces	105	43
		Strata.—Dudley District.	Ft.	In.
		Brooch Coal	2	6
178—179	1	*Brooch Ironstone, Dudley.*		
		Little Coal (not worked.)		
180, 181	2	*Pins Ironstone, Dudley.*		
182, 183	3	*Penny Earth Ironstone, Dudley.*		
184	4	*Ten Foot Stone, Dudley.*		
		Thick Coal	30	0
185—187	5	*Grains Ironstone, Dudley.*		
	6	*Gubbin Ironstone, Dudley.*		
188		*Gubbin.*		
189		*Cannock.*		
190		*Rubble.*		
191		*Brown Stone.*		
		Heathen Coal	3	0
		Bottom Heathen Coal	2	6
192, 193	7	*White Ironstone Binds, Dudley.*		
194, 195	8	*White Ironstone, Dudley.*		
196, 197		*White Ironstone, Brockmoor.*		
198, 199	9	*Cakes, or Bluestone, Dudley.*		
		Sulphur Coal	4	6
		New Mine Coal	2	6
		Fire Clay Coal	2	6
200, 201	10	*Fire Clay Balls, Dudley.*		
		Bottom Coal	2	0

The Dudley Division of the South Staffordshire and Worcestershire coal-field is principally celebrated for the Ten Yard, or Thick Coal, so named from its being 30 feet thick, and which may well be termed, *par excellence*, "The Thick Coal." This is the largest and most important bed of coal in the kingdom, and is of excellent quality, both for household purposes and for the manufacture of iron. When undisturbed by faults, and of average quality, this bed of coal, with the associated thin coals and ironstones, is worth at least 1,000*l.* per acre. The quality of iron made is very superior. It was in this district that coal was first used, in the year 1619, for the purpose of smelting iron.

The Gubbin and White Ironstones are the principal ironstones of this district. The Gubbin measures will average about 1,500 tons per acre; the White Ironstone varies much both in quantity and richness. It yields from 1,000 to, occasionally, 3,000 tons per acre; 1,500 tons may be taken as about the average.

		WOLVERHAMPTON DISTRICT.	Ft.	In.
		Sulphur Coal . . .	2	0
		New Mine Coal . .	6	6
		Fire Clay Coal . .	9	0
202, 203	1	*Poor Robin's, Bunker's Hill.*		
204	2	*Fire Clay Balls, Bunker's Hill.*		
205	3	*Rough Hill White, Darlaston.*		
		Bottom Coal . . .	10	0
206, 207	4	*Gubbin and Balls, Bunker's Hill.*		
		Mealy Grey Coal . .	2	3
208, 209	5	*Blue Flats, Bunker's Hill.*		
210, 211	6	*Bristol Diamonds, Darlaston.*		

The space of ground occupied by the above measures from the Sulphur Coal to the Bristol Diamonds is about 90 yards. These measures occupy a position in the general coal series, below the Thick Coal of the Dudley District; and attain in the Wolverhampton Field a much greater thickness and importance than at Dudley, where scarcely any of the above measures of coal and ironstone prove workable. The ironstones are all of extremely good quality, averaging from 30 to 35 per cent. From the low cost at which they are generally raised, the number and variety of the measures both of coal and ironstone contained in so small a space of ground, and the superior quality of the iron produced, the Wolverhampton Division of the South Staffordshire coal-field may be considered as one of the most important, in proportion to its area, of any of our iron-making districts.

		BENTLEY AND BIRCH HILLS DISTRICT.
212, 213	1	*Brown Stone, Bloxwich.*—This is the only measure of Blackband in the South Staffordshire Coal-field. It lies underneath the lowest Heathen Coal, in two courses averaging about 12 inches, and does not prove south of Bentley. The other measures of this district do not vary greatly from those of Wolverhampton.

The annual production of iron in South Staffordshire and Worcestershire is nearly 600,000 tons. It is considered to be the second most important iron-making district in the kingdom, for although the production of pig-iron in Scotland is equal to that of this district, yet it far surpasses Scotland in the manufacture of wrought-iron; whilst the superior quality produced also gives it pre-eminence over that of Wales.

		Coventry and Bedworth Coal Field.
214, 215	1	*Bedworth Balls, Bedworth.*—Two courses, forming an exceedingly good and important measure of Ironstone, raised extensively for transport to the South Staffordshire Coal-field.

NORTH STAFFORDSHIRE.

General No.	*No. of Series.*	—	*Blast Furnaces.* In	Out
		PRINCIPAL WORKS :—		
		Silverdale	1	4
		Apedale	2	2
		Kidsgrove	3	.
		Goldendale	2	1
		Etruria	3	.
		Longton	2	1
		21 Furnaces . . .	13	8

NORTH STAFFORDSHIRE—*continued.*

General No.	*No. of Series.*	*Strata.*	Ft.	In.
		Gutter Coal . . .	2	6
		Red Shag Coal. . .	2	0
220	1	*Bassey Mine, Foley Colliery, Longton.*—Four courses; thickness 2 to 3 feet: in some places (as at Apedale) it attains the great thickness of 6 feet.		
		Bassey Mine Coal . .	2	3
		Spincroft Coal . .	4	0
		Great Row Coal . .	8	0
		Cannel Row Coal . .	5	0
221	2	*Wood's Mine, Foley Colliery, Longton.*—Four courses = 10 inches.		
		Wood's Mine Coal . .	1	0
222	3	*Deep Mine, Foley Colliery, Longton.*—Four courses.		
		Deep Mine Coal . .	3	9
223	4	*Chalky Mine, Foley Colliery, Longton.*—Four courses.		
224	5	*New Mine, Foley Colliery, Longton.*—Two courses.		
		New Mine Coal . .	1	8
225	6	*Hanbury Mine, Foley Colliery, Longton.*—Two courses.		
226	7	*New Ironstone, Foley Colliery, Longton.*—Five courses = 16 inches in 3½ feet of ground.		
		Knowles Coal . . .	6	0
227	8	*Prior's Field Mine, Foley Colliery, Longton.*—Three courses.		
228	9	*Knowles' Mine, Foley Colliery, Longton.*—Four courses = 2 feet 3 inches.		
		Bay Coal . . .	2	6
		Rider Coal . . .	3	0
		Ash Coal . . .	7	0
229	10	*Little Mine, Foley Colliery, Longton.*		
		Little Mine Coal . .	4	6
		Series from Shelton Colliery, Hanley.		
230 to 236	1 to 7	*Red Shag Ironstone. Gutter Mine. Bassey Mine. Penny Stone. Deep Mine. Chalky Mine. Gubbin Stone.*		
		Series from Apedale, near Newcastle.		
237 to 249	1 to 13	*Blackband Ironstone*—4 to 5 feet thick. *Red Shag*—6 feet thick. *Red Mine*—9 feet thick. *Bassey Mine*—7 feet thick. *Cannel Mine. Black Mine. Rusty Mine. Chalky Mine. Little Mine. New Mine. Brown Mine. Thickband. Gold Mine.*		

These last two series are not numbered according to their position in the coal measures. Many of them belong to the same measures as those of the Foley Colliery, Longton, although named differently.

The North Staffordshire coal-field, although not of great importance *directly*, as an iron-making district, its annual produce being only about 55,000 tons, is yet of great importance from the amazing extent of ironstone which it contains, and the large quantities sent thence to the South Staffordshire, and the North Welsh iron districts. No other known coal-field contains anything like an equal number and extent of ironstone measures. From the Bassey Mine to the Knowles Mine, a series of measures at the Foley Colliery, Longton, of only 250 yards in thickness, there are nine distinct workable measures of ironstone. At Apedale, the Blackband, Red-shag, Bassey Mine, and Red Mine, ironstones, are respectively 4, 6, 7, and 9 feet thick. In consequence of so large a proportion of the cheapest worked ironstone measures being Blackband or carbonaceous, and also from the inferior quality of its coals, the iron of this district is inferior. The thickness of the coal measures already known, is upwards of 1,100 yards, containing 32 seams of coal, varying in thickness from 5 inches to 8 feet. Of these, there are 14 beds below the Little Mine coal, all of which, excepting one, are from 2 to 7 feet thick.

YORKSHIRE.—(Northern District.)

General No.	*No. of Series.*	——	*Blast Furnaces.*	
		PRINCIPAL WORKS :—	In	Out
		Bowling	3	2
		Low Moor	1	2
		New Begin	2	0
		Shelfe	.	1
		Bierley	3	1
		Farnley	1	.
		16 Furnaces	10	6
		Strata.	Ft.	In.
	1	*White Bed Mine, Bierley.*—Yield per acre, 1,200 tons.		
300		Top Flats.		
301		Low Flats.		
302		White Balls.		
303		Middle Balls.		
304		Low Measure.		
		Coal	.	4
	2	*Black Bed Mine, Low Moor.*		
305		Top Balls.		
306		Flat Stone.		
307		Middle Balls.		
308		Rough Measure.		
309		Low Measure.		
310		Basset Stone.		
		Black Bed Coal	2	3
		Better Bed Coal	2	0

Annual production of iron about 25,000 tons. The quality of iron made, very superior. The Low Moor and Bowling marks are especially celebrated. The beds of coal in this district are exceedingly thin. The Better Bed Coal is the only one used for iron-making purposes. The White Bed and Black Bed Mines of this district probably correspond with the Thorncliffe White Mine and the Clay Wood Mine of the southern division of this field.

YORKSHIRE.—(Southern District.)

General No.	*No. of Series.*	——	*Blast Furnaces.*	
		PRINCIPAL WORKS :—	In	Out
		Worsbro' Dale	.	1
		Elsecar	.	3
		Milton	1	1
		Thorncliffe	1	1
		Chapeltown	1	1
		Holmes	1	1
		Parkgate	1	.
		13 Furnaces	5	8
		Strata.	Ft.	In.
		Low Wood, or Hobbimer Coal	9	6
311	1	*Swallow Wood Mine, Milton.*—Yields about		
312		1,500 tons per acre.		
313		Flats.		
		Balls.		
		Bottom Measure.		
		Swallow Wood Coal	4	9
314	2	*Ledgett Mine, Milton.*—Yields 1,800 tons		
315		per acre.		
316		Flats.		
		Balls.		
		Bottom Measure.		
317	3	*Tankersley Mine, Milton.*—Yields 4,000 tons		
318		per acre.		
319		Top Measure.		
		Middles.		
		Bottom Measure.		
		Deep End Coal	5	10
320	4	*Thorncliffe, or Old Black Mine, Parkgate.*—		
321		Yields 1,500 tons per acre.		
		Balls.		
		Holing Measure.		
		Parkgate or Manor Coal	7	6
322	5	*Thorncliffe White Mine, Parkgate.*—Yields		
323*a*		1,500 tons per acre.		
323*b*		Flats.		
		Balls.		
		Holing Measure.		
		Thorncliffe Thin Coal	3	0
324	6	*Black or Clay Wood Mine, Parkgate.*		
325		Balls.		
326		Brown George.		
		Whetstone.		
		Silkstone Coal	4	0
		Mortomley Coal	3	0

Annual production of iron about 20,000 tons. Thickness of measures from the Hobbimer to Mortomley beds of coal, about 430 yards. The entire thickness of the coal series is, however, much more. The measures thin out rapidly towards the north.

DERBYSHIRE.

General No.	*No. of Series.*	——	*Blast Furnaces.*	
		PRINCIPAL WORKS :—	In	Out
		Unston	1	.
		Renishaw	1	1
		Staveley	2	2
		Duckmanton	.	1
		Brimington Moor	1	.
		Newbold	1	.
		Wingerworth	1	1
		Clay Cross	1	1
		Morley Park	2	.
		Alfreton	2	1
		Butterley	2	1
		Codnor Park	2	.
		West Hallam	1	1
		Stanton	2	1
		29 Furnaces	19	10
		Strata.	Ft.	In.
		Yard Coal	3	6
327–334	1	*Measure and Balls Rake, Staveley.*—Yield per acre about 2,500 tons.		
		Whetstone; Flampards; White Measure; Cab; Old Bear; First Balls; Flat Balls; Bottom Measure.		
		Main Hard Coal	6	0
		Dunsill Coal	4	0
335–337	2	*Swallow Wood Rake, Stanton.*—Yield per acre 3,000 tons.		
		Tunnel Coal (*not worked*)	2	6
338	3	*Tan Yard, or Pender Park Rake, Staveley.*		
339		Yield per acre 2,000 tons.		
340		Red Measure.		
		Balls.		
		Cockle.		
341	4	*Ruff, or Cement Rake, Alfreton.*—Yield		
342		per acre 1,800 tons.		
343		Top Measure.		
		Balls.		
		Bottom Measure.		
344	5	*Brown Rake, Butterley.*—Yield per acre		
345		2,500 tons.		
346		Balls.		
		Top Measure.		
		Bottom Measure.		
		Thin Coal (*not worked*).		
347	6	*Black Rake, Butterley.*—Yield per acre		
348		2,000 tons.		
		Top Measure.		
		Bottom Measure.		
		Yard, or Ell Coal	3	6
		Main Soft Coal	5	0
349*a*349*b*	7	*Poor Rake, Alfreton.*		
350	8	*Blue Rake, Butterley.*—Yield per acre 900 tons.		
		Lower Hard Coal	4	6
351	9	*Spring, or Ridding's Rake, Alfreton.*		
352	10	*Dog-tooth Rake, Staveley.*—Yield per acre		
353		2,000 tons.		
354		White Measure.		
355		Sugar Plum Measure.		
356		Marble Measure.		
		Balls.		
		Snail Horn.		
		This rake is called Wallis' Rake, at Butterley, south of which it does not prove.		
357	11	*Brown Measure, Clay Cross.*—Yield per acre 800 tons.		
		Furnace Coal	4	6
358	12	*Nodule Rake, Morley Park.*—Yield per acre		
359		1,600 tons.		
		Cinder Measure.		
		Balls.		
		South of Clay Cross the Nodule Rake is known by the name of the Dog-tooth Rake.		
360	13	*Three Quarter Balls, Clay Cross.*		
		Three Quarter Coal	2	6
361–373	14	*Black Shale Rake, Staveley.*—Yield per acre from 4 to 8,000 tons.		
		Whetstone; Chitter; Cheeses; Bear; Top Blues; Lower Blues; Old Man; Old Woman; Double Chitter; White Balls; Flampards; Red Measure; Dun; Beams; Roof Measure; Bottom Balls.		

DERBYSHIRE—*continued.*

General No.	No. of Series.	—	Ft.	In.
374, 5, 6	15	*Striped Rake, Kirk Hallam.*—Yield per acre 2,500 tons.		
		Clod Coal . . .	5	6
377	16	*Green Close Rake, Morley Park.*—Yield per acre 1,000 tons.		
		Balls.		
		Bottom Measure.		
		Coal	3	0
378	17	*Holly Close Rake, Morley Park.* — Yield per acre 1,200 tons.		
		Balls.		
		Measure.		
379	18	*Black, or Ketland's Rake, Morley Park.*—		
380		Yield per acre 3,000 tons.		
381—383		Three Measures.		
384		Balls.		
385a385b	19	*Bacon Flitch Rake, Alfreton.*		
386	20	*Yew Tree Rake, Morley Park.*—Yield per acre 1,000 tons.		
		Coal	1	6
		Kilburne Coal . . .	5	0
387-394	21	*Honeycroft Rake, Stanton.*—Yield per acre 6,000 tons.		
		Chitters; Tufty Balls; Barren Beet; Grindstone Measure; Grinder's Wife; Big Balls; Bottom Flats; Brick Measure.		
395-399	22	*Civilly Rake, Stanton.*—Yield per acre 4,000 tons.		
		Rachell Measure; Chance Balls; Bottom Measure; Chitters; Coal Measure.		
		Furnace Coal . . .	2	3
404-404	23	*Dale Moor Rake, Stanton.*—Yield per acre 3,000 tons.		
		Clunch Balls; Roof Measure Balls; Roof Measure; Over Bottom; Bottom Balls.		

Annual production of iron about 60,000 tons. Average thickness of coal measures, from magnesian limestone to Kilburne, or lowest worked coal, 600 yards. Many of the beds of ironstone lie in such a thickness of measure as only to be workable to advantage by open work or bell-pits. Where these means of working can be adopted, the produce per acre is oftentimes very large; in the Honeycroft Rake it is 6,000 tons per acre; in the Black Shale 8,000 tons.

NORTHUMBERLAND, CUMBERLAND, and DURHAM.

General No.	No. of Series.	—	Blast Furnaces.	
		PRINCIPAL WORKS:—	In	Out
		Walker	2	.
		Tyne	2	.
		Wylam	1	.
		Hareshaw	.	3
		Redesdale	.	3
		Birtley	1	2
		Witton Park	3	1
		Taw Law	2	3
		Consett and Crookhead . .	7	7
		Stanhope	1	.
		38 Furnaces . . .	19	19
		Strata.	Ft.	In.
405	1	*Blackband, Hadley, Northumberland.*		
406, 407	2	*Blackband, Haydon Bridge.*—This bed probably occupies the position of one of the beds of coal underneath the Great Limestone, and forms an interesting instance of the manner in which thin beds of Coal sometimes change into beds of Blackband Ironstone. It averages, probably, three feet in thickness.		
408—410	3	*Ballstone, Haltwhistle, Northumberland.*		
411, 412	4	*Ballstone, Nent Head, Cumberland.*—These measures (Nos. 3 and 4) lie in the Plate bed over the Great Limestone, and in about 6 yards of ground: they have been worked extensively on some parts of the out-crop. Average yield 30 to 35 per cent.		

NORTHUMBERLAND, CUMBERLAND and DURHAM—*continued.*

General No.	No. of Series.	—	Ft.	In.
413	5	*Brown Hæmatite, Kilhope Fell, near Nent Head.* — This bed corresponds with the Fell Top Limestone bed of this district; which in this locality is converted into a bed of Brown Hæmatite, probably owing to its being intersected by a considerable number of small veins carrying iron "riders." It is from 3 to 7 feet thick, and of good quality.		
414, 415	6	*Brown Hæmatite, Nent Head.*—This bed corresponds with the little limestone bed of this district. It is about 7 feet thick, quality very variable.		
416, 417	7	*Brown Hæmatite, Silly Hole Vein, Alston.*		
418	8	*Brown Hæmatite, Manor House Vein, Alston.*		
419	9	*Brown Hæmatite, Nest Vein, Alston.*		
420	10	*Brown Hæmatite, Stanhope, Durham.*		
421	11	*Brown Hæmatite, St. John's Chapel, near Stanhope.*		
422	12	*Carbonate of Iron, Stanhope.*		
423	13	*Carbonate of Iron, Alston.*		

Annual production of iron about 90,000 tons. The iron works of this district are gradually increasing in importance, the cost of fuel being so low as to permit ores to be brought from many different localities. The black bands of Scotland, and of Haydon Bridge, the brown hæmatites, and white carbonates of Alston and Weardale, and the argillaceous ironstones of the lias of Whitby and Middlesborough, are all used for the supply of the iron works of this district.

