Mineralogia Cornubiensis; a treatise on minerals, mines, and mining. Containing the theory and natural history of strata, fissures, and lodes, with the methods of discovering and working of tin, copper, and lead mines, and of cleansing and metalizing their products; shewing each particular process for dressing, assaying and smelting of ores. To which is added, an explanation of the terms and idioms of miners / By W. Pryce.

Contributors

Pryce, William, 1725?-1790.

Publication/Creation

London : Printed and sold for the author by J. Phillips [etc.], 1778.

Persistent URL

https://wellcomecollection.org/works/mrk9ztrg

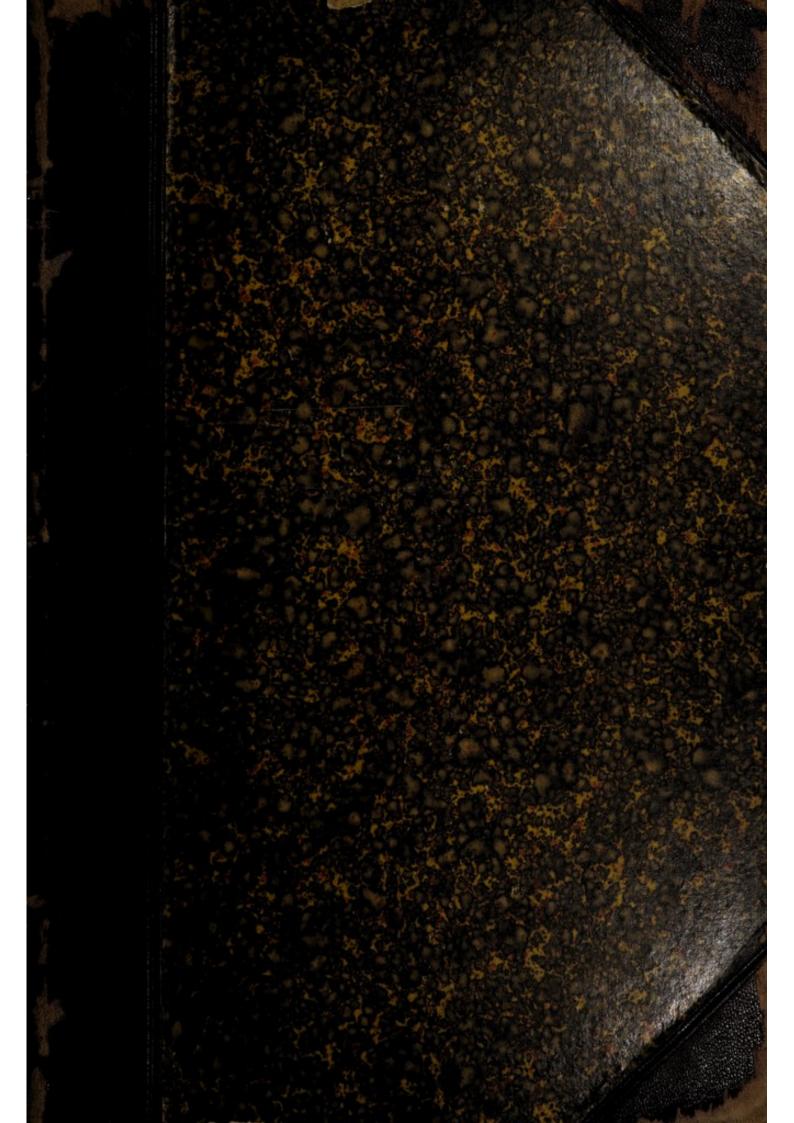
License and attribution

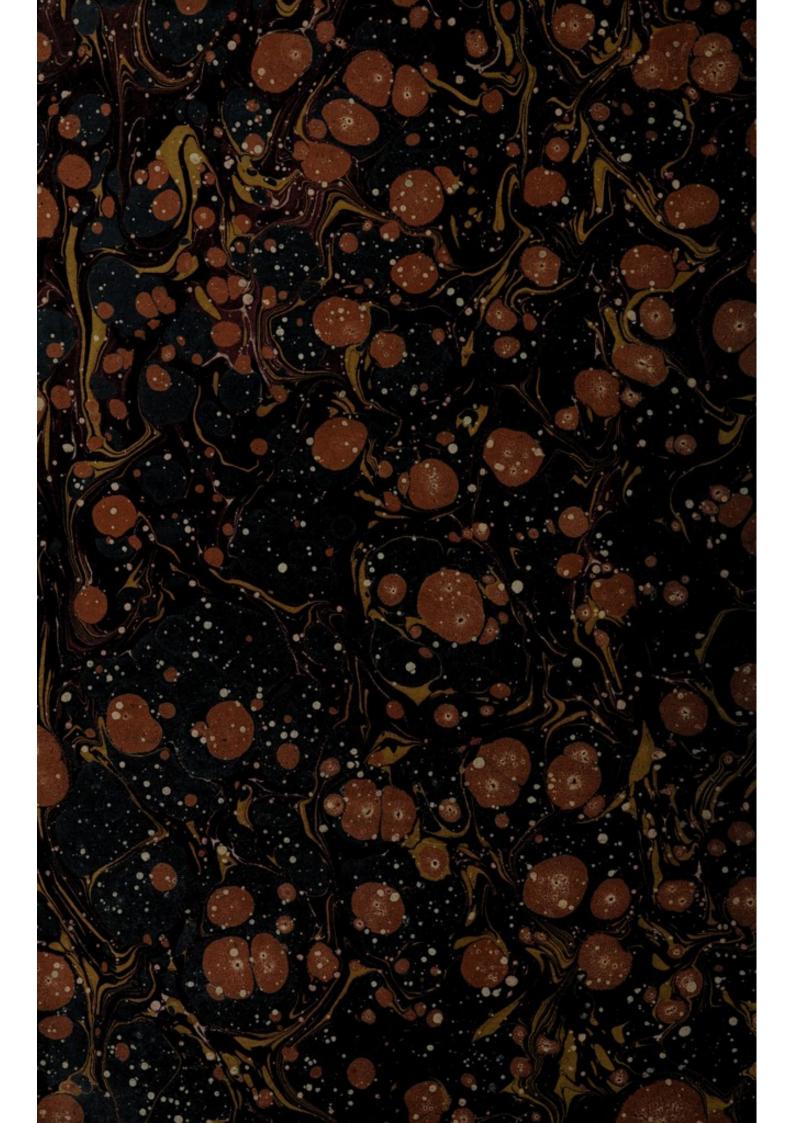
This work has been identified as being free of known restrictions under copyright law, including all related and neighbouring rights and is being made available under the Creative Commons, Public Domain Mark.

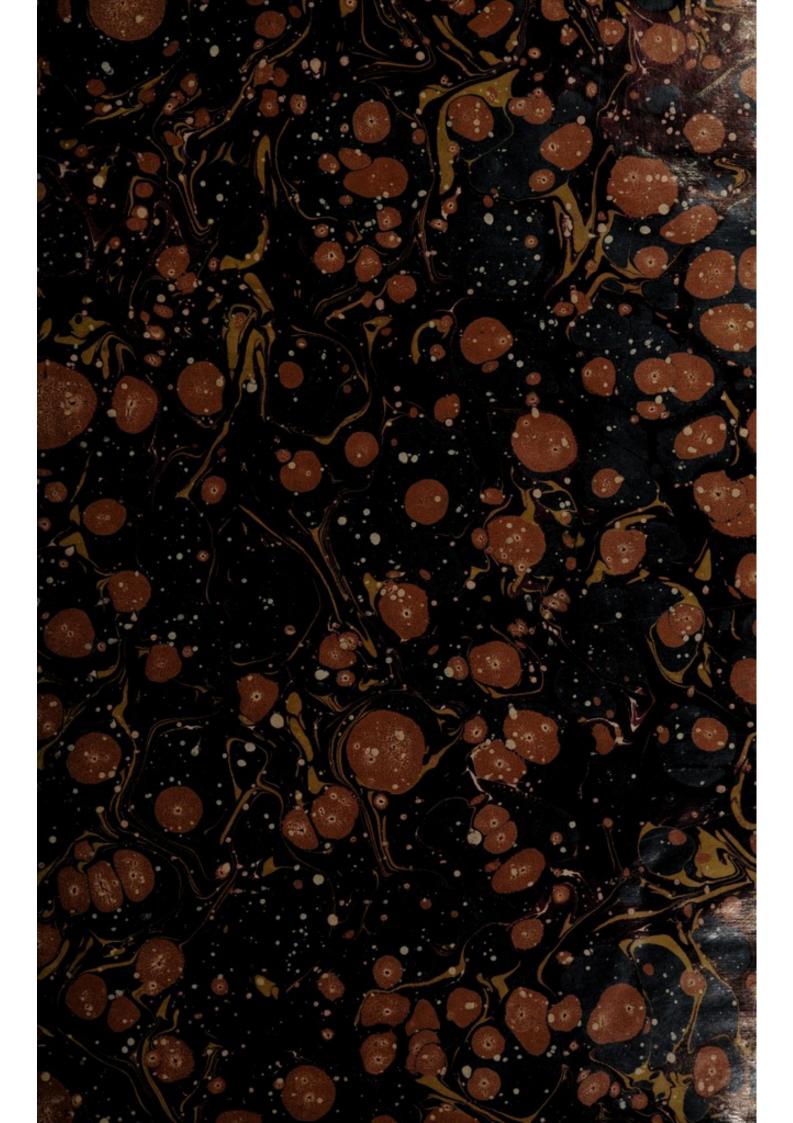
You can copy, modify, distribute and perform the work, even for commercial purposes, without asking permission.