The *brown hæmatites* deserve especial attention. They are found associated in very large masses, with the lead veins of this district, and occasionally they occur as distinct and regular beds. They contain from 20 to 40 per cent. of iron. Sometimes they exist as "riders" to the vein, sometimes they form its entire mass, and, in this case, they occasionally attain a thickness of 20, 30, and even 50 yards. Their employment for iron-making purposes is only recent, but the supply of ore which they can furnish is almost unlimited, and when some better means of separating the zinc and lead associated with them shall have been discovered, they will, doubtless, be found to be of great importance. Remarkable changes sometimes occur in the character of the metalliferous veins of this district; the same vein which at one point bears principally lead ore, changing to a calamine vein, and then again to brown hæmatite.

LANCASHIRE and WEST CUMBERLAND.

General No.	No. of Series.	—	Blast Furnaces.	
		PRINCIPAL WORKS:—	In	Out
		Cleator Iron Company . .	3	0
		3 Furnaces		
424-429	1-6	*Hæmatite, Cleator Iron Ore Co., near Whitehaven.*	Ft.	In.
430	7	*Hæmatite, Harrison, Ainslie, & Co., Ulverstone.*—Clay ore lying close to surface.		
431	8			
432	9			

The production of iron in this district is very limited, being confined to the Cleator Works, and one or two small charcoal works in the Ulverstone district. The quality of the latter, charcoal being used for fuel, is very superior, and the produce commands the highest prices, as it combines, with the fluidity of cast-iron, a certain malleability, especially after careful annealing. The iron of the Cleator Works is smelted with coal, and though, in consequence, not equal to the other, is yet of superior quality. The ore, both of the Whitehaven and the Ulverstone and Furness districts, is raised most extensively for shipment to the iron works of Yorkshire, Staffordshire, and North and South Wales. In quality, these ores may be considered as the finest in this kingdom, and the supplies which these districts are calculated to produce are very great. The large per centage of iron which they contain, from 60 to 65 per cent., and their superior quality, also enable them to bear the cost of transport, and they are becoming every day of greater importance. They are found, both as veins traversing the beds of the mountain limestone formation, transversely to the lines of stratification, and also as beds more or less regular. The former is the general character of the Ulverstone and Furness ores, no clearly defined bed being, as yet, known in that district, whilst at Whitehaven there are two, if not more beds of irregular thickness, but with clearly defined floors and roofs, and oftentimes sub-divided themselves by regular partings. These beds attain a considerable thickness, occasionally 20 or 30 feet. The area over which they extend is not as yet well known; but they have been worked extensively for many years, and the workings upon them are rapidly increasing. They lie beneath and close to the coal measures, which both furnishes the necessary fuel, and also important beds of argillaceous ironstones for admixture.

FOREST OF DEAN.

General No.	No. of Series.	—	Blast Furnaces.	
—	—		In	Out
		PRINCIPAL WORKS:—		
		Cinderford	3	.
		Forest of Dean Company . .	2	.
		5 Furnaces . . .	5	.
			Ft.	In.
433–438	1 6	*Hæmatite.*		

Annual production of iron about 30,000 tons. The ores of the Forest of Dean are Carboniferous, or Mountain Limestone ores, lying beneath the coal measures, which are not here productive in argillaceous ironstones as in the other principal coal-fields of the kingdom. Besides the limestone ore, there is a bed of ore in the Millstone Grit measures; but which is only worked very locally. The limestone ore occupies a regular position in the limestone measures, although in itself exceedingly irregular, assuming rather the character of a series of chambers than a regular bed. These chambers are sometimes of great extent, and contain many thousand tons of ore, which is generally raised at an exceedingly low cost, no timbering or other supports for the roof being required. The supply of ore producible in the Forest of Dean is almost unlimited. The iron made from it is of a red short nature, and especially celebrated for the manufacture of tin plates. Its superior quality always commands a high price. This ore is raised extensively for shipment to the iron works of South Wales. It was worked at a very ancient date either by the Romans or the Britons, as is evident from the remains of old workings along the outcrop of the ore bed. This ore averages from 30 to 40 per cent.

General No.	No. of Series.	—	Ft.	In
—	—	*Geological Formation: Granite and the Older Rocks.*		
439	1	*Compact Micaceous Iron Ore, Hennock, Devon.*—Found in lodes varying from 1 to 12 feet wide, bearing east and west. These lodes are in coarse-grained porphyritic granite. The ore is associated with Quartz, Clay, Schorl, and Hornblende. It contains 60 per cent.		
440	2	*Soft Micaceous Iron Ore, Hennock.*—Found associated with No. 1.		
441	3	*Magnetic Oxide, Haytor, Devon.*—Found inter-stratified with a compact Felspathic and Horblende Slate. It is associated with Asbestos, Actynolite, Garnet, Opal, Quartz, and Clay. It contains 70 per cent.		
442	4	*Compact Brown Iron Ore, Bishopsteignton, Devon.*—Found in irregular masses, in Limestone. It contains 60 per cent.		
443	5	*Compact and Crystallized Brown Iron Ore, Brixham, Devon.*—Found in irregular masses, in Limestone. It contains 55 per cent.		
444	6	*Red Hæmatite, Sheviock, Cornwall.*—Found in lodes in Clay Slate.		
445	7	*Brown Hæmatite, Sheviock, Cornwall.*		

The micaceous iron ores and the magnetic oxides of Dartmoor (Hennock, &c.) are only just beginning to be known. The quality of iron which they produce is of a superior description, and is calculated to make the finest steel. These ores are not at present raised extensively; but will doubtless become more so when their character is better known, and the localities in which they are found more thoroughly explored. They are sent principally to the South Wales Iron District.

General No.	No. of Series.	—	Ft.	In.
—	—	*Geological Formation. Granite and the Older Rocks.*		
446	1	*Pysolitic Iron Ore, Tremadoc, Cærnarvonshire.*		
447	2			
448	3			

These iron ores have, at different periods, been worked to a considerable extent for transport to South Wales. They are of inferior quality; but the large masses in which they lie, enable them to be raised at a very trifling expense. They are found at Tremadoc, Pwllheli, Cærnarvon, Island of Anglesea, and many other localities round the North Welsh Coast; and will doubtless at some period, prove of importance, from the great extent to which they are there developed.

General No.	No. of Series.	—	Ft.	In.
—	—	*Geological Formation. Grauwacke.*		
449	1	*Hæmatite, Brendon Hills, Somersetshire.*		
450	2	*Soft Hæmatite, Brendon Hills, Somersetshire.*—Found in lodes varying from 1 to 6 feet in thickness, in Grauwacke and Gray Slate. These lodes are not at present worked extensively; but they form the site of very old and extensive workings, probably by the Ancient Britons.		
		Geological Formation. New Red Sandstone.		
451	1	*Fine Hæmatitic Conglomerate, Newent, Gloucestershire.*		
452	2	*Hæmatitic Conglomerate, Newent, Gloucestershire.*		
453	3	*Hæmatitic Conglomerate, Brockwell, near Wotton Courtney, Somersetshire.*		
454	4	*Hæmatitic Conglomerate, Brockwell.*		
455	5	*Hæmatitic Conglomerate, Frampton Cotterell, Somersetshire.*		
456	6	*Hæmatitic Conglomerate, Cowbridge, South Wales.*		

These Hæmatitic conglomerates are found at the base of the New Red Sandstone, and generally occupy the position of its lowest bed. Their character as working ores is very variable, being sometimes mixed up with so much extraneous material as almost to be worthless; but occasionally they exist in regular beds, and contain so large a proportion of Hæmatite as to become of considerable importance.

General No.	No. of Series.	—	Ft.	In.
—	—	*Geological Formation. Lias, &c.*		
457	1	*Ironstone, Whitby.*		
458	2			
459	3			
460	4	*Ironstone, Middlesborough.*		
461	5			
462	6	*Silicious Ironstone, Saxelby, near Lincoln.*—Bed 2 to 3 feet thick.		
463	7	*Silicious Ironstone, near Northampton.*		
464	8			

The clay ironstones of the Lias are only just beginning to add to our iron-making resources. They furnish an instance of the unexpected development of national wealth, arising from the facilities afforded by railroads. Nos. 1, 2, and 3, are raised along the outcrop of the beds along the coast from Whitby to Scarborough. The cost of raising is trifling. Nos. 4 and 5 are from an important bed recently opened at Middlesborough. The thickness of the bed is very irregular, sometimes attaining a thickness of 12 or 14 feet, its average thickness is about 6 feet. Nos. 7 and 8 are from the Oolite, near Northampton. They are at present of no commercial value; but are curious, as showing the almost universal dissemination of this important ore.

General No.	No. of Series.	—	Ft.	In.
—	—	*Geological Formation. Green Sand.*		
465	1	} *Ironstone, Sussex.*		
466	2			

These specimens are of great interest, as belonging to the formation which was formerly one of our principal sources of iron; but which, furnishing with its ores no fuel to smelt them, was abandoned, upon the exhaustion of its forests, by the iron trade for the coal-fields, where all the requisites for this manufacture exist. Perhaps, like the lias of Whitby, &c., the Green Sand of Sussex may again, by means of railroads, at no distant period, furnish the iron trade with additional supplies of this important ore.

428 STIRLING, J. D. MORRIES, F.R.S.E., *Scotland, and 13 Great Cumberland Street, London*—Inventor.

Pig iron:—Scotch, hot blast. Same iron containing malleable iron—scraped process; patented in 1846. The same, a mixture of malleable and cast-iron melted together, and the pig (or ingot) broken to show the complete union of the metal.

Specimens of castings of the mixture, called "toughened cast-iron," and the breaking weights.

Improved patent malleable iron, showing the fibrous structure produced in iron naturally cold; short process—the addition of zinc or calamine to iron in the puddling furnaces. The strength of the iron is thus greatly increased.

Hardened, or anti-laminating iron for the top bar of rail, tires of wheels, &c. This iron, or alloy of iron, has the character of steel, is said to wear well, and not to laminate.

Rails composed of Nos. 5 and 6, to show the difference of the two sorts of iron. Tires of Nos. 5 and 6.

Bell metal, consisting chiefly of iron. Bells of the same metal, stated to be superior in tone to common bell metal, at a diminished cost.

Common zinc cake, broken to show the fracture. Zinc alloyed with about five per cent. of iron, to show the difference in fracture from the preceding.

Alloys of copper and other metals with the alloy of zinc and iron.—Patented in 1846-48.

Sheets of zinc, and alloy of zinc covered with tin, and alloys of tin.—Patented in 1851.

Sheets of iron covered with zinc, and alloys of zinc, and subsequently with tin, and alloys of tin.

Several other alloys and specimens exhibited for strength, structure, and cheapness.

[The report of the Commissioners appointed to inquire into the applications of iron to railway structures, gives the following as the results of experiments on Mr. Morries Stirling's iron, composed of calder iron. No. 1, hot blast, mixed and melted with about twenty cent. of malleable iron scrap, gave a breaking weight per square inch of section of 25,764 lbs., equal to 10·474 tons. Another specimen, composed of No. 1, hot blast Staffordshire iron, from Ley's works, mixed and melted with about fifteen per cent. of common malleable iron scrap, required a breaking weight as above, of 23,461 lbs., equal to 10·474 tons.—R. H.]

429 BANKART, FREDERICK, & SONS, *Redjacket Copper Works, near Neath, Wales*—Inventors and Manufacturers.

Various stages of the process of copper smelting, as practised at Redjacket Works, according to the exhibitors' patent process.

[This process is as follows:—Copper pyrites reduced to a fine state of division are roasted at a moderate temperature: the result is, that the sulphur of the ore combines with the oxygen of the air, and thus becomes converted into sulphuric acid. The copper is also oxidized; and the acid combining with it, a sulphate of oxide of copper is produced. A second roasting, with an addition of rich sulphur ore, converts all the metal into this salt. It is now dissolved in water, and the copper precipitated by iron. It has been found that the copper thus prepared is of remarkable purity.—R. H.]

Rees' patent fuel, prepared from coal alone.

Pure native carbon, found in the collieries of Messrs. Penrose and Starbuck, Vale of Neath, and electrodes manufactured from it by the exhibitors.

Stained glass window, executed by the exhibitors, containing a number of small pieces of glass united upon plate-glass. By this means the use of the lead joinings hitherto employed is obviated, and effects not hitherto attainable in this description of work are produced.

430 ABERCARN AND GWYTHEN COLLIERIES COMPANY, *Newport, Monmouthshire*—Proprietors.

Block of Abercarn stone; a hard compact sandstone which resists the action of the weather and of fire, and is one of the hard and durable stones found in the sedimentary rocks; it forms a part of the carboniferous (or coal-bearing) series of strata in South Wales. The block is formed in the shape of an obelisk, for the purpose of exhibiting on each face different modes of workmanship in the dressing of the stone.

Block of Abercarn and Gwythen charcoal-vein coal, adapted for steam-vessels; exported at Newport.

Block of Abercarn rock-vein coal.

Complete set of the tools used in raising these materials.

[The Abercarn stone, worked in the coal-grit of Monmouthshire, has an argillo-silicious cement, and is rather micaceous. There are 25 feet of workable stone, and large blocks can be procured. It is very durable, and not expensive. It weighs about 168 lbs. to the cubic foot. —D. T. A.]

431 WALES, J., *Newcastle.*

Model of coal mine, old flint wheel, and Davy-lamps.

432 WOOD, H. L., *Newcastle.*

Underground working of coal.

434 TAYLOR, R., *Falmouth*—Proprietor.

Model of the machinery and apparatus used for dressing the inferior copper ores called halvans, at the Tywarnhaile mines, the property of His Royal Highness the Prince of Wales, in the Duchy of Cornwall, consisting of—

Crushing mill, which pulverizes the ore more effectually than the common stamping mills.

Reservoir for receiving the pulverized mineral, and passing it, by the action of a stream of water, to the shaking trunk.

Self-acting shaking-trunk, in which the mineral is separated into proper sizes, for the subsequent processes, by means of a revolving cylindrical sieve, instead of the ordinary process of shaking or stirring it with shovels in a stream of water.

A tye, for cleaning the rough grain ore which does not pass through the cylindrical sieve, and preparing for sale part of the ore which settles at the head.

Double lever jigging machine, for dressing the poorer portion of the mineral from the tye, technically called the tails: by a single operation of this machine, the earthy matter is separated from the ore, and rendered fit for sale. With some qualities of halvans, the use of the tye is dispensed with, and the rough grain comes direct from the shaking sieve to the jigging-machine.

Round buddle, for dressing the fine-grained mineral, which passes through the sieve and settles in the shaking-trunk; the ore which it contains is rendered fit for sale by being twice buddled.

Slime pit, for receiving those portions of the mineral which are reduced to so fine a powder as to be carried away, in the shaking and other processes, by the stream of water.

Self-acting trunks, for removing a large proportion of the earthy matter contained in the slimes; when thus concentrated, the slime ore is rendered fit for sale, by being twice buddled.

Specimens of the mineral in its several states of preparation, and of the clean ore, accompany the model.

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435 RUEL, W. H., *Holborn.*
Crucibles for assaying, &c.

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436 MOREWOOD & ROGERS, *Steel Yard Wharf, Upper Thames Street.*

1. Patent galvanized tinned iron corrugated sheet, used in the erection and roofing of buildings; fire-proof, and not liable to be attacked by vermin. Possesses great strength, combined with lightness.

2. Patent galvanized tinned iron sheet, corrugated, and curved; used in the construction of roofs, verandahs, &c.

3. Patent galvanized tinned iron sheet, applicable to most of the purposes for which zinc, iron, or tin-plate are used.

4. (*Removed to Central Avenue.*)

5. Patent stamped tile of galvanized tinned iron, used for roofing of buildings. Is more easily fixed than any other kind of metallic roofing; is less liable to be disturbed by the wind, or otherwise get out of order; and also packs close for shipment

All the above possess the strength of iron, with perfect protection from rust.

6. Sample of exhibitors' patent tin-plate, more durable and cheaper than the ordinary tin-plate; used for many of the purposes to which tin-plate is applied, and is manufactured in various sized sheets up to 8 feet long and 3 feet wide.

7. Specimens of moulded gutters and architectural mouldings, made of exhibitors' patent galvanized tinned iron.

8. Samples of Morewood and Rogers's patent plumbic zinc. A new article, consisting of sheet zinc encased in lead; combines the strength of zinc with the power of lead in resisting the action of acids, &c.

9. Sample of patent ferric sheet lead. A new article, combining the pliancy (and power of resisting weather and acids) of lead with the strength of iron. Used for roofing, and other purposes to which sheet lead is applied. May be used much thinner than sheet lead, which renders it cheaper than that material, and it is not liable to pucker and crack from the action of the sun.

10. Sample of exhibitors' patent compound iron and copper wire, the copper being external; possesses the strength of iron combined with the durability and conducting power of copper. Used for electric telegraph and most purposes to which copper wire is applied.

11. Sample of exhibitors' patent compound iron and brass wire, the brass being external.

12. Sample of exhibitors' patent compound iron and lead wire; possesses the strength of iron with the durability and economy of lead.

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437 VIEILLE MONTAGNE ZINC MINING COMPANY. H. F. SCHMOLL, General Agent, 12, *Manchester Buildings, Westminster*—Producer.

Colossal statue of The Queen on her throne, in the attributes of royalty, eighteen feet high, in imitation of bronze, sculptured by M. Dantin, sen., and cast in zinc by M. Paillard, Paris. (*This is placed in the Nave—Foreign side.*)

Busts of The Queen and H.R.H. Prince Albert, life size, in imitation of bronze, sculptured by Francis.

Statuette of Sir Robert Peel, two feet high, in imitation of bronze, sculptured by Noble.

Eos, favourite greyhound of H.R.H. Prince Albert, life size, in imitation of bronze, sculptured by Francis; all cast in zinc by Karl Schröder, of London.

Model of sections of Her Majesty's ship "Albion," two-decker, of 90 guns, bolted with zinc bolts and painted with zinc paint; by Philip Trant, working shipwright of the Royal Dockyard, Plymouth; these bolts and butts do not rust like iron bolts; they have great strength and durability, and are cheaper than copper bolts.

Model of a frigate of 50 guns, sheathed with zinc and painted with zinc paint; also by Trant.

Designs in perforated zinc by Charles Jack.

Sundry specimens of zinc manufacture.

[Castings in zinc are bronzed in two ways; one is simply the application of a kind of paint, and the other is by producing on the surface an actual coating of copper by electro-chemical action. The use of zinc bolts is of very recent introduction; they appear less liable than iron to corrosion, unless they form part of a galvanic current, when they are rapidly destroyed. Zinc castings bronzed are very durable, and can be produced at a moderate cost. —R. H.]

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438 GLOVER, T., *Clerkenwell.*
Meters; and the large gas-meter for measuring the gas supplied to the building.

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439 BERGER, FREDERICK, 12 *Cornhill.*

Specimens of native red and grey-copper ores, from Trenance mines, Cornwall. These deposits were taken from the lode now working in the serpentine formation, being part of a slab of copper of 30 feet in length; produce 96 per cent. The grey ore produces 78 per cent.

[The general condition of copper in the serpentine rocks is curious. Fissures running through these rocks are filled in with heterogeneous matters, an occasional slab of native copper being found in the crack. It has not hitherto been usual to discover more than a few isolated patches of copper ore; and Trenance mine, on the junction of the serpentine with the Hornblendic slate, is a remarkable exception, producing native copper, the grey sulphuret of copper, and the red oxide of copper.—R. H.]

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440 BOLITHO, EDWARD, *Penzance.*

Model of a reverberatory tin smelting furnace and circular table, 51 inches in diameter. The table revolves on rollers. The model stands in the centre of the table, and is surrounded by specimens of various ores prepared for smelting, as well as products from the smelting works.

[Near this is placed a model of the dressing floors, in one of the mines of the Duchy of Cornwall, in which will be found illustrations of the mode of washing, &c. The tin ores containing arsenic and sulphur are submitted to a roasting process to expel these, and such as contain wolfram are treated by some chemical method, such as that devised by Mr. Oxland, and elsewhere described. The tin ores are then submitted to the smelting process, as shown in this model, a portion of carbon being employed to prevent the oxidation of the metal.—R. H.]

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441 LONGMAID, WILLIAM, *London*—Manufacturer.

Rock salt, chloride of sodium, from Cheshire. Ore, cupreous pyrites, containing sulphur, copper, silver, oxide of tin, iron, silica, &c., from Cornwall. Salt and ore, mixed and ground. Sulphate ash, the calcined product of the former, containing sulphate of soda, chlorides of silver and copper in a soluble state, and oxides of tin and iron, silica, and other insoluble matters. Bleaching powder, hypo-chlorite of lime, the chlorine of which is obtained by passing a current of dried air through a close furnace (heated externally) in which the ore and salt are in process of calcination. Silver and copper precipitate, and their produce. Glauber's salts, crystallized sulphate of soda. Salt cake, anhydrous sulphate of soda. Black ash, containing caustic and carbonated soda, sulphide of calcium, and coal. Crude alkali, the lixiviated product of crocus. Purified alkali, or carbonate of soda, obtained from the former. Crystallized carbonate of soda. Bi-carbonate of soda. Insoluble portion of sulphate ash. Crocus, oxide of iron, separated from the former by elutriation, iron the produce. Tin ore, bin-oxide of tin, obtained from the residual matters of the insoluble portion of sulphate ash, by further elutriation, as practised at the mines of Cornwall and Devon, in heating tin ores, tin the produce. Roman, or blue vitrol, sulphate of copper, obtained from copper precipitate, by oxidizing the precipitate and treating it with sulphuric acid. Carburetted oxide of iron. Black ash waste. Black and brown iron paint. Limestone, carbonate of lime.

[The following is a simple explanation of the essential details of this process:—

Copper pyrites (the double *sulphuret of copper and iron*) is combined with salt (*chloride of sodium*), and roasted at a certain moderate temperature. By this, a double decomposition is effected. Sulphate of soda is produced by the combination of the sulphur of the ore with oxygen, to form, first, sulphuric acid, which then unites with the soda of the chloride of sodium. The copper is also converted into a soluble sulphate, the iron being left in a state of per-oxidation, the chlorine liberated, which is employed in the manufacture of bleaching powder.—R. H.]

442 BREADALBANE, Marquis of, *Taymouth, Aberfeldy, Perth*—Producer.

Specimens from the copper mine of Tomnadashin, on the south side of Loch Tay, Perthshire.

443 REDRUTH LOCAL COMMITTEE, *Redruth*—Collectors.

Specimens of copper ore from various mines in Cornwall: illustrations of the various processes it undergoes in preparation for the market, together with the methods for determining the per centage of pure copper. Specimens of the stratum in which the ore is found.

No.	Description of Ore.	Mine.	Parish.	Stratum.
1	Yellow ore . . .	Alfred Consols	Gwinear	Slate.
2	Yellow with fluor spar.	Wheal Buller.	Redruth	Granite.
3	Yellow ore . . . (3–7)	Tywarnhayle .	Illogan .	Slate.
4		Wheal Buller.	Redruth	Granite.
5		East Crofty .	Illogan .	Slate.
6		Treviskey . .	Gwennap	Granite & Slate. (6–7)
7		South Frances	Illogan .	
8	Yellow, grey, and black	Carn Brea . .	Illogan .	Granite. (8–13)
9	Grey ore . . .	Treviskey . .	Gwennap	
10	Grey ore . . .	South Bassett.	Illogan .	
11	Black and grey . .	South Frances	Illogan .	
12	Black in Gosan . .	Wheal Buller.	Redruth	
13	Black in Gosan . .	South Frances	Illogan .	

[The county of Cornwall is the most important mineral district of the United Kingdom, for the number of its metalliferous minerals, many of which are not found in any other part of our islands. At a very early period of our history, mines were worked around the sea-coasts of Cornwall, of which the evidences are still to be seen at Tol-pedden-Penwith, near the Land's End; in Gwennap, near Truro; and at Cadgwith, near the Lizard Point. The traditionary statements that the Phœnicians traded for tin with the Britons in Cornwall, are very fairly supported by corroborative facts; and it is not improbable that the *Ictes*, or *Iktis*, of the ancients was St. Michael's Mount, near Penzance.

In the reign of King John, the mines of the western portion of England appear to have been principally in the hands of the Jews. The modes of working must have been very crude, and their metallurgical processes exceedingly rough. From time to time the remains of furnaces, called *Jews' houses*, have been discovered, and small blocks of tin, known as *Jews' tin*, have not unfrequently been found in the mining localities.

Till a comparatively recent date, tin was the only metal which was sought for; and, in many cases, the mines were abandoned when the miners came to the "yellows," that is, the yellow sulphuret of copper. The greatest quantity of tin has been produced by "streaming" (as washing the débris in the valleys is termed); and this variety, called "stream tin," produces the highest price in the market.

The conditions under which these deposits occur, are curious and instructive. At the Carnon Tin Stream Works, north of Falmouth, the rounded pebbles of tin are found at a depth of about 50 feet from the surface, beneath the bottom of an estuary, where trees are discovered in their place of growth, together with human skulls, and the remains of deer, amidst the vegetable accumulations which immediately cover the stanniferous beds. According to Mr. Henwood's measurement, the section presents first about 50 feet of silt and gravel; then a bed of 18 inches in thickness of wood, leaves, nuts, &c., resting on the tin ground, composed of the débris of quartz, slate, and granite, and the tin ore. At the Pentuan Works, near St. Austell, similar deposits occur, proving a material alteration in the level during the period expended in the formation of this deposit. Tin is also worked out of the lode in many parts, the ore occurring both in the slate and the granite formations. The modes of "dressing" the tin ore, preparing it for the smelter, and the processes of smelting, are illustrated in the Exhibition.

There has been a remarkable uniformity in the quantity of tin produced in Cornwall during a long period, as will be seen from the following table:—

Years.	Tons.	Price per Cwt. £.	s.
1750	1,600	..	
1760	1,800	..	
1770	2,000	..	
1780	1,800	3	0
1790	2,000	3	15
1800	1,500	5	0
1810	1,400	7	0
1820	1,700	3	5
1830	3,500	3	0
1840	5,000	3	15

The produce of this metal within the last few years has been as follows:—

Years.	Tons.
1844	7,507
1845	7,739
1846	8,945
1847	10,072
1848	10,176
1849	10,719

The copper mines, now so important, were so little worked until a recent period, that in 1799, we are told in a Report on the Cornish mines, that "it was not until the beginning of the last century that copper was discovered in Britain." This is not correct, for in 1250, a copper mine was worked near Keswick, in Cumberland. Edward III. granted an indenture to John Ballanter and Walter Bolbolter, for working all "mines of gold, silver, and copper:" but that the quantity found was very small is proved from the fact, that Acts of Parliament were passed in the reigns of Henry VIII. and Edward VI., to prevent the exportation of brass and copper, "lest there should not be metal enough left in the kingdom fit for making guns and other engines of war, and for household utensils:" and in 1665, the calamine works are encouraged by the Government, as "the continuing these works in England will occasion plenty of rough copper to be brought in."

At the end of the seventeenth century, some "gentlemen from Bristol made it their business to inspect the Cornish mines, and bought the copper for two pounds ten shillings per ton, and scarce ever more than four pounds a ton."

In 1700, one Mr. John Costar introduced an hydraulic engine into Cornwall, by which he succeeded in draining the mines, and "he taught the people of Cornwall also a better way of assaying and dressing the ore."

The value and importance of the copper mines since that period has been regularly increasing. During a term of about 30 years, 220 mines have sold their ores at the public sales. The following table, from a report by Sir Charles Lemon, Bart., M.P., represents the progress of copper mining, from 1771 to 1837:—

Years.	Tons of Ore.	Tons of Copper.	Total Value of Ore.	Standard Value per Ton.
			£.	£.
1771	27,896	3,347	189,609	81
1780	24,433	2,932	171,231	83
1799	51,273	4,223	469,664	121
1800	55,981	5,187	550,925	133
1802	53,937	5,228	445,094	111
1805	78,452	6,234	864,410	170
1808	67,867	6,795	495,303	100
1809	76,245	6,821	770,028	143
1812	71,547	6,720	549,665	111
1814	74,322	6,369	627,501	130
1816	77,334	6,697	447,959	98
1818	86,174	6,849	686,005	135
1821	98,426	8,514	605,968	103
1825	107,454	8,226	726,353	124
1827	126,710	10,311	745,178	106
1831	146,502	12,218	817,740	100
1837	140,753	10,823	908,613	119

The produce of the copper mines of Cornwall, since 1845, has been as follows:—

Years.	Ore in Tons.	Copper in Tons.	Money Value. £.	s.
1845	162,557	12,883	919,934	6
1846	150,431	11,851	796,182	6
1847	155,985	12,754	889,287	0
1848	147,701	12,422	720,090	0
1849	146,326	11,683	763,614	0
1850	155,025	12,254	840,410	0

With the improvements in the construction of the steam-engine, the facilities for working the mines have been increased. The first steam-engine employed in the county, was set to work at Huel Vor Tin Mine, near Helstone, in 1713, by Newcomen; but it was not until the reconstruction of the engine by Watt was effected, that steam power was generally employed for draining the mines. The rapid advance made by Cornish engineers in the perfection of their engines will be seen by the following return of the duty, that is, the performance of each, which is reckoned by the number of millions of pounds lifted a foot high by the consumption of a bushel of coals:—

Name of Mine.	Highest Duty.
Stray Park, 1813 . . .	29,000,000
Dolcoath, 1816 . . .	40,000,000
Consolidated Mines, 1822	44,000,000
Consolidated Mines, 1827	67,000,000
Fowey Consols, 1834 . .	97,000,000
United Mines, 1842 . .	108,000,000

A brief statement of the quantity of coals consumed per month, in a few of the principal mines, will show the extent to which steam power is now employed.

	Bushels of 94 lbs.
Fowey Consols, 1835 . . .	101,246
Godolphin, 1839	129,801
Fowey Consols, 1840 . . .	203,699
United Mines, 1842 . . .	84,862

Two examples of Cornish engines may be seen near the Metropolis, one at the East London Water Works, and the other at Brentford.

The lead mines of Cornwall have produced of the argentiferous sulphuret, during five years, the following number of tons of ore:—

	1845	1846	1847	1848	1849
Callington . . .	950	1,138	1,249	957	625
Huel Mary Ann . .	..	166	192	334	873
Cornubian . . .	420	..	..	..	..
E. and W. Haven .	16	..	..	..	..
Huel Trelawney . .	280	529	883	413	1,296
Camelford . . .	180	..	..	..	..
E. Huel Rose . .	7,883	5,191	6,424	5,333	4,758
N. „ . .	..	..	84	30	75
Cargol	55	306	954	964	505
Oxnams . . .	..	188	47	470	269
Huel Rose . . .	57	375	378	399	107
„ Penrose . .	116	11	..	..	..
Holmbush . . .	..	12	60	154	102
New Quay . . .	73	..	..	..	..
Porthleven . . .	8	82	..	..	..
Pentire	..	34	..	..	..
Cubert	..	136	354	68	..
Leman	..	30	73	..	..
Huel Concord . .	..	30	30	..	..
Huel Trehane . .	..	..	312	..	459
Herodscoombe . .	..	..	37	..	..
Herodsfoot . . .	..	..	375	721	1,050
Great Callestock Moors	..	..	109	..	..
Callestock . . .	..	..	116	179	..
Treyorden . . .	..	..	..	..	28
Huel Penhale . .	..	..	..	..	50
„ Golden . .	..	..	..	..	80
Cartheu Consols . .	..	..	..	..	45

The produce of zinc is not easily attainable, but it is now somewhat considerable, as is also that of arsenic, and of the iron pyrites, used in the manufacture of sulphuric acid.

The number of individuals employed in 59 Cornish copper mines, was computed by Sir Charles Lemon, in 1837, to be—

Men	10,624
Women . . .	3,802
Children . . .	3,490

The men alone work underground; the women and children are employed on the surface, picking and dressing the ore.

Mr. W. J. Henwood estimates the number employed at—

Men	18,472
Women . . .	5,764
Children . . .	5,764
	30,000

Beside the minerals peculiarly industrial, a very large variety of beautiful mineralogical specimens are produced in the county. A large trade in Kaolin—china clay—is carried on; and of the building and ornamental stones of Cornwall, granites, slates, porphyries, serpentines, and other kinds, a considerable variety in the natural state, and wrought into articles of use and ornament, will be found in the Exhibition. The accompanying map is intended to furnish information as to the metalliferous mineral wealth of Great Britain generally, and the site of different mines is represented by symbols which will render the map intelligible as a means of reference in studying the metalliferous minerals in Class 1.—R. H.]

444 GRYLLS, S., & REDRUTH COMMITTEE.
A large mass of copper pyrites.

445 LEAN, J., *West Caradon Mine, Liskeard.*
Grey and native copper ore.

446 PUCKEY, JOHN, *St. Blazey, St. Austell*—Agent.
Mass of copper ore, about 1,500 lbs. in weight, from Par Consols mine, St. Blazey, Cornwall. This specimen contains some quartz and chlorite, and shows the "walls" and inclination of the lode.

[The produce of this mine for some years has been as follows:—

Years.	Ore in Tons.	Copper in Tons.	Cwts.	Total Value. £.
1845	5,655	464	10	30,881
1846	6,065	557	12	35,144
1847	6,101	625	10	42,953
1848	8,470	914	8	52,353
1849	12,228	736	9	47,249
1850	7,152	641	2	44,090

—R. H.]

447 WELLBORNE, W., *Bodmin.*
Iron ore.

448 TAYLOR, J., *Cornwall.*
Iron ores from Restormel.

449 DREW, JOSEPH, *St. Austell.*
Iron ore, magnetic and oxidulated, from the Trerank mine, near St. Austell. Brown hæmatite, from the same mine. Iron ores. Red hæmatite, from Treverbyn mine.

450 BENNETT, CARR, & CO., *Moorgate Street.*
Copper ores, gossan, &c., St. Brenard, Cornwall.

451 TAYLOR, R.
Mining tools, as used in the Cornish mines.

452 DUCHY OF CORNWALL.
Sections of Cornish copper mines.

453 DEVON GREAT CONSOLIDATED COPPER MINING COMPANY—*Tavistock.*
Specimens of copper ore.

454 SECCOMBE, SAMUEL, *Phœnix Mines, Liskeard*—Producer.
Specimens of tin and copper ore, and gozzar. Pieces of copal and of the stratum from the side of the lode.—All from one lode in Phœnix mines in the parish of Lenkinghorne, near Liskeard.
Fire-bricks.
Specimen of native copper from West Caradon mine.
Piece of barytes from Wheal Mary Ann.

455 WELLBORNE, W., *Bodmin.*
Tin ore and tin.

456 READWIN, T. A., *Winchester Buildings.*
Tin stone, from Wheal Augusta, St. Just.

457 DIAMOND, J., *Tavistock.*
Tin ore, from Wheal Mary.

457A BIRD, JOHN, *Wallwyd, Merioneth, Wales*—Proprietor.
Specimen of silver lead ore, weighing 350 lbs., containing 16 cwt. 3 qrs. 10 lbs. of lead per ton, 82¾ oz. of silver per ton of lead, extracted from the great Cowarch silver lead mine, which has been in work seven years, and is situate on the Browddwy estate, the property of the exhibitor. Exported from Aberdovey, North Wales.

458 COLLETT, W. R., *Limerick.*
Copper ore, from the River Shannon.

459 BLEE, ROBERT, *Redruth*—Inventor.
Safety bucket to be used in mines for drawing up persons or produce. This bucket is furnished with guides to run in grooves which extend along the whole depth or shaft of the pit. To the guides are fixed strong crooks to which the drawing-rope is attached. So long as the tension of the rope continues, the crooks are held in over the bucket. Should the rope break, and its tension consequently cease, the crooks are immediately thrown out by springs, which constantly act on them, and cause the crooks to take hold on the iron staves of strong ladders fixed at the back of the grooves throughout their length.

460 POLKINGHORNE, W., *Fowey Consols Mine, Tyewardreath*—Inventor.
Synopsis exhibiting the standard, produce, price, and quantity of Cornwall and Swansea copper ores sold, amount of money realized, and the quantity of fine copper produced.

461 MICHELL, F.
Pick for dressing granite.

462 ARTHUR, J.
Apparatus for lifting pumps from mines full of water.

462A BOYD, C., 15 *Addison Road, Kensington.*
Mineral washing case, invented by John Hunt.

463 EDDY, J.
Apparatus for lifting pumps.

464 TRESIZE, T., *Perran Foundry.*
Model of improved smelting furnace.

465 VINCENT, T., *Redruth.*
Model of a steam-engine by a working miner.

466 HOSKING, R., *Perran Foundry, Falmouth.*
Model of compound valve for pumps.

467 TRURO LOCAL COMMITTEE.
Articles illustrating lead, from East Wheel Rose, near Truro, Pentire Glaze, near Wadebridge, and other Cornish mines.

[Wheel, or wheal, appended to the names of most of the Cornish mines, is a corruption from an old word, probably Cornish, Huel, which was employed to signify a mine.

East Wheel Rose has proved the most productive lead mine in the west of England, the returns of lead from this mine being for a few years as follows:—

Years.	Ore in Tons.	Lead in Tons.
1845	7,883	5,191
1846	4,729	3,114
1847	6,424	3,854
1848	4,758	2,856
1849	5,333	3,191.—R. H.]

468 TRURO LOCAL COMMITTEE.
Articles illustrating tin, from various Cornish mines (supplied by George Nicolls Simmons, Mr. Henry Bor-

row, of Truro; Capt. Webb, of St. Austell; Capt. Evans, of St. Agnes; Mr. J. N. R. Millett, of Penzance; and other gentlemen, from Great Beam Mine, near St. Austell, Budnick Mine, in Perranzabulal, Rocks Mine, in St. Agnes, Friendly Mines, in St. Agnes; Mineral Court Mine, in St. Stephen's, and from various mines in the Penzance district), exhibiting the ore in its various stages until it leaves the miner's hands as black-grain tin. A block of white tin very free from impurity, the produce of Mineral Court Mine, supplied by the adventurers, and a rude smelted block of tin supplied by Mr. G. N. Simmons, found in Ladock, near Truro, and supposed to have been smelted when the Phœnicians traded to Cornwall for tin.

[Tin appears to have been raised in Cornwall from a very early period. Traditionary evidence, supported by strong corroborative facts, appears to prove that the kingdoms around the Mediterranean Sea were supplied with tin from Cornwall by the Phœnician merchants at a very early date. The circumstance of this metal being found in the beds of streams, and in deposits at the base of the primary rocks, from which it could be obtained without much labour, may have been the cause of its being early known to the Britons.