Wellcome Collection 183 Euston Road London NW1 2BE UK T +44 (0)20 7611 8722 E library@wellcomecollection.org https://wellcomecollection.org





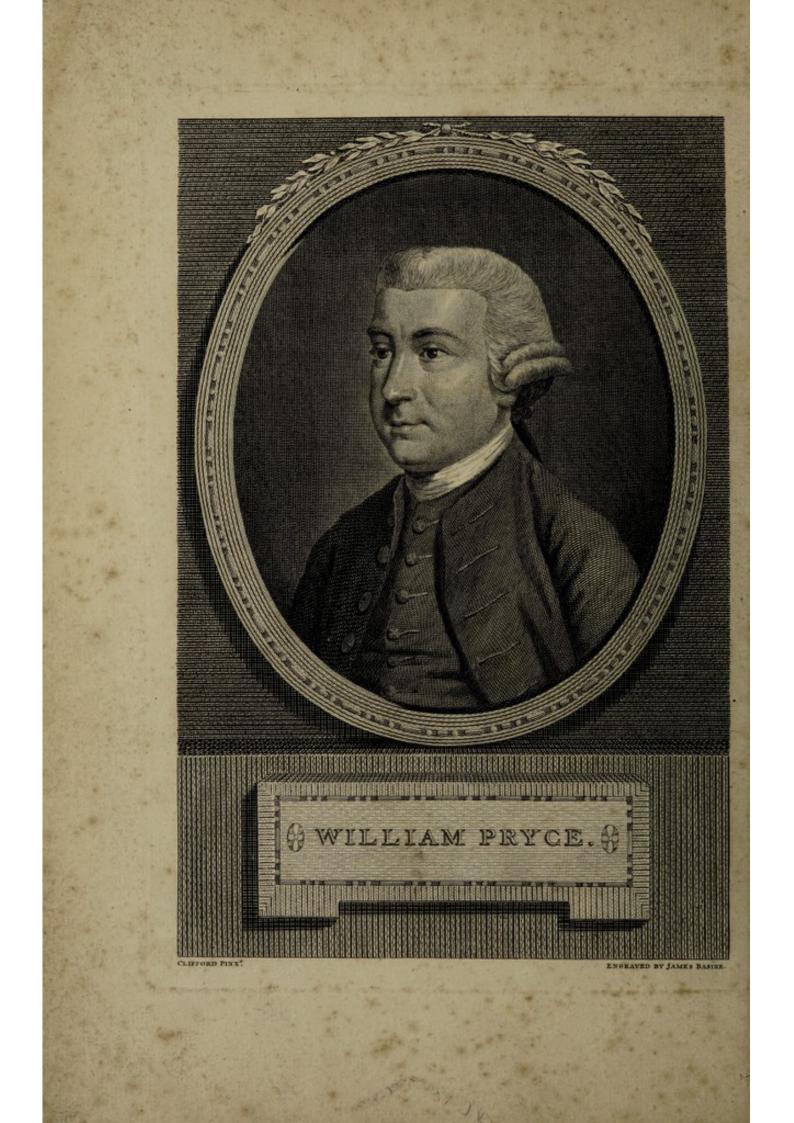












MINERALOGIA CORNUBIENSIS;

James A Maculton

T R E A T I S E O N MINERALS, MINES, A N D MINING:

CONTAINING THE THEORY AND NATURAL HISTORY OF STRATA, FISSURES, AND LODES, WITH THE METHODS OF DISCOVERING AND WORKING OF TIN, COPPER, AND LEAD MINES,

CLEANSING AND METALIZING THEIR PRODUCTS; shewing each particular process for DRESSING, ASSAYING, and SMELTING of ORES. TO WHICH IS ADDED,

AND OF

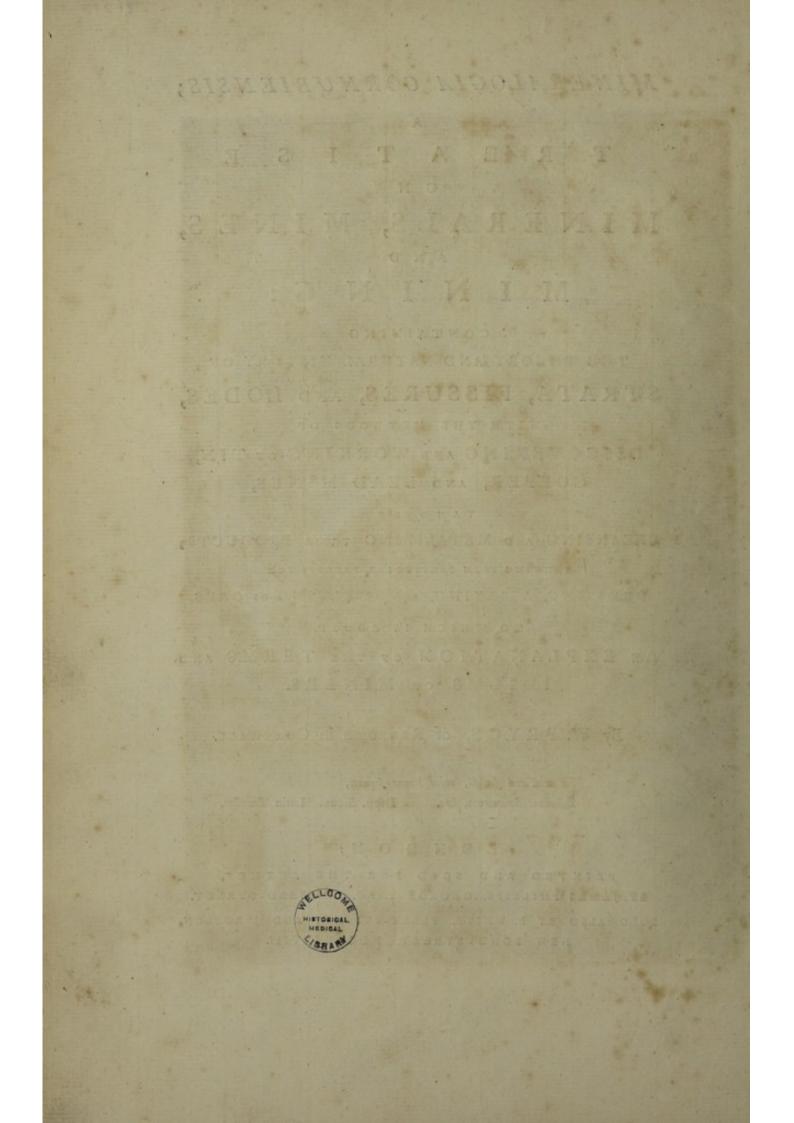
AN EXPLANATION OF THE TERMS AND IDIOMS OF MINERS.

By W. PRYCE, of REDRUTH in CORNWALL.

Hi ex Terrá faxofá, cujus Venas sequuti, Effodiunt STANNUM, Sc. DIOD. SICUL. Latin Translat.