The oxide of tin is usually found deposited in beds in water-worn pebbles, and mixed with the debris of the neighbouring hills. There can be but little doubt that these tin deposits are the result of the disintegrating action of the atmospheric causes and of water; some of the tin beds, 30 or 50 feet from the present surface, contain vegetable matter, as branches of trees, and large logs of wood; and at Carnon stream works, human skulls were discovered amidst the debris, 53 feet below the surface.

Tin is also found in the lode, either as peroxide, cupreous-sulphuret of tin, or tin pyrites, the analysis of the peroxide giving—peroxide of tin, 96·265; silica, 0·750; peroxide of iron and manganese, 3·395.

Many indications of early tin-mining are to be found in Cornwall. Peculiar furnaces of a very rude description are sometimes discovered, these are known as Jews-houses, the trade in tin having been for a long period in the hands of the Jews; and blocks of this metal, such as the one exhibited, are called also Jews' tin. For many centuries the Dukes of Cornwall drew a large revenue from the tin produced in the county. The tin when smelted into blocks was forwarded to the nearest coinage town, there to be stamped by the Duchy officers, who cut a piece off the corner of each block, which was retained as the Duchy's dues. In 1337, Edward the Black Prince was created Duke of Cornwall, and then the average profit of the coinage was 4000 marks per annum. In 1814, the revenues to the Duchy from tin was about 8,500*l.*, and the average tin revenue from 1820, to the abolition of the coinages in October, 1838, has been estimated at 12,000*l.*, per annum. In 1750, about 2,000 tons of tin were produced in Cornwall, and in 1838 about 5,000; since that period the quantity cannot be accurately ascertained, the trade in tin being in the hands of a few, and the purchases of ore being usually made by private contract.—R. H.]

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469 LOCAL COMMITTEE, *St. Austell*—Collectors.

Alluvium, in which stream tin ore is found. The ore as prepared for sale. Specimens of pebbles of tin ore.

Building stones from the vicinity of St. Austell, prepared in cubes.

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470 WELBORNE, J. W., *St. Austell, and* 38 *Albemarle Street*—Manager.

Slab of rosin tin ore, from the Par. Consols mine, near St. Austell, Cornwall.

Stone of the magnetic oxide of iron, from Roche Rock iron mine.

Sulphuret of copper, or yellow copper ore, from Bodmin Wheal Mary Consols, near Bodmin.

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471 WHITE & GRANT, *Dalmarnock Road, Glasgow*—Inventors and Manufacturers.

Patent safety cage and detaching catch for mine-shafts, to prevent accidents from the breaking or over-winding of ropes or chains.

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472 HOSKING, R., *Perran, Cornwall.*

Reversing apparatus, for horse whim and stamping machinery.

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473 SWANSEA COMMITTEE, *Swansea*—Manufacturers.

Specimens of copper ore, and of calcined ore, blistered and refined copper, &c.

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474 TAYLOR, JOHN, *London.*

Collection of rare and metalliferous metals.

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475 THORNE, WILLIAM, *Barnstaple*—Proprietor.

Pseudomorphic spathose iron, showing the structure of box and slipper specimens; yellow sulphuret of copper; peacock copper; foliated mundic and crystallized white quartz; from the Virtuous Lady Mine, near Tavistock, Devon.

[These singular formations are due to the deposit of the sulphuret of iron upon crystals of sulphate of lime, which have been dissolved out subsequently. They have been rarely met with in any other mine.—R. H.]

Crystallized white iron, with lead and Fahlertz ores, containing silver, from the Combmartin Mines, in North Devon.

Specimens of killas, or clay slate, white iron, crystallized white quartz, mundic, and lead and Fahlertz ores, from the Wheal Golden Mine, Perranzabuloe, Cornwall.

Hydraulic cement and raw mineral paint, from Bickington Quarry, near Barnstaple, Devon.

Ashlar-stone, hone-stone, clay, and granite gravel, from Tavistock, near Barnstaple.

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476 GOODHALE & REEVES, *for the Ringerige Nickel Work, Vigersund, viâ Drammen, Norway*—Proprietors and Producers.

Nickel ore; from mines in the district of Ringerige, in Norway (about thirty miles north-west from Christiania), worked only last year: containing 2·80 per cent. nickel, with 40·46 sulphur, 56·03 iron, and 0·40 copper.

[The Norwegian mines have lately attracted much attention in this country on account of the cobalt and nickel ores they contain.—R. H.]

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477 JOHNSON & MATTHEY, 79 *Hatton Garden*—Manufacturers.

Specimens of metals and metallic compounds:—Platinum crucibles, with capsule covers; and with ordinary covers. Capsules, spatula, and large basin of this metal; oxide and sponge platinum.

Palladium; part of an ingot; a cup, soldered with fine gold; another, smaller, raised with the hammer; alloy of silver and palladium used by dentists and philosophical instrument makers; oxide of palladium; and its salts, red and yellow.

Iridium; pure metallic in vase; and the native alloy, as used for nibs of pens; its oxide and salts.

Rhodium; metallic in vase; its crystal of sodo-chloride; oxide; and phosphuret.

Uranium; its oxide; glass vessel showing the colour produced by the oxide of uranium.

[Platinum was discovered by Ulloa in 1735, but it was first rendered available by Dr. Wollaston. The largest supply of the metals platinum, palladium, iridium, rhodium, and uranium, is obtained from the Uralian Mountains; some is procured from the alluvial deposits of Brazil and other parts of South America. These metals, except uranium, are commonly found combined. Uranium is procured from pitchblende, uranite, and other minerals found in Cornwall and Bohemia.—R. H.]

[The colour produced by mixing a minute portion of the oxide of uranium in a mass of molten glass is one of the most beautiful colours obtained by art. It is a charming golden green of an opalline lustre so peculiar as to distinguish it from all other colours in glass.—R. E.]

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478 Pimm, Henry, & Co., 29 *Newhall Street, Birmingham*—Manufacturers.

Gold and silver leaf, and bronze powders.

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479 Mathison, G. F., *Royal Mint Refinery.*

Sulphuric acid process of separating gold, silver, and copper.

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480 Pattinson, Hugh Lee, *Newcastle-upon-Tyne*—Inventor.

Specimens to illustrate the exhibitor's process for the separation of silver from lead: viz., original lead; crystallized lead; slabs of lead, to show the form of the crystals; rich lead; plate of silver obtained by submitting rich lead to cupellation. Large drawing to illustrate the process.

[This process of desilverizing lead is founded on the physical fact, that lead crystallizes at a temperature above that at which silver solidifies, and in this process of aggregation, the silver is separated from the commoner metal. It is effected by the use of hemispherical cast-iron pans, holding about three tons of metal, which are heated by a fire below them; the argentiferous lead is placed in these, and melted, after which the fire is withdrawn, and all made air-tight below. The workman now begins to agitate the mass, which he does with an iron rake, removing the solid parts from the edges, as solidification takes place. With an iron strainer the solid crystals are removed as fast as they are formed; these are nearly pure lead, the liquid mass left behind being rich in silver. This process is repeated three or four times, the mass left after the last operation, which contains from 3 to 400 ounces of silver to the ton, is then submitted to the process of cupellation, by which the lead is oxidized, and the silver left in a state of purity behind.

By the original method, lead ores containing less than 20 ounces of silver to the ton scarcely paid the expense of working. By this process, ores containing only three ounces to the ton, are made to yield their silver.—R. H.]

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481 Hallett, George, *Broadwall, Blackfriars*—Manufacturer.

Antimony. Sulphuret ore, from Sarawak, Borneo, Leghorn, Tuscany; oxide ore, from Algeria. Refined sulphuret of antimony, commercially known as "Crude Antimony:" used in medicine, dyeing, pyrotechny, and chemistry.—Metallic antimony, commercially known as "Regulus," with fracture shown; designated as "Best bowl Regulus." Metallic antimony, more highly refined, exhibiting its naturally crystallized, or fernlike surfaces, and its fracture; commercially known as "Best French quality Regulus."—Used principally to harden other soft and ductile metals; viz., with lead and tin for printing types; with copper and tin (and sometimes lead), for Britannia or Queen's metal, pewter wares, &c. Melted with tin, it has of late been used as an anti-friction alloy, for railway axles and other bearings, in metallic rings or collars for machinery, &c. As this alloy is not so much heated by friction as the harder metals, less grease is consumed.

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482 Hunt, John—Inventor.

Mineral washing-case, constructed for the washing of gold, silver, lead, tin, copper, and mineral ores in general.

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483 A Collection of Minerals,

Contributed by agents and workmen connected with the lead mines of Allendale, Alston Moor, Weardale, Caldbeck, and Keswick, including 170 specimens, arranged and cemented together by Mr. Isaac Robinson, of Nenthead, for the Great Exhibition of 1851, under the general superintendence and direction of Mr. T. Sopwith, and a Committee of Mining Agents connected with the above districts.

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484 Sopwith, Thos., F.R.S., &c., *Allenheads, Durham*—Producer.

Specimens of lead ores and associated minerals, with examples of the various stages of progress, from their being excavated in the mine and carried through the several departments of washing and smelting, until furnished and ready for the market in the form of a cake of silver, and a pig, or piece of lead, known as W. B. Lead.

The specimens of minerals usually associated with lead ores are collected from various mines, and are fitted together in a separate case, under the direction of the exhibitor, by Messrs. Cain and Wallace of Nenthead, and others.

The general arrangement of the strata in which these ores and minerals are found, is exhibited by a section of part of the lead-mining district belonging to Wentworth Blackett Beaumont, Esq., at Allenheads, in the county of Northumberland, and from whose mines the specimens of lead ores and examples of processes *during conversion into lead and silver* are taken; and a further illustration of the geological structure of this part of England is given by an isometrical plan and section by the exhibitor, showing a considerable tract of mining ground in the manor of Alston Moor, in the county of Cumberland.

The principal phenomena of mineral veins and displacement of the strata in which lead ore is obtained in the north of England, are shown by dissected models invented by the exhibitor, and examples of the finished products are contained in a separate case, from Mr. Beaumont's smelt-mills, under the direction of his agent, Mr. Thomas Steel.

This collection, the general nature of which is here briefly indicated, is intended to illustrate the geological position and usual products of the north of England lead-mines. The following is the order of the five several portions, and which are more particularly described under these several heads in the sequel:—

I. Sections of Strata at Allenheads and Alston.
II. Models to illustrate Mineral Veins, etc.
III. Minerals associated with Lead Ores.
IV. Examples of the various stages of progress from the Mine to the Market.
V. Lead and Silver prepared for Sale.

I. As the express object of this collection is to afford a general view of the whole of the principal features relative to the extensive and important departments of British industry connected with lead-mining, and as this information is more expressly intended for the use of those who are not locally conversant with the physical conditions under which lead ores are usually obtained, the exhibitor has, in the first instance, thought it necessary to present clear and distinct views of the geological structure of the district in which the chief lead-mines of the north of England are situated, in order that, without going into purely technical details, which are only of local interest, the several strata and order of superposition may be readily understood.

As an approximate comparative view of produce, it may be considered that the lead raised in Mr. Beaumont's mines amounts to about one-fourth of the quantity raised in England, about one-sixth of the produce of Great Britain, and about one-tenth of that of the whole of Europe, including the British Isles. They have been extensively worked from time immemorial; part of them are situated in the manors belonging to Mr. Beaumont in the dales of East and West Allen, in the south-west part of Northumberland, and others are situated in the wild district of moors which forms the western extremity of the county of Durham.

This part of the country happens to be at once the centre of the island of Great Britain, and by far the most elevated part of it, which is thickly populated, for, scattered over hills and dales which present an aspect of verdant cultivation, mixed with heathy moors, are to be found some thousands of inhabitants, nearly the whole of them either employed in lead-mines or smelting-mills, or indirectly deriving a livelihood from some connection with lead-mining business. Allenheads forms a central position in the midst of these mines, and the agent's house, shown on the section, is exactly 1,400 feet above the level of the sea, and is the highest house of its magnitude in Great Britain,—nor are many of the cottages of shepherds, and other moorland habitations, of greater elevation.

The datum, or base line of the Allenheads section, is 700 feet above the level of the sea. The drawing, 16½ feet in length, is on a true scale of 100 feet to an inch; by a true scale being meant, that the lengths and heights are projected to the same scale or proportion, so that a true miniature profile of the country is given, as well as a correct reduction of the relative size of the various rocks. The extent of country thus shown is not quite 4 miles, being 3 miles 1,220 yards.

The spectator is supposed to be looking to the north, and the section commences at a point about half a mile eastward from a place called Kilhope Head, which is conspicuously marked in all English maps, inasmuch as the three counties of Northumberland, Durham, and Cumberland all meet in one spot. At about three-quarters of a mile from the point of commencement, the section represents the hill called Kilhope Law; it is on the boundary line of the counties of Northumberland and Durham, and is the highest point of land in the last-named county, being 2,206 feet above the level of the sea. But out of the limits of this section, and about 10 miles south-west from Kilhope Law, the same strata which are here delineated reach an altitude of 2,901 feet above the sea, and this is the highest elevation attained by the rocks which form the carboniferous or mountain limestone of the north of England.

Such being the stratification of the central portion of the narrow part of the island of which the coal-fields of the Tyne and Wear form the extremity on the east, bordering the German Ocean for some distance north and south of Newcastle, while a similar coal-field is found at the western extremity near Whitehaven, it may be observed, with reference to these coal-fields, that they lie over or upon the mountain limestone formation. The coal-beds so extensively worked in the Newcastle and Durham coal-mines, or collieries, gradually rise to the west, and one by one crop out, or bassett, according to the undulations of the country. At length, at about 20 miles west of the German Sea, the lowest of the coal-beds crops out, and from beneath it gradually appear the limestone strata, which continue to rise nearly coincident with the general rise of the country until they reach the summit of Cross Fell (2,901 feet); and this general and very gradual inclination of the strata, a feature of the greatest importance in practical mining, is clearly and accurately delineated in this section.

In a thickness of about 2,000 feet of the alternating beds of sandstone, clay, and limestone, which form the strata of the mining districts of Allendale, Alston, and Weardale, there is one single stratum of limestone called the "great limestone," the veins in which have produced nearly, if not quite, as much ore as all the other strata put together. This stratum is delineated on the section, and may be observed lying at a depth of about 850 feet below the summit of Kilhope Law. Somewhat exceeding 2 miles eastward of this, at Allenheads the top of the great limestone is 230 feet from the top of a shaft called Gin-hill Shaft. Its thickness, which is tolerably uniform over several hundred square miles of country, is about 60 feet, and it is from this stratum of limestone that nearly all the specimens in this collection have been obtained.

The dislocations of strata which constitute for the most part important mineral veins, are exhibited more in detail in the series of geological models which form a part of this collection; but some of the great features of displacement may be noticed on the section.

At about a quarter of a mile to the west of, or left-hand direction from, Kilhope Law, the great limestone and all other associated beds are thrown down a depth of about 150 feet for a space of nearly 700 feet; and again, at the distance of nearly a mile from Allenheads, a vast dislocation takes place, by which the great limestone, it will be seen, is brought nearly to the surface, the amount of displacement being about 400 feet. It is in the great limestone that by far the most extensive portion of the workings of Allenheads lead-mines are situated, and the galleries drawn on the section convey a general idea of the position of the mines. In a great thickness of strata above the great limestone only two beds of that rock are found. One of these is called "little limestone;" it is from 10 to 12 feet thick, and is 75 feet above the top of great limestone; the other is still more inconsiderable, being only 3 or 4 feet thick, and is 440 feet above the great limestone. It is remarkable with what exactness this thin bed is found near the summit of hills, the intervening spaces having apparently been removed by denudation, so as to form in one case a gap of 6½ miles, and in another of 1¾ miles, in which the Tell Top limestone is entirely cut off.

But beneath the great limestone, as will be seen by the lines of blue colour, are several beds of the same description of rock, viz., at distances respectively of 30, 106, 190, 250, and 287 feet, and the thickness 2, 24, 10, 15, and 35 feet. These are known by descriptive local names, and comprise all that are of significance as regards lead-mining operations.

The Allenheads mines being situated for the most part at depths from the surface varying from 200 to 600 feet, are drained partly by ordinary water-wheels, some of which are shown on the section, and partly by the new hydraulic engines invented by Mr. W. G. Armstrong, and four of which are now in use for draining and other mining purposes at Allenheads mines.*

The isometrical plan and section of Nentsberry, by the exhibitor, is intended to exemplify the manner in which isometrical projection may be used in the delineation of mines and mining districts. In ordinary plans and sections, only one plane, or set of parallel planes can be truly represented, but by this method of projection three several planes may be combined in one drawing, and lines crossing at right angles, as, for instance, north and south lines intersecting east and west lines, may be correctly projected, and vertical lines added on the same projection.

The area represented by this drawing is about one-fourth of a square mile, each side being nearly half a mile in length. It is situated on the River Nent, midway between the source of that river at Nenthead and the market town of Alston. It includes some of the most interesting and prominent features of the strata and mines in that district, and amongst others the aqueduct called Nentfine Level, originally projected by the celebrated Smeaton, the engineer, who held the agency of these mines in 1775.

A copy of this section is deposited in the Government Office of Mining Records, and a further account of the several mining and other details is given in vol. ii. of "The Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne."

II. Models to illustrate Mineral Veins.—Plans

* *See* Transac. Civil Engineers, 1850 and 1851.

and sections, although of great use, and indeed indispensable for all well-conducted mining operations, are yet incapable of conveying information relative to solid forms in so complete a manner as may be accomplished by the use of models, which are, in fact, a reduced representation of the actual form of objects. The utility of models is further increased when they are made in separate portions, so as to admit of being dissected and put together again. By this means, not only the surface of the earth, but even the interior of mines may be correctly represented.

The models contained in the series now exhibited are exact duplicates of a series made for the Museum of Practical Geology, and copies of which, on a smaller scale, are published. The details which accompany the published models may be had separately; and the following catalogue briefly indicates the principal points illustrated, as having a bearing upon the lead-mining districts :—

Model No. 1 represents a square mass of part of the carboniferous, or mountain limestone strata. The little and great limestone are both represented in this model, and the upper portion admits of being removed to show the result of the extensive denudation which is so conspicuous throughout the mining dales of the north of England.

Model No. 2 represents the principal seams or beds of coal in the district east of the lead-mines of the north of England, and situated, as regards geological sequence, above the mountain limestone strata.

Model No. 3 separates into four sections, in order to illustrate the displacement of strata by what is called the "throw" of mineral veins, and the effects of denudation, which take away all surface indications of such displacement.

Model No. 4 is intended to illustrate the deceptive appearances which are often presented at the surface by the successive outcrop of the same beds of coal, limestone, or other strata. Conditions which require the most careful considerations in agriculture as well as mining, and which are especially deserving of attention in the exploration of newly discovered lands.

Model No. 5. Dislocations of strata require not only to be studied as regards the virtual section, but also as regards both horizontal and inclined planes. Whether the object of search be coal, limestone, or any other member of a series of stratified rocks, it will be obvious, on examining the divisional plane of this model, that an adit or level may be driven upon this plane so as to intersect the desired stratum, or wholly avoid it.

Model No. 6. This represents the intersection of mineral veins and the disruption of strata caused thereby. The apparent shifting of a vein from its ordinary bearing is here shown to be only a result of ordinary mechanical displacement.