LONDON:

PRINTED AND SOLD FOR THE AUTHOR, BY JAMES PHILLIPS, GEORGE-YARD, LOMBARD-STREET. SOLD ALSO BY B. WHITE, FLEET-STREET; AND J. ROESON, NEW BOND-STREET. MDCCLXXVIII,



TO HIS

ROYAL HIGHNESS

GEORGE,

PRINCE OF WALES,

AND

DUKE OF CORNWALL;

THIS WORK

IS

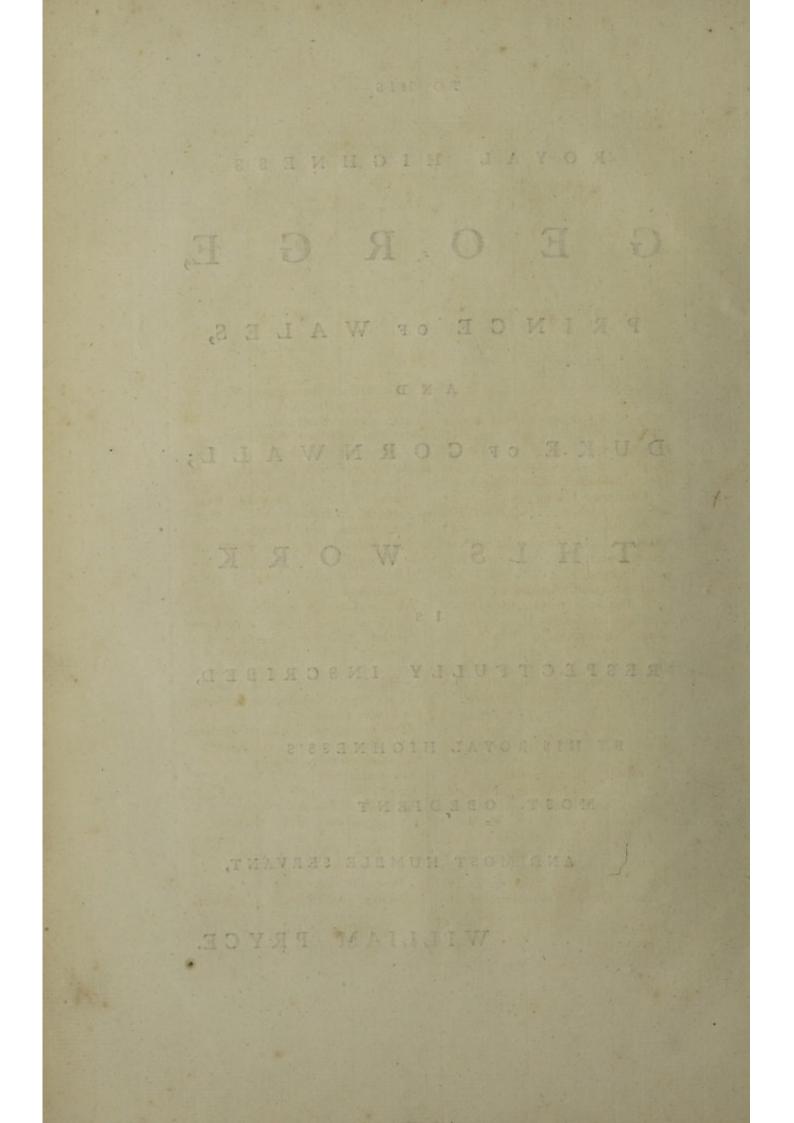
RESPECTFULLY INSCRIBED,

BY HIS ROYAL HIGHNESS'S

MOST OBEDIENT

AND MOST HUMBLE SERVANT,

WILLIAM PRYCE.



THE

E S M

OFTHE

B S C RI E R S.

wet Lord Erelly.

JIGHT Hon. Earl of Antrim, 3 Copies Right Hon. Earl of Altamont Right Hon. Lord Arundel, 2 Copies John Laurence Aikenhead, Efq; Grofvenor-Place Stanefby Alchorne, Efq; Aflay-Mafter to the Mint Rev. Gerveys Allen, Falmouth Sir Launcelot Allgood, Bart. Mr. Allifon, Falmouth Mr. Anderfon, Apothecary, Bath Mr. Benjamin Angel, Isleworth Antiquarian Society Swete Nicholas Archer, Efq; Trelafk, Cornwall John Arfcott, Efq; Tedcott, Devon John Aftley, Efq; Pall Mall William Atkinfon, Efq; Ditto

B B

Right Hon. Earl Bective Rev. Dr. Bagot, Dean of Chrift

- Church, Oxford Sir George Baker, Bart. M. R.
- F. R. S.

Mr. John Barber, Engraver

- Sir Robert Barker, Bart, F. R. S. Rev. William H. Barker, A. M. Prebendary of Llanddewy, South-Wales
- Frederick Barnard, Efq; King's Li-2 Copies brarian,

Hon. Daines Barrington, V. P. of the R. and A. S.

- Hon. Barry Barry, M. P. Ireland Mr. James Bafire, Engraver to the R. and A. S.
- Francis Baffet, Efq; Tehidy, Cornwall, a Plate and 4 Copies Frederick Barnard Beamish, Efq;

M. P. in Ireland

John Beard, Efq; Penzance

John Beauchamp, Efq; Pengreep, Cornwall, 2 Copies

Joseph Beauchamp, Esq; Trefince, Cornwall

Mr. Beckett, Bookfeller, Adelphi, 2 Copies

- Stephen Bell, Efq; Agent at Falmouth, P. G. M. Cornwall
- Late George Bell, Efq; Agent at Falmouth, P. G. M. Cornwall
- Mr. Francis Bennallack, Bofvigo, Truro

Meff. Bennet and Hake, Rotterdam Mr. Thomas Bentley, Greek-Street Rowland Berkley, Efq; G. T.

Mr. Caleb Birchall, Horfehay

Late Sir Walter Blackett, Bart. M. P. Sir Edward Blackett, Bart.

George Blewett, Efq; Marazion,

3 Copies

John Bond, Efq; M. P. Corff Caftle Mr. Hugh Booth, Cliffgate-Bank, Newcastle Underline

Late Rev. George Borlafe, Marazion

Lato Languis of California California

| Late Rev. Walter Borlafe, L. L. D. Vice-Warden of the Stannaries SamuelBorlafe, Efq; Caftle-Horneck, Cornwall Rev. George Borlafe, A. M. Fellow of Peter-Houfe Coll. Cambridge, and Regiftrary to the Univerfity Rev. William Borlafe, Vicar of Mad- derne, Cornwall William Bofanquet, Efq; London Hon. Mrs. Bofcawen, 2 Copies Mr. Samuel Botfield Matthew Boulton, Efq; Soho, Bir- mingham Mr. Bowles, Cornhill William Boys, Efq; Sandwich, Kent Mr. Andrew Bradley, Coalbrook- Dale Capt. Brathwaite, of the Hampden Pqt. Falmouth Mr. Edward Bray, Attorney, Ta- viftock Owen Sal. Brereton, Efq; M. P. F. R. and A. S. Mr. William Brown, Strand Hon. James Browne, M. P. Ireland Hawkins Brown; Efq; Ruffel-Street William Brutton, A. M. Rector of Southill, and Vicar of Cullumpton, Devon Rev. John Brutton, A. M. Rector of Southill, and Vicar of Cullump- ton Rev. James Buckingham, Vicar of Stithyans, Cornwall John Buller, of Morval, Efq; M. P. 2 Copies John Buller, Efq; M. P. Lord of the Admiralty, and Auditor of the Dutchy of Cornwall Francis Buller, Efq; King's Counfel, and Chief Juftice of Chefter Mr. Henry Burgum, Pewterer, Briftol Mr. John Burrel, Borrowfonnefs, | Right Hon. Earl of Cork Right Hon. Lord Vifcount Courtenay Right Hon. Lord Carysfort, 2 Copies Mr. William Calcott, Bookfeller, Banbury John Call, Efq; Whiteford, Corn- wall Rev. Cornelius Cardew, Truro Rev. Thomas Carlyon, of St. Juft, Cornwall Sir David Carnegie, Bart. Matthew Carrat, Efq; Hatton-Gar- den The Carron Company, Scotland Sir Thomas Cave, Bart. Late Mr. John Cauldwell, Chemift, Smithfield John Caulett, M. B. St. John's College, Cambridge Anthony Chamier, Efq; Deputy Secretary of State William Chapman, Efq; Newcaftle Mr. William Chapple, Exeter William Chapter, Efq; M. P. Rev. Dr. Chelfum, Student of Chrift Church, Oxford Mr. Michael Clarke, Chemift, Apo- thecary's Hall Mr. Thomas Colke, Thanet's Build- ings, Temple-Bar Rev. Thomas Coke, L. L. D. Rev. Francis Cole, of Trengoffe, <i>Plate and 2 Copies</i> R. P. Coles, Efq; Cadaxton, Gla- morganthire Rev. J. B. Collins, Rector of Cam- borne, Cornwall Edward Collins, Efq; Iombard- Street |
|---|---|
| Briftol | Street |
| Scotland | Michael Collinfon, Efq; |
| Robert Butler, Efq; | Dr. Colwell, Plymouth Charles Cooke, Efq; Lion-Houfe, |
| Grouge Blaweth Effit Merizian, | Prescott, Lancashire |
| Infan Bond, P.Co. M. P. Com Callia | William Cooper, Surgeon, Shrewf- bury |
| Right Rev. John Garnet, Lord Bi- | Robert Corbett, Efq; Longnor, Salop |
| thop of Clogher, Ireland | Late Humphrey Cotes, Efq; Que- |
| Right Rev. Walter Cope, Lord Bi- ihop of Clonfert, Ireland | Mr. James Cox, (Mufeum) Jeweller |
| Right Hon. Marquis of Carmarthen, | inter Junes Coxy (indicanity Jewener |
| 3 Copies | Daniel |