Model No. 7 represents the surface denudation of mineral veins, by which an apparent complexity of form is introduced, as regards the outline of the strata on the curved contour of the surface.

Models 8 to 12 represent various conditions of stratified rocks in relation to their inclination, as compared with that of the surface, presenting conditions highly explanatory of facts which are of constant occurrence in mining, and of the first importance in geological surveys; but any detailed explanation of such phenomena would exceed the proper limits of this description.

III. Minerals associated with Lead Ores.—The plans, sections, and models already described convey a general idea of the geological and mining conditions of the district from whence the specimens illustrative of lead-mining have been chiefly obtained. The remainder of the collection is arranged with a view to exhibit, first, the productions upon which the industry of the lead-miner has to be exercised; secondly, the processes by which he renders these productions fit for use; and thirdly, the results of his labour.

In considering the best manner of following out any classification of this natural order or arrangement, the exhibitor had in view to exhibit the first named in a separate case, containing labelled specimens of the principal rocks, ores, and spars of Allendale and Alston, then in a series of cases to show the various processes, and finally, in another separate case; corresponding with the first, to exhibit the finished products of lead and silver. As regards the second and third divisions of this arrangement no alteration was made; but the first, now under description, was modified and altered under the following circumstances.

A number of agents and other parties interested in lead-mining, and chiefly residing in Alston Moor, were anxious to send a collection of minerals collected from lead-mines to the Exhibition, and a working miner, Mr. Isaac Robinson, who was one of the parties, was anxious to fit up this case in a manner corresponding to some small collections which he had cemented together, and which had been much admired. As such a collection formed, in point of fact, the essential feature of the first division, which had been contemplated, being specimens of the minerals associated with lead, it was considered, at a meeting of the parties concerned, that it should be fitted up as proposed by Mr. Isaac Robinson, under the general superintendence and direction of the exhibitor and others. This was accordingly done, and the case contains upwards of 2,000 specimens fitted together, not as a representation of any particular cavern, but grouped so as to present to view an example of almost every mineral substance usually found in immediate connection with lead-ores. Some of the examples are interesting as ornamental spars. But spars are not alone useful as ornaments: they are partly used in the arts, and they also afford instructive indications in tracing the course of mineral veins. The whole of this case was cemented together by Mr. Isaac Robinson during the intervals of his ordinary hours of work.

IV. Examples of the various stages of progress from the Mine to the Market.—This part of the collection is arranged in five cases, each containing six boxes of one square foot each, being in all thirty boxes.

Fifteen of these boxes, in a line furthest from the front edge of the counter, contain specimens of lead-mining from the excavation of the ore in the mine, and showing the several stages of progress until ready to send to the smelt-mill; and the other fifteen boxes, in a line nearest to the front of the counter, contain specimens of the ore as prepared for smelting, and its various stages of progress, until manufactured into lead and the silver separated; these finished products being contained in Division No. 5 of this collection.

Case No. 1.—Lead ore, as first separated from the vein in which it is found, and which in this state is called "bouse" in the north of England lead-mines, and the places in which it is deposited at the surface are called bouse teams. The depositing of the ore in these places is greatly facilitated at Allenheads by the use of tipping frames, of a new construction, by Mr. W. G. Armstrong, of the Elswick Engine Works, near Newcastle-on-Tyne. This example is from a "flat" vein in Allenheads mines, in the great limestone, which rock forms the curiously laminated matrix with which the ore is intermixed. The ore and rock thus intermixed require to be separated, as is exhibited by the following examples. By a flat vein, or "flatts," is meant a horizontal extension of mineral substances to a considerable distance from the ordinary vertical or steeply inclined veins, which extend in the manner of fissures through the various beds of rock forming the district. The regular lamination of the ore is worthy of attention, as leading to speculations on the origin of mineral veins; a subject of great practical importance. The example here shown is taken from a part of the "flatt workings," at a distance of about 20 feet from the principal or nearly vertical part of the vein.

Case No. 2. "Bouse," or lead ore, as extracted from the vein, and showing an example of the curiously polished surface, which is a frequent characteristic of veins, and which would appear at first sight to have been very carefully polished by artificial means, many of the surfaces being sufficiently clear to reflect the images of objects in a tolerably definite form. The local name of such bright and polished surfaces is "*slickensides;*" and the suggestion mentioned in the notice of the last specimen, as to the value of scientific inquiry, applies with still greater force to the class of phenomena of which this is one of the most curious indications.

CASE NO. 3 contains a portion of the ordinary bouse, or ore, as newly worked from the vein, and much intermixed with the materials contained in Cases 1 and 2, as well as with other earthy and sparry contents of veins. The produce of mineral veins varies from pure galena, of which some pieces are shown, to masses of rock in spar, in which the ore is so thinly disseminated as not to repay the trouble of extraction.

CASE NO. 4. The intermixed rocks and ores shown in the preceding cases are first subjected to "picking," and then to "washing," on a grate. The first of these operations separates from the general mass all such pieces of galena as are either not mixed with other substances, or which can be readily separated with a hammer on what are called "knocking-stones," and the second has the effect of clearing away all earthy matter. These specimens, picked from the heap and washing-grate, are ready for smelting after being reduced with a hammer to the size of the ore contained in Case No. 9.

CASE NO. 5 contains ordinary "bouse," or lead ore taken from the *trunking-box* after passing through the *washing-grate*, being, in fact, a process of *washing and sizing*, with a view to the further operations exhibited in the following cases.

CASE NO. 6 contains specimens of ordinary bouse, which from the size of the pieces and intermixture of rock and ore, require to be passed through the rollers of the crushing-mill.

CASE NO. 7. Specimens of the same bouse, or ore, after having passed through the rollers of the crushing-mill.

CASE NO. 8. So far the processes have consisted simply of extraction of the ore from its place in the mine,—of the pure samples of ore being picked out and washed and sized, ready for being smelted at once, without further operations,—of the remainder or poorer samples being washed and separated by an iron grate or sieve into two sizes, the larger having to be ground between rollers to reduce it to the same size as the smaller, which had passed the grate, and when reduced to this stage, the whole is ready for an operation called "hotching," which consists in placing the ore in a tub with water—the bottom of this tub is a sieve—and the whole is subjected to a rapid vibratory vertical movement, or shaking, by which a separation of the ore takes place. The water so far lessens the weight as greatly to facilitate the downward movement of the ore, which of course is much heavier than the spar and other materials connected with it. The vibratory movement is sometimes given by manual labour: a long arm, moving with a spring, is jerked up and down by a strong lad jumping on a raised stand, so as to produce the required motion. The same results may be obtained by machinery; and a model of a hotching apparatus accompanies these specimens. It represents the mode in which the hotching tubs are worked in some of Mr. Beaumont's mines in West Allendale; and both the mode of applying the machinery, and the manufacture of the model representing it, are due to the ingenuity of Mr. Joseph Hetherington, one of the engineers or wrights employed at these mines.

The ore prepared as has already been described, and after being shaken in the "*hotching-tub*," the upper part is entirely waste or refuse, and is called "cuttings," of which this case, No. 8, contains a specimen.

CASE NO. 9 contains lead ore as obtained from the bottom of the hotching-tub, and is ready for being smelted.

CASE NO. 10 contains what is called "undressed smiddum," being what has passed through the sieve of the hotching-tub into the box or case of water in which the hotching-tub vibrates.

CASE NO. 11 is the "smiddum," after being dressed or cleared from all foreign substances in what is locally called a "buddle," and the ore, in being so washed, is said to be "buddled."

CASE NO. 12. In all operations where a stream of running water is employed to wash lead ores, it is obvious that many of the smaller particles will be carried away with the stream. These particles are allowed to settle by their specific gravity in what are called slime-pits, being merely reservoirs in which the water passes over a long space with a very tranquil movement. In the Case No. 12 is an example of the *slime* or deposit in these slime-pits, undressed.

CASE NO. 13 contains a specimen of what is called "slime ore," having been extracted or separated from the slime shown in Case No. 12. This separation is effected by manual labour in what are called "*nicking-trunks*," and is made ready for a final washing or separation in the "dolly-tub."

CASE NO. 14 contains slime ore obtained, not by manual labour, but by means of a patented invention of Mr. Brunton's, by which the slime, being first freely mixed with water, is allowed to fall on a revolving canvas cloth, inclined at a moderate angle, and upon which also drops of water are constantly falling, so as to keep the surface well wetted. The heavier particles of ore being thus free to move, are carried *up* the slightly inclined surface of the canvas, and so pass round a roller to a cistern below, in which they are deposited, while the lighter particles of earthy matter and spar are at once carried *down* the canvas by the stream of water. The ore thus obtained requires finally to be washed in the dolly-tub, after which it is fit for being smelted.

CASE NO. 15 contains slime ore as taken from the dolly-tub, which is the last operation connected with the washing and dressing of lead ores, as usually practised in the lead-mines belonging to Mr. Beaumont, and in the lead-mines generally of this part of the kingdom.

The German buddle is also occasionally used in dressing slime ores. A considerable improvement was made in this apparatus about 30 years ago by Mr. Robert Stagg, of Middleton, in Teesdale.

CASE NO. 16 exhibits a specimen of "selected" or superior lead ore, in the form in which it is sent to and deposited at the smelt-mill, ready to be smelted.

CASE NO. 17 contains an example of the ordinary or common lead ore, as prepared and ready for smelting.

CASES NOS. 18 and 19 contain the same ores (select and common) after having undergone the operation of being "*roasted*," or exposed to a suitable temperature in a reverbatory furnace, the object being to free it from the sulphur contained in galena, pure specimens of which consist of lead 86·6 and sulphur 13·3. By this process the ore is rendered more easily reducible.

CASE NO. 20. Grey slags formed in the process of ore hearth smelting, and from which the lead is afterwards obtained at the slag hearth.

CASE NO. 21. Black slags, being the residuum obtained from the slag hearth, and which assume the granulated form from being made to flow, when in a melted state, into water.

CASES NOS. 22 and 23 contain examples of the crystals of selected and common lead, as formed in the process of separating or desilvering the ore: patented by Mr. H. L. Pattinson, and first brought into operation at Mr. Beaumont's smelt-mills.

CASES NOS. 24, 25, and 26, contain specimens of the fume or deposit in the long flues connected with the smelt-mills: that in No. 24 being the ordinary fume collected in the flue, No. 25 the same, after being roasted for the ore hearth, and No. 26 the same, roasted for the slag hearth. The flues or chimneys are built of stone, 8 feet by 6 feet inside, and are upwards of 8½ miles long.

CASES NOS. 27, 28, and 29.—Litharge in the ordinary round state, and two varieties of *Timsed litharge* which has been passed through a sieve.

CASE NO. 30.—Skimmings from the surface of melted lead, showing iridescent hues, which are frequently of great intensity and beauty.

V. LEAD AND SILVER PREPARED FOR SALE.—The following are contained in the large upright case which completes the several objects sent in illustration of lead-mining, viz.:—

No. 31. Lead made from roasted lead ore, and placed in a model-mould same as No. 37.
No. 32. Grey slag lead, in mould.
No. 33. Selected lead, in mould.
No. 34. Common lead, in mould.
No. 35. Lead made from ore-hearth fume, in mould.
No. 36. Lead made from slag-hearth fume, in mould.
No. 37. Empty mould, marked W. Blackett, which name, or its initials, viz., W. B., form the well-known mark of the lead produced from Mr. Beaumont's mines.
No. 38. A pig, or piece of common lead, weighing 12 stones, or 1½ cwt.
No. 39. A pig, or piece of selected lead, weighing 12 stones, or 1½ cwt.

In the above examples, Nos. 31 to 37 are models of reduced size. The dimensions of the ordinary pieces of lead, as manufactured for sale, are shown in Nos. 38 and 39. The number of pieces usually manufactured at these mines in a year, if laid in one continuous line, would extend upwards of 70 miles in length.

No. 40. A cake of silver produced from lead raised in Mr. Beaumont's mines, and weighing 8,000 ounces.

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485 Oxland, Robert, *Buckland Street, Plymouth*—Inventor and Manufacturer.

A series of specimens illustrative of an improved process for dressing ores of tin; containing wolfram (the tungstate of iron and manganese). Invented by the exhibitor, for the separation of the wolfram from the ores of the Drake Walls Tin Mine, on the Cornish side of the river Tamar. This process is now in regular operation at the mine. In consequence of the specific gravity of wolfram, which is from 7·100 to 7·500, being greater than that of the black tin of the mines or the pure native oxide of tin, which is only from 6·3 to 7·00, it has been found impossible to separate the wolfram from the tin oxide by the usual mechanical process of washing in a stream of water. This led to the necessity of adopting the patent chemical process explained with the description of the series of specimens.

No. 1. "Tin witts:" the ore obtained from the stamps floors, where, subsequently to its having been crushed or stamped down to a suitable size, it has been washed in a stream of water, in order to separate the earthy particles with which it was associated. The clean "witt" contain native oxide of tin; black tin, or rosin-tin and wolfram, with iron and arsenical pyrites, generally containing some copper. In the course of washing the "witts" are sorted into different parcels, according to the size of the particles, and are known as jigged, marked A; flucan, B; smalls, or "smales," C; slime, D; roughs, or rows, E. The "witts" are calcined in a reverberatory furnace, usually constructed of fire-brick throughout, but the furnace shown in the accompanying sketch has been found to be as well adapted for this purpose, as for the process for which it was originally intended. The calcination is continued until all the sulphur and arsenic is evolved.

The residue No. 2 contains black tin, or native tin oxide, peroxide of iron, wolfram, some sulphate of copper, and a small quantity of earthy matter. By a series of washing operations on the burning house floors, the peroxide of iron, sulphate of copper, and earthy matters are removed, and the product obtained is No. 3, which consists of oxide of tin, with most of the wolfram. The process is in the next place employed for the removal of the wolfram. Its proportion having been ascertained by analysis, a quantity of sulphate of soda, or salt cake, is mixed with the ore sufficient to supply a slight excess of the equivalent of soda for the quantity of tunstic acid present; but with the sulphate of soda, must be mixed sufficient coal dust or charcoal to afford carbon or carburetted hydrogen, for the decomposition of the sulphuric acid and the conversion of sulphate of soda into sulphide of sodium. The mixture is exposed to heat on the bed of the furnace described below; a smoky or reducing flame is at first employed, but after the whole of the charge has been at a red heat for some time, an oxidating flame is necessary to complete the operation. Thus the sulphate of soda is first converted into sulphide of sodium, then the tungstic acid of the wolfram combines with the soda, producing tungstite of soda, setting the sulphur free as sulphurous acid, and leaving the iron in the condition of a light finely divided peroxide.

The product No. 4, is drawn from the furnace into the wrinkle, or chamber beneath, and is thence removed whilst still hot into tanks containing water, which quickly dissolves the tungstate of soda. The solution is run off into receivers, and the residue is removed to the burning house floors, where, by a series of washings, the peroxide of iron is removed, and the native oxide of tin obtained pure and ready for the smelting house, as seen in No. 5. An ore which had fetched only 42*l.* per ton has by this operation been so much improved in quality as to obtain 56*l.* per ton.

The tungstate of soda, No. 6, is obtained in the crystalline form by the evaporation to the crystallizing point of the solution in which it was separated from the tin. It is proposed to be used as a substitute for stannate of soda as a mordant for dyeing purposes.

Tungstic acid, No. 7, may be employed for the same purpose, or for the manufacture of tungstate of the tungstous oxide with soda, a compound much resembling gold.

The tungstate of lead, No. 8, and tungstate of lime, No. 9, are good white pigments, (manufactured from the tungstate of soda) from which was also obtained the metallic tungsten, No. 10, and sulphuret of tungsten No. 11. The former is for use in the manufacture of metallic alloys; the latter has been proposed as a substitute for black-lead. The furnace is constructed in the usual manner, excepting that a cast-iron bed has been employed to prevent the loss that would arise from the reaction of the silica of the bricks, the soda, and the tin oxide on each other. The fire, after passing over the bed, is also made to circulate beneath it before passing away to the chimney.

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486 Brucciani, D.

Facsimile of the largest piece of gold found in California.

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487 Jordan, C., *Manchester*.

Specimens of metals and their alloys.

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488 Garland, Thomas, *Fairfield, Redruth*—Manufacturer.

Impure oxide of arsenic, obtained from tin ores (containing arsenical pyrites) by calcination.

Commercial oxide of arsenic, obtained from the foregoing by sublimation in reverberatory furnaces, and afterwards ground to an impalpable powder.

A finer quality of the preceding.

Lump arsenic, obtained from the preceding by sublimation in close retorts.

[Arsenic is found native occasionally, but is more frequently combined with other metals, of which iron, cobalt, nickel, silver, copper, antimony, and manganese are the chief. It is very soft but brittle, and volatilizes readily at a temperature of 365° Fahrenheit. It combines with oxygen in *white arsenic* (arsenious acid), and with sulphur in *realgar* and *orpiment*. The former substance is used in medicine, in the manufacture of glass, &c. The sulphurets are valuable pigments, both in dyeing and in the fine arts.—D. T. A.]

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489 Lowe, J., 30 *Gracechurch Street*—Part Proprietor.

Copper, from the exhibitor's patent works, Penclawdd.

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490 Rowlandson, Thomas, 7 *Esher Street, Kennington*—Patentee.

Bluestone — a compound of bisulphuret of iron, sulphuret of lead (galena), bisulphuret of copper, sulphuret of zinc (black jack), &c., some silver and gold, obtained at the Isle of Anglesey; also at the Vale of Ovoca, Wicklow, Ireland.

The zinc salts can be converted into chloride of zinc and sulphate of soda; these can be employed in a variety of forms for preserving animal and vegetable substances, deodorizing, &c.

Specimens illustrating the processes by which the sulphuret is converted into sulphate of zinc, which is washed out, and leaves the lead, gold, and silver to be extracted in the ordinary mode by smelting.

Specimens of ores and products from the Cwm-eisian Gold Mine, Merionethshire.

[The existence of gold in many of the rocks of Wales has been long known. There is every reason for believing that the Romans worked the mine at Gogofan, near Pumpsant, Caermarthenshire. This is not only proved by the remains of mine workings, which have been lately examined by the mining geologist to the Geological Survey, but by the gold ornaments which have been found in the Vale of Cothy, near this spot, which are evidently of Roman workmanship. The mine at Cwm-eisian yielded gold disseminated through the quartz, but not being sufficiently remunerative, the works have been abandoned.—R. H.]

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491 HARRISON, J., *Bakervale, Derbyshire.*

Lead ore, from Mogshaw mine, Bakervale.

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492 ROWE, RICHARD, *Laxey Glen, Douglas, Isle of Man*—Joint Proprietor.

Silver lead ore, and blende ore, being the produce of the Laxey Mines, in Laxey Glen, parish of Lonan, Isle of Man.

[Mines were worked at an early period in the Isle of Man, but the neighbourhood of Laxey first attracted attention at the commencement of the present century. In 1811, only three hands were employed; in 1848, there were at least 300 in the mine. The mine is situated about a mile and a half from the sea, up the Laxey Valley, where an adit is driven 400 fathoms into the heart of the mountain; from this adit the shaft has been sunk about 130 fathoms. The returns of lead ore for the last five years have been as follows:—

Years.	Lead Ore. Tons.	Lead. Tons.
1845	327	155
1846	220	104
1847	375	247
1848	695	461
1849	815	546

In addition to this, about 200 tons of the sulphuret of zinc are annually raised.—R. H.]

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493 CUMMING, J. G., *Isle of Man.*

Argentiferous galena, from the Foxdale Mines, containing 36 ounces of silver to the ton.

[This lead ore is procured from a granite vein, running N.N.W. and S.S.E., nearly magnetic; it improves in quality, and increases in quantity downward, which is an unusual occurrence. It is now being worked at 50 fathoms from the surface.—R. H.]

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494 BYERS, JOSHUA, *Stockton-on-Tees, Durham*—Producer and Manufacturer.

Lead ore from Grasshill Mine, Teesdale.
Silver and litharge from the same mine.
Refined, common, and slag lead.
Thin sheet-lead and lead pipe.

495 BURR, THOMAS, WILLIAM, & GEORGE, *Shrewsbury*—Producers and Manufacturers.

Mineral specimen, raised at the Snailbeach lead mines, Shrewsbury, weighing 12 cwt., containing cubes of lead and zinc ore, in conjunction with carbonate and sulphate of barytes.

[The produce of the Snailbeach Mines since 1845 has been as follows:—

Years.	Lead Ores. Tons.	Lead. Tons.
1845	3,000	2,000
1846	3,852	2,700
1847	3,486	2,440
1848	3,463	2,436
1849	3,196	2,301

The returns for 1850 are not yet completed.—R. H.]

Composition tube, being an amalgam of certain metals, calculated to resist the action of acids contained in water or gas.

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496 The DUKE of DEVONSHIRE, and his Agent, Capt. EDDY, *Grassington.*

Specimen of the Devonshire lode at Grassington mines.
Specimen of the gritstone, in which the lead occurs.
Veins: specimens from other lodes.
Transverse section of the Devonshire lode.

[The lode in the Grassington mines offers an exception to the common rule of lead veins in England, the whole produce being obtained in gritty beds alternating with the limestone and shale, and not in the limestone, as it usually occurs. The veins worked in this district are generally with faults, and the veinstone is chiefly calc spar, fluor spar, and barytes.—D. T. A.]

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497 PATTINSON & CAIN, *Newcastle-upon-Tyne*—Producers.

Specimens of a peculiar ore of lead, viz., arsenio-phosphate of lead, rarely found in such large masses. From Dry Gill Mine, near Hesket New Market, Cumberland.

[This appears to be the mineral called by Breithaupt, Kampylit, an arseniate of lead, in which the arsenic is partially replaced by phosphorus.

The arsenio-phosphate of lead from this mine has been employed in glass manufacture, for the purpose of giving high transparency to the best flint or crystal, which appeared to be produced by the formation of a lead glass, which may be regarded as a phosphate of lead and silica. —R. H.]

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498 BENNETT, THOMAS, 11 *Woodbridge Street, Clerkenwell*—Manufacturer.

Specimen of uniform leaf gold, manufactured by steam machinery, for gilding large plain surfaces, and for exterior decorations; of an extra deep colour, for gilding looking-glasses, cornices, &c.

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499 SMITH, R., *Blackford, Perthshire*—Inventor.

Minerals from the Ochills, collected by the exhibitor. Two new alkaloids, "*cytisuine,*" found in the bark of the laburnum in combination with meconic acid; and euphorbine, from *Euphorbia officinalis.* Starch, from the tubers of the *Lunaria biennis;* and iodine, from the *Polytrichum undulatum.*

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500 DUBLIN COMMITTEE.

Specimens of iron and tin plate.

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501 DOWNMAN, H. H.

Wood impregnated with block tin.

502 Jenkins, William Harry, *Truro.*

Specimens of arsenic:—White arsenic, arsenious acid, used in glass manufactories, in patent shot manufactories, for washes for sheep, to preserve the wool and prevent the fly, and for preventing smut in wheat, &c.; white arsenic, in crystals, and sublimated, for the same purposes. Realgar, sulphuret of arsenic, used by painters as orange red pigment; orpiment, used by painters as yellow pigment.

503 Davey, Stephen, *Redruth*—Miner.

Specimens of ores of zinc.

504 Cole, H.

Zinc ore.

505 Williams & Sons, *County Wicklow, Ireland.*

Sulphur ore; manganese ore, from Glandore Mining Company.

506 Grey, John, *Dilston, Corbridge*—Agent.

Blende and calamine from Alston Moor, Cumberland. Four plates of spelter, two whole, and two broken, produced from the same.

507 Maguire, Thomas, Secretary to the General Mining Company for Ireland, 2 *Burgh Quay, Dublin*—Producers.

Silver-lead ore (argentiferous galena), from Shallee mines, Tipperary; exported from Dublin to the river Dee, in North Wales. This ore produces 75 per cent. lead, and from 44 to 54 ounces of silver to the ton.

[The Shallee mines made their first return of lead in 1847, it being then 209 tons of lead ore, which produced 125 tons of lead. Since that time the quantity raised has been regularly increasing.—R. H.]

Silvery-copper ore (argentiferous sulphuret of copper), from Gurtuadyne, near silver mines, county Tipperary; exported from Dublin to Swansea, South Wales. This ore produces 12½ per cent. copper, and about 27 ounces of silver to the ton of ore.

Copper ore (sulphuret of copper), from Ballynoe, near silver mines, county Tipperary, exported from Dublin to Swansea, South Wales. Average produce, about 40 tons per month. This ore produces 25 per cent. of copper. Copper ore, from Lackamore, county Tipperary, similarly exported. This ore produces 36 per cent. of copper.

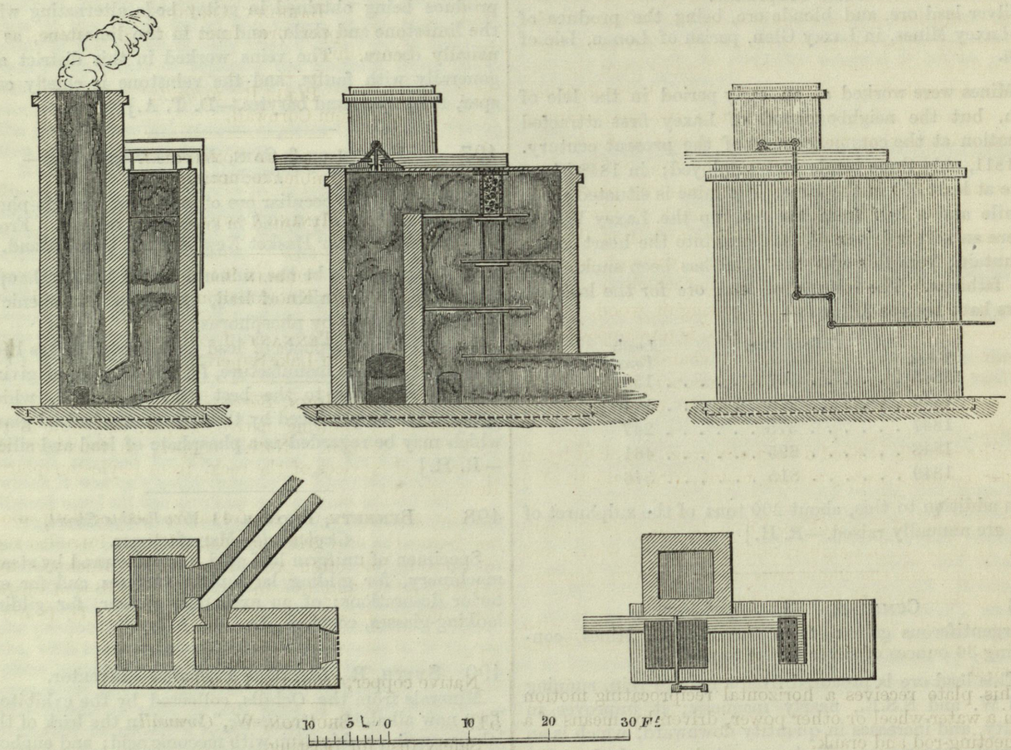
Specimens of all these ores, as taken from the mine, and as dressed for market.

508 Royal Dublin Society of Ireland.

Specimens of lead ore in its various stages; lead, lead-pipe; patent shot; sheet of copper.

509 His Grace the Duke of Buccleuch, *Drumlanrig Castle.*

Model of the furnaces and pots employed on the Duke of Buccleuch's mines, at Wanloch Lead-hills, in Dumfriesshire, for separating pure silver from the rich lead ore of that district.



The following illustrations accompany the model.

A block of pure silver, weighing more than 120 lbs.; separated from the rich lead, and purchased by silversmiths as "unalloyed."

(*a*) Original lead as brought from the mines after smelting, containing 7 oz. 9 dwts. 8 grains of silver.

(*b*) Crystals of lead after passing through one process of crystallization.

(*c*) The same, after a second crystallization.

(*d*) Rich lead, containing 81 oz. 1 dwt. 8 grains of silver; and now ready for the last process of oxidization, by which the silver is finally separated from the lead.

(*e*) Marketable lead from the crystallizing process; and which contains from ½ to ¾ of an ounce of silver per ton.

(*f*) Models of the great ingot moulds employed for forming the pigs of lead of commerce.

(*g*) Model of the great spoon-strainers employed for separating the pure, or nearly pure lead, from the molten liquid.

The operation depends upon the property which lead possesses in weak alloys of crystallizing at a certain temperature, by which means those crystals, at the moment of forming, can be extracted, and thus separated from the silver mass.

By a particular manipulation in transferring the concentrated lead and silver from pot to pot, the mass is at last reduced to an alloy, containing some 80 or 90 ounces of silver to the ton of lead, and much beyond which point it is not found advantageous to crystallize.

The rich lead is now simply melted in the refining furnace, on a very large cupel, formed of bone ash, exposing a great surface to the draught of air passing over it. The oxygen of the atmosphere is rapidly imbibed by the lead, which becomes the litharge of commerce. This is raked off as quickly as it forms; and finally, the silver is left perfectly, or very nearly, pure, and run into ingots for the market.

(*g*) Is the litharge or minium thus withdrawn from the melted surface.

Model of the lead vapour-condensing apparatus, at Wanloch Lead-mines, as improved by the exhibitor.

A collection of minerals from the Wanloch Lead-mines, or Lead-hills.

[In all great smelting works of this class, the smoke rising from the furnaces is highly charged with noxious vapours, containing, besides other poisonous matter, a large quantity of lead; many attempts have been made to obviate this nuisance, and the system adopted by the exhibitor has been found to be very successful.

An oblong building in solid masonry about 30 feet in height, is divided by a partition wall, into two chambers, having a tall chimney or tower adjoining, which communicates with one of the chambers at the bottom. (See engraving.) The smoke from the various furnaces, eight in number, and about 100 yards distance from the condenser, is carried by separate flues into a large chamber, from thence by a larger flue, it enters the first chamber of the condenser at the very bottom, and is forced upwards in a zigzag course towards the top, passing four times through a shower of water constantly percolating from a pierced reservoir at the summit of the tower. The smoke is again compelled to filter a fifth time, through a cube of coke some two feet square, through which a stream of water filters downwards, and which is confined to its proper limits by a vertical grating of wood.

The smoke having reached the top, is now opposite the passage, into the second, or vacuum chamber.

This is termed the exhausting chamber, and is about five feet by seven feet inside, and 30 or more feet in height.

On its summit is fixed a large reservoir, supplied by an ample stream of water, always maintaining a depth of 6 to 10 inches.

The bottom of this tank is of iron, having several openings, or slots, 12 in number, about an inch in width, and extending across the whole area of the reservoir, communicating directly with the chamber beneath.

On this iron plate, works a hydraulic slide-plate, with openings corresponding in one position with those in the reservoir.

This plate receives a horizontal reciprocating motion from a water-wheel or other power, driven by means of a connecting-rod and crank.

In the middle of every stroke, the openings in the plate correspond with those in the bottom of the reservoir, and a powerful body of water falls as a shower bath, the whole height of the vacuum chamber, and in doing so, sweeps the entire inside area, carrying with it every particle of insoluble matter held suspended in the vapours coming from the furnaces.

The atmospheric pressure, of course, acts in alternate strokes as a blast at the furnace-mouths, and causes a draft sufficiently strong to force the impure vapours through the various channels, in connexion with the water, the wet coke and exhausting chamber, until it passes purified and inert into the atmosphere.

The water, saturated with particles of lead, &c., held in mechanical solution, finally passes into great dykes or reservoirs, excavated for the purpose; and there deposits its rich charge of metal.

(*h*) Is the lead collected from this "fume," or deposit, which contains about 33 per cent. of pure lead, and about 4 oz. 17 dwts. and 7 grains of silver to the ton.

(*i*) The condensed fume roasted.

The results of this arrangement are most apparent, and beneficial to the surrounding neighbourhood.

Formerly, the noxious fumes passing from the shafts of the furnaces, poisoned the neighbourhood; the heather was burnt up; vegetation destroyed, and no animal could graze, or bird feed near the spot.

Now, the heather is seen in luxuriance close around the establishment, the sheep graze within a stone's throw of the chimney's base, and game on all sides take shelter. —J. A. L.]

510 WALLACE, WILLIAM, & COWPER, T., *Nenthead, Alston*—Proprietors.

Carbonate of lead, from Little Eggleshope Lead Mine, in Teesdale, county of Durham.

Minerals from Alston.

511 BARRETT, Captain.

Cobalt and copper ores from Cormiston mines, near Kendal, Lancashire.

512 BLEE, R., *Redruth.*

Cobalt ores, from Cornwall.

513 LISKEARD COMMITTEE.

Iron pyrites; hornblende; antimony.

514 CALLY MINING COMPANY, *Scotland.*

Copper ores.

515 DUBLIN SOCIETY.

Copper ore, from Knockmahon mines, Waterford.

516 TENNANT, J., *Strand.*

Copper ore, from Lake Superior.

517 GRAHAM, JOHN, *Barrhead, near Glasgow.*

Greenstone, showing native copper, as found in the rock when broken. Native copper, as found in the fissures and crevices of the rock, from Boyleston quarry Renfrewshire.

[The greenstone of Renfrewshire occurs both above and below the coal-grits and coal. It is an intruded rock of variable but often very considerable thickness and extent, and is likely to contain small quantities of various metalliferous substances and native metals.—D. T. A.]

518 BERGER, J.

Native copper, from the Lizard.

519 BRUNTON, W., *Cornwall.*

Safety fuse for blasting.

520 COPELAND, G. A., *Pendennis, Falmouth*— Inventor and Manufacturer.

Safety blasting cartridges, adapted for all kinds of blasting; intended to afford protection to the workmen from premature explosions, &c. The expedition in search of Sir John Franklin was furnished with them, by order of Her Majesty's Government, for ice-blasting in the arctic regions.

521 OFFLAHERTIE, H.
Lead ore, from Glengola mines.

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522 FORBES, ALEXANDER C., 12 *Old Burlington Street.*

Two specimens of Cinnabar, from the mines of New Almaden, in Upper California; one of 14lb. 1oz., the other of 13lb. 2oz. On analysis by Dr. Hoffman, they are found to consist of:—Mercury, 67·25; Sulphur, 10·33; Insoluble matter, 22·55. The insoluble matter consisting chiefly of silica, alumina, and traces of iron. On distillation with lime, 3,750 grains yielded 2,625 grains of mercury, or 70 per cent.

The mine has been worked one year; and in the month of November 1850, it yielded 127,500 lbs. of pure mercury. This is exported from San Francisco to the ports of Spanish America.

[Cinnabar is the only important ore of mercury, but is found in several states, sometimes in crystals, in laminated and granular masses, in a fibrous condition, and mixed with bitumen to the extent of 6 or 8 per cent. It is soft: (specific gravity =8·1 when pure), and is a sulphuret of mercury (Hg. S.). The mines of Almaden, in Spain, and Idria, in Carinthia, are those from which the chief supply has hitherto been obtained; but the discovery of mercury in the mountains on the coast of California, some years since, promises to affect the supply very considerably, when sufficient means are employed to work the mines extensively.—D. T. A.]

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523 DAVIES & TAYLOR, *Aberystwyth.*
Lead ores.

[The Cardiganshire mines are among the most interesting in the kingdom. They were worked at a very early period, probably by the Romans. Henry VII. encouraged mining by several grants, involving privileges to those who would work these mines. In the reign of Queen Elizabeth, there was a grant made of all these mines to Thomas Thurland and Daniel Houghsetter, Germans, who worked these mines for some time. They eventually passed into the hands of Sir Hugh Middleton, who realized so large a profit by working them, that in 1608, he set about the great work of bringing the New River from Ware to London, for which he was knighted by James I.

The present value of the Cardiganshire mines will be seen by the following list of the produce of these mines in 1849.

MINES.	Lead Ore Returns.		Lead Returns.	
	Tons.	Cwts.	Tons.	Cwts.
Lisburne Mines	2,733	0	1,804	0
Cwm-y-stwyth	583	0	333	0
Esgair-hir	. .		. .	
Cwm-sebon	55	0	33	0
Llanfair Clydogau	206	0	134	0
Goginan	1,160	0	766	0
Gogerddan Mines	131	0	87	0
Nanty-y-creiau	. .		. .	
Pen-y-bont-pren	12	0	7	0
Cefn-cwm-brwyno	10	0	7	0
Bwlch Consols	635	0	425	0
Nanteos	177	0	106	0
Aberystwyth (small mines)	31	0	20	0
Llanymaron	. .		. .	
Llanbadarn	. .		. .	
Bron-berllan	. .		. .	
Brynarian	40	0	28	0
Cwm-erfin	116	0	78	0
Daren	29	0	20	0
Eisteddfodd	20	15	14	0
Llwyn Malys	32	0	21	0
Bwlch-cwm-erfin	18	0	12	0

R. H.

524 HUNT, ROBT.
Mining map of Cornwall.

525 NIXON, Rev. A., *Nathfield, Dunfanaghy, Donegal, Ireland*—Producer.
Siliceous sand, from Muckish mountain, near Sheephaven on Ballyness.
Slate, from Ballyboes quarry, recently opened.
Steatite, found in large masses on the sea-shore.

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526 SQUIRES & SONS, *Stourbridge.*
Model of a glass-house furnace, with pots of Stourbridge fire-clay, showing one in a working state; and of a pot in which the glass is melted.

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527 MARTIN, REBECCA, *Higher Blowing House, St. Austell*—Producer.
Porcelain or China clay, natural, and as prepared for the market.
Siliceous sand, used in the manufacture of glass and China stone, and in glazing and enamelling earthenware.

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528 TRUSCOTT, C., *St. Austell.*
Cornwall China stone, and China clay, native and calcined; in a state for porcelain; and for bleaching and paper-making.

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529 JAMES, JOHN, *Blaina, near Abergavenny, Wales*—Inventor.
Model of a closed top-blast furnace, for smelting iron ore, &c.

AN ACCOUNT OF THE NATURE AND EXTENT OF THE VARIOUS DEPOSITS OF MINERAL FUEL IN VARIOUS PARTS OF THE WORLD. Accompanied by a map, showing the extent and position of the principal coal-fields of Europe and North America. By D. T. ANSTED, M.A., F.R.S., &c., Prof. Geol., K.C.L.

1. *General Account of Materials used for Fuel.*

The chief source of supply of valuable fuel is, and always has been, derived immediately or distantly from the vegetable kingdom. Whether in the form of wood, peat, lignite, or coal of various kinds, the original substance of all fuel has been found to have this origin, and thus it would seem that the power of vitality exerted in producing woody fibre has been from time to time stored up, as it were, into vast reservoirs, where it might be preserved safely and permanently for an indefinite period.

In warm climates, where the growth of vegetation is extremely rapid, and comparatively little fuel is needed: or in the early periods of civilization, before men congregate in large masses in towns, or are actively employed in manufacture, there is little need of more fuel than is supplied by the natural growth of forests; but under other circumstances, where forests are gradually removed, and the consumption of fuel at the same time increases, the reserved stores are greatly needed, and must ultimately be reckoned among the main sources of a country's wealth. The accumulations of mineral fuel in the British islands may be ranked as one of those natural advantages without which our country could not possibly have taken up and held for a long time the position she occupies among the nations of the earth, and thus, as one of great and principal sources of its mineral treasure, the coal deposits of England demand and deserve our careful attention. The relative supply of other countries, and the activity and energy displayed in taking advantage of the existence of mineral fuel, must also be worthy of attention, as illustrating and explaining the condition of many manufactures, and the probable advance of the inhabitants of such districts in the refinements of civilization. Since the introduction of steam-power for all purposes of machinery, the consumption of coal has very greatly increased, and at present it would be difficult to set any limits to the use of so valuable a material.

The changes undergone by vegetable matter when buried in the earth and accumulated in large quantities, and the length of time needed to produce any marked alteration, are subjects rather interesting, it may seem, to the chemist than to the practical man, who looks only for fuel that he may employ economically. But inasmuch as the real condition of coal varies considerably, and different kinds are valuable for different purposes, it is desirable that the whole history of coal and lignite beds, and of peat and turf, should be generally understood by every one using any or all of these substances extensively.

Vegetable matter consists of particles of carbon with minute proportions of several other elements arranged round minute cavities or cells, many of these being mechanically connected to form the varieties of vegetable fibre. A large quantity of water is also present, and so long as the vegetable lives there is a constant change and circulation of material particles kept up, replacing and renewing the different portions. When death takes place there is a tendency to decomposition, or the separation of the whole into minute atoms, having no further relation to each other. But this is frequently checked by various conditions, such as the presence of some substances derived from plants themselves, or the absence of sufficient oxygen gas to allow the change to take place, by mixing with the carbon, and becoming carbonic acid gas, the first step in the process of destruction. These causes operate constantly, but partially, and thus a large quantity of vegetable matter is always in the course of decomposition, while, in particular spots, a large quantity is constantly being accumulated. The latter condition is seen in our climate in the gradual but steady increase of peat bogs. The former is too common to require further notice.

2. *Peat and Turf.*

Accumulations of vegetable matter may be chiefly composed either of succulent vegetation, grasses, or marsh plants, or of trees, and the structure and condition of woody fibre is well known to be very different from that of grasses and succulent plants. There are thus two very distinct kinds of material preserved, the one undergoing change much less rapidly than the other, and perhaps much less completely. It is easy to prove that, from the accumulation of forest trees has been obtained the imperfect coal called lignite, while from marsh plants and grasses, mixed occasionally with wood, we obtain peat, turf, and bog. All these substances consist to a great extent of carbon, the proportion amounting to from 50 to 60 per cent., and being generally greater in lignite than in turf. On the other hand, the proportion of oxygen gas is generally very much greater in turf than in lignite. The proportion of ash is too variable to be worth recording, but is generally sufficiently large to injure the quality of the fuel.

As a very large quantity of turf exists in Ireland, covering, indeed, as much as one-seventh part of the island, the usual and important practical condition of this substance as fuel can be best illustrated by a reference to that country. This will be understood by the following account of its origin abstracted from the "Bog Report" of Mr. Nimmo. He says, referring to cases where clay spread over gravel has produced a kind of puddle, preventing the escape of the waters of floods or springs, and when muddy pools have thus been formed, that aquatic plants have gradually crept in from the borders of the pool towards their deep centre. Mud accumulated round their roots and stalks, and a spongy semi-fluid was thus formed, well fitted for the growth of moss, which now, especially spears of *Sphagnum*, began to luxuriate; this absorbing a large quantity of water, and continuing to shoot out new plants above, while the old were decaying, rotting, and compressing into a solid substance below, gradually replaced the water by a mass of vegetable matter. In this manner the marsh might be filled up, while the central or moister portion, continuing to excite a more rapid growth of the moss, it would be gradually raised above the edges, until the whole surface had attained an elevation sufficient to discharge the surface-water by existing channels of drainage, and calculated by its slope to facilitate their passage, when a limit would be, in some degree, set to its further increase. Springs existing under the bog, or in its immediate vicinity, might indeed still favour its growth, though in a decreasing ratio; and here, if the water proceeding from them were so obstructed as to accumulate at its base, and to keep it in a rotten fluid state, the surface of the bog might be ultimately so raised, and its continuity below so totally destroyed, as to cause it to flow over the retaining obstacle, and flood the adjacent country.

In mountain districts the progress of the phenomenon is similar. Pools, indeed, cannot in so many instances be formed, the steep slopes facilitating drainage, but the clouds and mists resting on the summits and sides of mountains, amply supply their surface with moisture, which comes, too, in the most favourable form for vegetation, not in a sudden torrent, but unceasingly and gently, drop by drop. The extent of such bogs is also affected by the nature of the rock below them. On quartz they are shallow and small; on any rock yielding by its decomposition a clayey coating, they are considerable; the thickness of the bog (for example in Knocklaid, in the county of Antrim, which is 1,685 feet high) being nearly 12 feet. The summit bogs of high mountains are distinguishable from those of lower levels, by the total absence of large trees.

As turf includes a mass of plants in different stages of decomposition, its aspect and constitution vary very much. Near the surface it is light-coloured, spongy, and contains the vegetable matter but little altered; deeper it is brown, denser, and more decomposed; and finally, at the base of the greater bogs, some of which present a depth of 40 feet, the mass of turf assumes the black colour, and nearly the density of coal, to which also it approximates very much in chemical composition. The amount of ash contained in turf is also variable, and appears to increase in proportion as we descend. Thus, in the section of a bog 40 feet deep, at Timahoe, those portions near the surface contained $1\frac{1}{2}$ per cent. of ashes, the centre portions $3\frac{1}{4}$ per cent., whilst the lowest four feet of turf, contained 19 per cent. of ashes. In the superficial layers, it may also be remarked, that the composition is nearly the same as that of wood, the vegetable material being but little altered, and in the lower we find the change into coal nearly complete. Notwithstanding these extreme variations, we may yet establish the ordinary constitution of turf with certainty enough for practical use, and, on the average specimens of turf selected from various localities, the following results have been obtained :—

The calorific power of dry turf is about half that of coal; it yields, when ignited with litharge, about fourteen times its weight of lead. This power is, however, immensely diminished in ordinary use, by the water which is allowed to remain in its texture, and of which the spongy character of its mass renders it very difficult to get rid. There is nothing which requires more alteration than the collection and preparation of turf; indeed, for practical purposes, this valuable fuel is absolutely spoiled as it is now prepared in Ireland. It is cut in a wet season of the year; whilst drying it is exposed to the weather; it hence is in reality not dried at all. It is very usual to find the turf of commerce containing one-fourth of its weight of water, although it then feels dry to the hand. But let us examine how that affects its calorific power. One pound of pure dry turf will evaporate 6 lbs. of water; now in 1 lb. of turf, as usually found, there are $\frac{3}{4}$ lb. of dry turf, and $1\frac{1}{4}$ lb. of water. The $\frac{3}{4}$ lb. can only evaporate $4\frac{1}{2}$ lbs. of water; but out of this it must first evaporate the $\frac{1}{4}$ lb. contained in its mass, and hence the water boiled away by 1 lb. of such turf is reduced to $4\frac{1}{4}$ lbs. The loss is here 30 per cent., a proportion which makes all the difference between a good fuel and one almost unfit for use. When turf is dried in the air, under cover, it still retains one-tenth of its weight of water, which reduces its calorific power 12 per cent., 1 lb. of such turf evaporating $5\frac{1}{3}$ lbs. of water. This effect is sufficient, however, for the great majority of objects; the further desiccation is too expensive and too troublesome to be used, except in some especial cases.

The characteristic fault of turf as a fuel is its want of density, which renders it difficult to concentrate within a limited space the quantity of heat necessary for many operations. The manner of heating turf is, indeed, just the opposite to that of anthracite. The turf yields a vast body of volatile inflammable ingredients, which pass into the flues and chimney, and thus distribute the heat of combustion over a great space, whilst in no one point is the heat intense. Hence for all flaming fires turf is applicable, and in its application to boilers it is peculiarly useful, as there is no liability to that burning away of the metal, which may arise from the local intensity of the heat of coke or coal. If it be required, it is quite possible, however, to obtain a very intense heat with turf.

The removal of the porosity and elasticity of turf, so that it may assume the solidity of coal, has been the object of many who have proposed mechanical and other processes for the purpose. It has been found that the elasticity of the turf fibre presents great obstacles to copression, and the black turf, which is not fibrous, is, of itself, sufficiently dense.

Not merely may we utilize turf in its natural condition, or compressed, or impregnated with pitchy matter, but we may carbonize it, as we do wood, and prepare turf charcoal, the properties of which it is important to establish. The methods of carbonization are of two kinds :—1. By heating turf in close vessels; by this mode loss is avoided, but it is expensive, and there is no compensation in the distilled liquors, which do not contain acetic acid in any quantity. The tar is often small in quantity, and the gases are deficient in illuminating power, hence the charcoal is the only valuable product. Its quantity varies from 30 to 40 per cent. by weight of the dry turf. The products of the distillation of 1,157 lbs. of turf were found by Blavier to be—charcoal, 474 lbs., or 41 per cent. ; watery liquid, 226 lbs., or 19·3 per cent.; gaseous matter, 450 lbs., or 39 per cent.; and tar, 7 lbs., or 6 per cent.; but the proportion of tar is variable, sometimes reaching to 24·5 per cent. when coked in close vessels.

The economical carbonization of turf is best carried on in heaps, in the same manner as that of wood. The sods must be regularly arranged, and laid as close as possible; they are the better for being large—15 inches long, by 6 broad, and 5 deep. The heaps, built hemispherically, should be smaller in size than the heaps of wood usually are. In general 5,000 or 6,000 large sods may go to a heap, which will thus contain 1,500 cubic feet. The mass must be allowed to heat more than is necessary for wood, and the process requires to be very carefully attended to, from the extreme combustibility of the charcoal. The quantity of charcoal obtained in this mode of carbonization is from 25 to 30 per cent. of the weight of dry turf.

The charcoal so obtained is very light and very inflammable; it possesses nearly the volume of the turf. It usually burns with a light flame, as the volatile matters are not totally expelled. This is shown by the composition of a specimen analyzed with the following result :—

Carbon	89·90
Hydrogen	1·70
Oxygen and nitrogen . .	4·20
Ashes	4·20
	100·00

For many industrial uses the charcoal so prepared is too light, as, generally speaking, it is only with fuels of considerable density that the most intense heat can be produced; but by coking compressed turf, it has been already shown, that the resulting charcoal may attain a density of 1,040, which is far superior to that of wood charcoal, and even equal to that of the best coke made from coal. As to calorific effect, turf charcoal is about the same as coal cokes, and little inferior to wood charcoal.

It is peculiarly important, in the preparation of the charcoal from turf, that the material should be selected as free as possible from earthy impurities, for all such are concentrated in the coke, which may be thereby rendered of little comparative value. Hence the coke from surface turf contains less than 10 per cent. of ash, whilst that of the dense turf of the lower strata contains from 20 to 30 per cent. This latter quantity might altogether unfit it for practical purposes.

The above account of turf and its value, for which we are much indebted to the work of Sir Robert Kane, on the Industrial Resources of Ireland, will be found to apply in an important way to many experiments lately tried with this kind of fuel, and illustrated by several objects exhibited by Mr. Cobbold, Mr. Reece Rees, Mr, J. Rogers, and others. The products obtained for economic use, by the more careful distillation of turf and peat, will be fully described by reference to the body of the catalogue.

3. *Lignite.*

Lignite also occurs in Ireland, especially on the shores of Lough Neagh, where it is partly used as fuel. The vast quantity of the lignite may be judged from a boring at Sandy Bay, described by Mr. Griffith. In 76 feet of depth there occurred three beds of lignite, one of 20, one of 25, and one of 15 feet thick, giving a total thickness of strata of fuel of 60 feet; the remaining 16 feet were clay. Elsewhere, the beds of lignite are not so much developed; but as the area of this tertiary basin extends over 100 square miles, the quantity of fuel therein contained may be considered of much public interest.

This lignite is intermediate between wood and coal, and is found on examination to present all the structure of wood, and is of a deep brown colour. When ignited, it gives off gaseous matter, which burns brilliantly, and leaves a dense black charcoal. Specimens are found to contain from 53·7 to 57·7 volatile matter, 30·0 to 33·6 carbon, 8 to 16 ash.

The economic value of the lignite appears from those analyses about two-thirds that of average coal. The heat which it produces is more diffused than that from coal, and less intense. Indeed, in all respects as to application to industrial uses, the position of lignite is between those of coal and wood. The attempts hitherto made to render this fuel available for various economic purposes have not been very successful.

At Bovey Tracy, in Devonshire, and at Brora, in Sutherlandshire, other beds of lignite occur, and have been partially used; and in various oolitic beds in Yorkshire similar mineral fuel exists to a small extent. None of these, as at present worked, present any features of considerable interest. Some beds of bituminous shale at Kimmeridge, Dorsetshire, and elsewhere, have been employed chiefly for local purposes.

But the lignite of Ireland is far inferior, both in extent and calorific power, to that of Germany, where fuel of this kind exists in several places, and to a vast extent. On the banks of the Rhine, in Nassau and its vicinity, and in the east of Europe, in Silesia, and in parts of Styria, deposits of this kind are exceedingly remarkable, and of great economic importance. Their thickness is sometimes enormously great, reaching to 120 feet, and even more, but the beds are generally detached and small, and more resemble drift accumulations than regular deposits. The value of these lignites for the manufacture of iron must ultimately be very considerable, as there exist abundant supplies of iron ore in the immediate vicinity of the fuel, both in Austria and on the Rhine, and also in Silesia.

The lignites of Germany often exhibit distinct woody structure, and can be referred to coniferous trees. They contain a somewhat large per centage of ash, do not form good and compact charcoal, and will not stand the blast of a blacksmith's forge. They are generally so wet as to require some exposure before being used, and when exposed to the air they often crack. In texture they are tough, and sometimes exhibit sufficient remains of their origin as to resist effectually the blow of a hammer, or, if breaking, only parting in the grain of the wood. The change they have undergone has, therefore, been too small to have given them any of the essential characters of true coal, but they still are so far reservoirs of carbon that we cannot doubt of their being ultimately rendered available.

4. *Nature and Distribution of Coal.*

True coal is so much altered from its original vegetable condition as to have left scarcely any traces of its true history. It is generally, however, associated with sands and clays, exhibiting numerous fragments of the ancient vegetation that obtained at the time of its formation; but these fragments are so far removed in every respect with the existing form of vegetation, as to afford little clue to the ancient condition of the earth in this respect. In coal all trace of true woody fibre has disappeared; the water originally present, and so injurious in the less altered forms of vegetable fuel, is entirely absent, or, if present at all, is so rather mechanically than chemically, while the water originally in the plant appears to have undergone decomposition, the hydrogen uniting with some part of the carbon to form carburetted hydrogen gas, often existing in the cells and between the plates of the coal, under considerable pressure, and the oxygen being almost entirely removed. The former vegetable has now become a mineral substance, and lies in vast beds of variable thickness, and overlying each other to the extent sometimes of more than a hundred in a single district; such beds being regularly interstratified with deposits of sand and clay, and occupying a distinct geological position, being, with only a very few exceptions, confined to rocks belonging to the newer part of the palæozoic series.

Between the Arctic Circle and the Tropic of Cancer repose all the principal carboniferous formations of our planet. Some detached coal deposits, it is true, exist above and below those limits, but they appear, so far as we know, to be of limited extent. Many of these southern coal-fields are of doubtful geological age: a few are supposed to approximate to the class of true coals, as they are commonly styled; others are decidedly of the brown coal and tertiary period; while the remainder belong to various intermediate ages, or possess peculiar characters, which render them of doubtful geological origin.

The coals of Melville Island and Byam Martin's Island certainly appear to be of the true coal period. We know that coal exists at numerous intermediate points, from the 75th to the 27th degree of north latitude in America, and also that it is worked on the Sulado and Rio Grande rivers in Mexico, for the use of the steamers.

Southward of the Tropic of Cancer, the existence of coal, corresponding with the European and American hard coal, is somewhat uncertain. There seems to be none on the South American continent, unless it be at Ano Paser, which needs confirmation, or in the province of Santa Catherina, in Brazil. On the African continent we have had vague accounts of coal in Ethiopia and at Mozambique, also at Madagascar; and quite recently we have had intelligence of large quantities of coal in the newly-ceded territory above Port Natal, on the eastern side of Africa; but we believe no geologist has examined those sites. In the Chinese and Burmese empires only brown coal appears to approach the tropic, but true coal seems to exist in the northern provinces. Southward of the Asiatic continent we are uncertain of the exact character of the coal deposits, such as occur abundantly at Sumatra, Java, and Borneo, and neighbouring islands. Coal, however, exists in these islands, and is of fair workable quality.

In New South Wales, the great coal-range on the eastern margin of that continent has sometimes been described as resembling the Newcastle coal in England, and sometimes it is described as of more ancient date. This coal differs essentially from that of any known European formation, but bears a strong resemblance to the Burdwan coal of India.

We have not yet arrived at the period when we could pronounce with any approach to certainty on the actual number of coal-basins in the world; the total number must, however, amount at least to from 250 to 300 principal coal-fields, and many of these are subdivided, by the disturbed position of the strata, into subordinate basins.* These basins or coal districts are, however, grouped into a comparatively small number of districts, and even many of these are little known, and not at all measured. The greater number occur in Western Europe and Eastern North America, while Central and Southern Africa, South America, and a large part of Asia, are totally without any trace of true carboniferous rocks. The remarks, therefore, that will follow, chiefly refer to the coal of our own and adjacent countries, or of the United States and British North America.

There are various kinds of coal obtained from mines worked in the true coal-fields, which may be grouped into bituminous coal, steam coal, and anthracite. Of the first the cannel is a remarkable variety, the coarser kinds of it being called in Scotland "parrot," and sometimes splint coal. It contains from 40 to nearly 60 per cent. of volatile matter, and the proportion of carbon varies within the same limits. It burns readily, taking fire like a candle, and giving a bright light, and much smoke. The ash varies from about 4 to 10 per cent. This coal yields on destructive distillation a very large quantity of gas, and is profitably used for that purpose. The gas is not only large in quantity, but remarkably pure, and of excellent quality for purposes of illumination. There is a large quantity of this kind of coal in the Scotch coal-fields, and it has also been found in the Newcastle district, in the Wigan portion of the Lancashire coal-field, and in the Yorkshire and Derbyshire coal-fields. America yields cannel coal in Kentucky, Indiana, Illinois, and Missouri. Cannel coal passes into jet, and may like jet be worked into various ornaments; but it is brittle, and not very hard. The seams are generally rather thin, although there are several important exceptions in which the quantity is very considerable. The coal of Belgium from one basin (that of Mons) seems to be of this kind.

Another and far more abundant kind of bituminous coal is that obtained abundantly in Northumberland and Durham, and commonly used in London and everywhere on the east and south coast of England. This kind is also highly bituminous, burns with much flame, and takes fire readily, but it swells and alters its form while burning, often assuming a striking and very peculiar appearance, illustrated by a column of coke exhibited by Mr. Cory, and also by other cokes shown by the coal trade of Northumberland and Durham. This caking coal, as it is called, yields, on an average of several analyses, about 57 per cent. of carbon, about 37·6 volatile matter, and 5 per cent. ash. Its specific gravity is 1·257, but sometimes higher. It leaves a red ash in an open fire, but requires to be deprived of its volatile matter before being exposed to a strong blast, owing to its tendency to cement together in a solid mass, and prevent a free draft through the grate or furnace in which it is employed. Not only the coals of the Newcastle coal-field in England, but those of France generally, of Bohemia, and Silesia, in Europe, and of Ohio, in North America, are of the caking bituminous kind.

The coals of Staffordshire, Yorkshire and Derbyshire, Lancashire, North Wales, and many other districts, contain nearly or quite as much bituminous and volatile matter as that of Newcastle, but does not cake and swell in the fire, and may, therefore, be employed directly where strong heat is required without previous coking. The coke obtained from this coal is little altered in appearance. The coal burns freely, will flame and give much heat, but is generally considered somewhat inferior for household purposes to that of Newcastle. It yields 50 to 60 per cent. carbon, 35 to 45 volatile matter, and a small quantity, often less than 5 per cent. of ash. The ash is often white. Most of the coals from the inland counties

* Taylor's "Statistics of Coal," Introduction, p. xxxvii.

readily show white lines on the edges of the beds, owing to the pressure of argillaceous earth which effloresces. In this respect they are less adapted for general use than the Newcastle coal, but many of them are of excellent quality.

Next in order to the coals of the midland counties generally, are those of some parts of North Wales, and many districts in South Wales, which contain a larger per centage of carbon, very little volatile matter and bitumen, and often but little ash; which burn, however, freely and without smoke, and are well adapted for steam purposes and the manufacture of iron, or where a strong blast and great heat is required. Such coals exist not only in England, but in France, Saxony, and Belgium to some extent. They are often tender or powdery, dirty-looking, and of comparatively loose texture, but they often stand exposure to the weather without alteration or injury. They are called steam coals, and the inferior kinds are known as culm. They contain carbon 81 to 85, volatile matter 11 to 15, ash 3, or thereabouts. Several varieties well known in commerce are exhibited by different proprietors, and the respective analyses will be found in many cases in the body of the Catalogue.

The last kind of coal is that called "anthracite," and it consists almost exclusively of carbon. This coal is also called non-bituminous, as the steam coal is semi-bituminous. The anthracites contain from 80 to upwards of 95 per cent. carbon, with a little ash, and sometimes a certain small per centage of volatile matter. They are heavier than common coal, take fire with difficulty, but give an intense heat when in full combustion with a strong draught. Anthracite occurs abundantly in the western part of South Wales, in the south of Ireland, in France, Saxony, Russia, and in North America, and the use of them is greatly on the increase. Amongst other things it is used for hop and malt drying, and lime burning with great advantage, but its chief use is in the manufacture of iron. The appearance is often bright, with a shining irregular fracture; the coal is often hard, but some varieties are tender and readily fractured. The ash of anthracitic coal is generally white. As a general rule the anthracites are deficient in hydrogen, but contain a certain proportion of oxygen gas.

The following table represents the weight of water evaporated by one pound each of several principal varieties of coal, and is, therefore,—other things being the same—a good index of the relative value of these fuels:—

	Lbs.	Oz.
Common Scotch bituminous coal .	5	14
Hastings Hartley main, Newcastle .	6	14½
Carr's West Hartley ditto . . .	7	5
Middling Welsh anthracite . . .	7	15¼
Merthyr bituminous coal (South Wales)	8	0
Llangenech steam coal, ditto . .	8	14½
Cameron's steam coal, ditto . .	9	7¾
Pure Welsh anthracite, ditto . .	10	8½

The relative importance of mineral fuel in various countries, as indicated by the actual coal area and the real production of different districts, may be understood by a reference to the subjoined table. This and other statistical facts are based chiefly upon the authority of Mr. Taylor* but have before been given in their present form by the author of the present essay.†

COUNTRIES.	Coal Area in Square Miles.	Proportion of whole Area of the Country.	Annual Production in Tons.
British Islands	12,000	1–10	32,000,000
France	2,000	1–100	4,150,000
Belgium	520	1–22	5,000,000
Spain	4,000	1–52	550.000
Prussia	1,200	1–90	3,500,000
Bohemia	1,000	1–20	
United States of America .	113,000	1–20	4,000,000
British North America . .	18,000	2–9	

* "Statistics of Coal," by R. C Taylor (London, J. Chapman, 1850).
† "Elementary Course of Geology" (London, 1848).

It will thus be seen how extremely important the coal-fields of the British islands really are when compared with any others elsewhere. This is the case not merely in the total annual production and the proportionate extent of the deposit, but also in the great number of points at which the coal can be advantageously worked. This will be best seen by reference to another table also here appended.

TABLE of the Principal Coal-Fields of the British Islands.

	Estimated Workable Area in Acres.	Number of Workable Seams.	Estimated Total thickness of Workable Coal in Feet.	Thickest Bed in Feet.	Total thickness of Coal-bearing Measures in Feet.
1. Northumberland and Durham District:—					
Newcastle Coal-Field .	500,000	18	80	7	.
2. Cumberland and Westmoreland, and West Riding of Yorkshire:—					
Whitehaven and Akerton	80,000	7	.	8	2,000
Appleby (three basins) .	17,000	.	.	.	.
Sebergham (Cumberland)	.	1	3	3	.
Kirkby Lonsdale . .	2,500	4	17	9	.
3. Lancashire, Flintshire, and North Staffordshire:—					
Lancashire Coal-Field .	380,000	75	150	10	6,000
Flintshire	120,000	5	39	9	200
Pottery, North Staffordshire.	40,000	24	38	10	.
Cheadle, ditto . . .	10,000	.	.	.	
4. Yorkshire, Nottinghamshire, Derbyshire, &c.:					
Great Yorkshire Coal-Field	650,000	12	32	10	.
Darley Moor, Derbyshire . } Shirley Moor, ditto . . }	1,500	.	.	.	.
5. Shropshire and Worcestershire:—					
Colebrook Dale, Shropshire.	12,000	17	40	.	.
Shrewsbury, ditto . .	16,000	3	.	.	
Brown Clea hill, ditto .	1,300	3	.	.	
Titterstone, Clea-hill, ditto	5,004		.	.	.
Lickey Hill, Worcestershire.	650		.	.	.
Bewdley, ditto . . .	45,000	.	.	.	.
6. South Staffordshire:—					
Dudley and Wolverhampton.	65,000	11	67	40	1,000
7. Warwickshire and Leicestershire:—					
Nuneaton	40,000	9	30	15	.
Ashby-de-la-Zouch . .	40,000	5	33	21	.
8. Somersetshire and Gloucestershire:—					
Bristol	130,000	50	90	.	.
Forest of Dean . . .	36,000	17	37	.	.
Newent, Gloucestershire .	1,500	4	15	7	.
9. South Welsh Coal-Field .	600,000	30	100	9	12,000
10. Scottish Coal-Fields:—					
Clyde Valley . . . } Lanarkshire . . . } South of Scotland, several small areas. }	1,000,000	84	200	13	6,000
Mid-Lothian . . .	.	24	94	.	4,400
East Lothian . . .	.	60	180	13	6,000
Kilmarnock . . . } Ayrshire . . . . }	.	3	40	30	.
Fifeshire	.	.	.	21	.
Dumfries Coal Region .	45,000	10	55	6	.
11. Irish Coal-Fields:—					
Ulster	500,000	9	40	6	.
Connaught	200,000	.	.	.	.
Leinster, Kilkenny . .	150,000	8	23	.	.
Munster (several) . .	1,000,000	.	.	.	.

The beds with which the coal is generally associated in the British islands are various sands and shales (imperfect slaty beds) of different degrees of hardness; but the actual coal seams themselves often repose directly on clay of peculiar fineness, well adapted for fire-brick, and generally called under-clay. The under-clay is used in many coal districts for various purposes of pottery. Bands of ironstone (impure argillaceous carbonate of iron) are very abundant in certain coal districts, but are almost absent in others. The Scotch coal-fields near Glasgow, the South Welsh, Yorkshire, and some others, are rich in ironstone, which is the chief source of the vast quantities of iron manufactured in this kingdom.

The principal coal areas of Europe, apart from those of the British islands, are those of Belgium, France, Spain (in the Asturias), Germany (on the Ruhr and Saare), Bohemia, Silesia, and Russia (on the Donetz). Of these the Belgian are the most important, and occupy two districts, that of Liége and that of Hainault, the former containing 100,000, and the latter 200,000 acres. In each the number of coal seams is very considerable, but the beds are thin, and so much disturbed as to require special modes of working. The quality of the coal is very various, including one peculiar kind, the Flenu coal, unlike any found in Great Britain, except at Swansea. It burns rapidly with much flame and smoke, not giving out an intense heat, and having a somewhat disagreeable smell. There are nearly fifty seams of this coal in the Mons district. No iron has been found with the coal of Belgium.

The most important coal-fields of France are those of the basin of the Loire, and of these, St. Etienne is the best known and largest, comprising about 50,000 acres. In this basin are 18 beds of bituminous coal, and in the immediate neighbourhood several smaller basins, containing anthracite. Other valuable localities are in Alsace, several in Burgundy, much worked by very deep pits, and of considerable extent; some in Auvergne, with coal of various qualities; some in Languedoc and Provence, with good coal; others at Arveyron; others at Limosin; and some in Normandy. Besides these are many others of smaller dimensions and less extent, whose resources have not yet been developed. The total area of coal in France has not been ascertained, but is probably not less than 2,000 square miles. The annual production is now at least 4,000,000 tons.

There are four coal districts in Germany, of the carboniferous period, besides several districts where more modern lignites occur. The principal localities for true coal are near the banks of the Rhine, in Westphalia; on the Saare, a tributary of the Moselle; in Bohemia; and in Silesia. The total annual production exceeds 2,750,000 tons.

Of these various localities, Silesia contains very valuable and extensive deposits of coal, which are as yet but little worked. The quality is chiefly bituminous, the beds few in number, but very thick, amounting in some cases to 20 feet. Some anthracite is found. Bohemia is even more richly provided than Silesia, the coal measures covering a considerable area and occupying several basins. More than 40 seams of coal are worked, and several of these are from four to six feet thick.

The basin of the Saare, a tributary of the Moselle, near the frontier of France, affords a very important and extensive coal-field, which has been a good deal worked, and is capable of great improvement. No less than 103 beds are described, the thickness varying from 18 inches to 15 feet. It is estimated that, at the present rate of extraction, the basin contains a supply for 60,000 years. On the banks of the Ruhr, a small tributary to the Rhine, entering that river near Dusseldorf, there is another small coal-field, estimated to yield annually nearly 1,000,000 tons. The whole annual supply from Prussia and the German States of the Zollverein, or Customs' Union is considered to exceed 2,750,000 tons.

Hungary and other countries in the east of Europe contain true coal-measures of the carboniferous period; but the resources of these districts are not at present developed. On the banks of the Donetz, in Russia, coal is worked to some extent, and is of excellent quality, but it belongs to the older part of the carboniferous period.

Spain contains a large quantity of coal, both bituminous and anthracitic. The richest beds are in the Asturias, and the measures are so much broken and altered in position as to be worked by almost vertical shafts through the beds themselves. In one spot upwards of 11 distinct seams have been worked, the thickest of which is nearly 14 feet thick. The exact area is not known, but it has been estimated by a French engineer that about 12,000,000 of tons might be readily extracted from one property, without touching the portion existing at great depths. In several parts of the province the coal is now worked, and the measures seem to resemble those of the coal districts generally. The whole coal area is said to be the largest in Europe, presenting upwards of 100 workable seams, varying from 3 to 12 feet in thickness.

There are in North America four principal coal-areas, compared with which the richest deposits of other countries are comparatively insignificant. These are the great central coal-fields of the Alleghanies; the coal-field of Illinois, and the basin of the Ohio; that of the basin of the Missouri; and those of Nova Scotia, New Brunswick, and Cape Breton. Besides, there are many smaller coal-areas which, in other countries, might well take rank as of vast national importance; and which, even in North America, will one day contribute greatly to the riches of various States.

The Alleghany, or Appalachian coal-field, measures 750 miles in length, with a mean breadth of 85 miles, and traverses eight of the principal states in the American Union. Its whole area is estimated at not less than 65,000 square miles, or upwards of 40,000,000 of acres.

The coal is bituminous, and used for gas. In Kentucky, both bituminous and cannel-coal are worked in seams about three or four feet thick, the cannel being sometimes associated with the bituminous coal as a portion of the same seam; and there are, in addition, valuable bands of iron ore. In Western Virginia there are several coal-seams of variable thickness, one, nine and a half feet, two others, of five, and others, of three or four feet. On the whole, there seems to be at least forty feet of coal distributed in thirteen seams. In the Ohio district, the whole coal-field affords, on an average, at least six feet of coal. The Maryland district is less extensive, but is remarkable as containing the best and most useful coal, which is worked now to some extent at Frostburg. There appears to be about 30 feet of good coal in four seams, besides many others of less importance. The quality is intermediate, between bituminous and anthracitic, and it is considered well adapted to iron making. Lastly, in Pennsylvania, there are generally from two to five workable beds, yielding, on an average, about ten feet of workable coal, and amongst them is one bed traceable for no less than 450 miles, consisting of bituminous coal, its thickness being from twelve to fourteen feet on the south-eastern border, but gradually diminishing to five or six feet. Besides the bituminous coal, there are, in Pennsylvania, the largest anthracitic deposits in the States, occupying as much as 250,000 acres, and divided into three principal districts.

The Illinois coal-field in the plain of the Mississippi is only second in importance to the vast area already described. There are four principal divisions traceable, of which the first, or Indiana district, contains several seams of bituminous coal, distributed over an area of nearly 8,000 square miles. It is of excellent quality for many purposes; one kind burning with much light, and very freely, approaching cannel-coal in some of its properties; other kinds consist of caking, or splint coal. In addition to the Indiana coal-field, there appears to be as much as 48,000 square miles of coal-area in the other divisions of the Illinois district, although these are less known, and not at present much worked. 30,000 square miles are in the state of Illinois, which supplies coal of excellent quality, and with great facility. The coal is generally bituminous.

The third great coal-area of the United States is that of the Missouri, which is little known at present, although certainly of great importance.

British America contains coal in the provinces of New Brunswick and Nova Scotia. The former presents three coal-fields, occupying in all, no less than 5,000 square miles; but the latter is far larger, and exhibits several very distinct localities where coal abounds. The New Brunswick coal-measures include not only shales and sandstones, as is usual with such deposits, but bands of lignite, impregnated with vitreous copper ore, and coated by green carbonate of copper. The coal is generally in thin seams, lying horizontally. It is chiefly, or entirely bituminous.

In Nova Scotia there are three coal regions, of which the Northern presents a total thickness of no less than 14,570 feet of measures, having 76 seams, whose aggregate magnitude is only 44 feet, the thickest beds being less than four feet. The Pictou, or central district, has a thickness of 7,590 feet of strata, but the coal is far more abundant, one seam measuring nearly 30 feet; and part of the coal being of excellent quality, and adapted for steam purposes. The southern area is of less importance. Besides the Nova Scotia coal-fields, there are three others at Cape Breton, yielding different kinds of coal, of which one—the Sydney coal—is admirably adapted for domestic purposes. There are here 14 seams above three feet thick, one being 11, and one 9 feet.

Coal, existing generally in beds of moderate thickness, inclined at a small angle to the horizon, and often at very considerable depth beneath the surface, is extracted most commonly by the aid of pits or shafts sunk to the bed, and galleries (levels or drifts) cut horizontally, or in the plane of the bed to a certain distance. By a number of such galleries, cut at right angles to each other, the whole bed, within certain limits, is completely laid open, the overlying beds being supported by the masses of coal (pillars or columns) left untouched between the galleries. In this way about one-third of the coal can be extracted, and afterwards, on the supporting columns being also removed, the roof falls in, and the work is regarded as finished. This method is called technically "the pillar and stall method," and is adopted in the Newcastle coal-field. In Yorkshire, and elsewhere, instead of such columns being left, the coal is removed entirely, and at once, without columns; the roof falling behind the work as it advances. This is the long-wall method. Other modes are occasionally followed when the condition of the coal requires it.

Owing to the gaseous substances contained in coal, and given off not only on exposure to heat, but also to a certain extent by pressure, many kinds of coal cannot safely be left during the process of extraction, without some defence from the open lights required by the miner in the mechanical operations of removing the coal from its bed, and conveying it to the pit bottom. An explosive gaseous compound is readily produced by the admixture of the gases given off by the coal, with common air, made to circulate through the workings, and, if neglected, this compound accumulates and travels on till it meets with flame, and then explodes, causing frightful destruction not only to the property of the mine-owner, but also to the life of the miner. Many contrivances have been suggested from time to time; on the one hand, to improve the ventilation of the mines, and on the other, providing means of illumination which would render accidents from explosion less probable, by removing the immediate cause. Examples of both will be found amongst the models and instruments exhibited in this class, and to these the reader is referred. It is not likely that any contrivances can render absolutely safe an employment which of necessity involves so many and such serious risks as are connected with coal-mining; but much may, no doubt, be done to diminish the danger both from imperfect ventilation and open light.

In concluding this notice of mineral fuel, it may be worth while to draw attention to the vast and overwhelming importance of the subject, by a reference both to the absolute and relative value of the material, especially in the British Islands. It may be stated as probably within the true limit, if we take the annual produce of the British coal-mines at 35,000,000 tons, the value of which is not less than 18,000,000*l.* sterling, estimated at the place of consumption, and therefore including, to a certain amount of transport cost, necessary to render available, the raw material. At the pit mouth the value of the coal is probably about half this, or 9,000,000*l.* sterling, and the capital employed in the coal trade is estimated at 10,000,000*l.* The average annual value of all the gold and silver produced throughout the world has been estimated to have amounted, in 1847, to nearly thirteen millions and three quarters stirling. We have therefore the following summary, which will not be without interest:—

	£.
Value of the coal annually raised in Great Britain, estimated at the pit mouth	9,000,000
Mean annual value at the place of consumption	18,000,000
Capital engaged in the coal trade .	10,000,000
Mean annual value of the precious metals obtained from North and South America and Russia . .	5,000,000
Total value of precious metals raised throughout the world in 1847 .	13,710,000
Mean annual value at the furnace, of iron produced from British coal .	8,000,000

It is hoped that all the errors which have been pointed out in the first issue of the Catalogue have been corrected; and it is particularly requested that any inaccuracies or deficiencies still existing may be communicated to the Catalogue Office at the Exhibition Building without delay, with a memorandum of the Class and Number where they occur.

Alphabetical Indexes are in course of preparation, and will be published shortly.

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