Daniel Crafter, Efq; Crafter, Alnwick, Northumberland Mr. Emanuel Mendez da Cofta,

Foffilift

- Hon. and Right Rev. Frederick Hervey, Lord Bifhop of Derry
- James Dagge, Efq; Killiganoon, Cornwall
- Henry Dagge, Efq; Great Ruffel-Street, Bloomfbury
- Mr. Abraham Darby, Coalbrook-Dale
- Mr. Samuel Darby, George-Yard, Upper Thames-Street
- John Davie, Efq; Biddeford
- Rev. Joseph Davie, Trinity College, Oxford
- Henry Dawkins, Efq; L.L.D. M.P. James Dawkins, Efq;
- John Day, Efq; Exeter
- The Dean and Chapter of Durham
- Dr. De la Cour, Bath
- Edward Huffey Delaval, Efq;

F. R. S. Parliament-Stairs Mr. John Denman, Holywell, Flintshire

- David Dennis, Efq; Penzance
- Dr. Derwin, F. R. S. Litchfield
- Thomas Devonshire, Efq; Truro
- Legh Dickenson, Esq; Redruth
- Mr. Dillon, Roper, Penryn
- Jeremiah Dixon, Efq; F. R. S.

Dr. Dobfon, Leverpool

- Capt. Donnellan, Pantheon, Oxford-Street
- Sir Francis H. Drake, Bart. M. P. The Druids Lodge of Love and
- Liberality, Redruth Thomas Dunckerley, Efq; Hampton-Court Palace
- Mr. William Duefbury, Porcelain Manufactory, Bedford-Street

Mr. Henry Durbin, Chemift, Briftol William Herbert Dyer, Efg; Aberglafiney, Carmarthenshire

Manaekan, Cogwall

Right Hon. Lord Edgeumbe Rt. Hon. Earl of Effingham, 2 Copies Right Hon. Earl of Ely

- Right Hon. Lord Vifcount Ennifkilling
- Right Hon. Lord Elphinstone
- Rev. Mr. Eccles, Rector of Bow, Middlefex
- Hugh Edwards, Efq; St. Ives
- Mr. John Edwards, of Hayle Copper-Works
- John Elliot, Efq; Lincoln's Inn Fields
- Mr. George Emerson, Grinton, Yorkfhire
- Mr. English, Westmorland
- The English Copper Company
- Mr. Thomas Ennis, Affayer, Redruth
- Philip Enouf, Efq; Falmouth Excter College Library, Oxford
- John Gordon, Turt. Invergordon,

Right Hon. Earl Ferrers

- Henry Arthur Fellows, Efq; Eggefford, Devon
- Thomas Fenton, Efq; Rothwell-Haigh, Leeds, Yorkshire
- James Fisher, Esq; C.C.C. Oxford
- Mr. John Fleming, Beaumaris
- Henry Fletcher, Efq; M. P.
- Mr. John Flint, Shrewfbury Mr. Daniel Foffick, Cannon-Street
- Samuel Foote, Efq; deceafed
- John Fothergill, M. D. F. R. S. Mr. John Fothergill, Merchant, Birmingham
- William Fowler, Efq; Kirland,
- near Bodmin, 2 Copies Mr. George Croker Fox, Merchant, Falmouth
- Mr. Charles Fox, Bookfeller, Falmouth
- Mr. Andrew Fox, Coalbrook-Dale Charles Frederick, Efg; Architect to the Ordnance
- Joseph Freeman, Efq; Clifton, Glouceftershire

John Freeman, Efq; Briftol

Stephen Fuller, Efq; Brightling, Suffex

D

G

Right Hon. Earl Galloway Right Hon. Lord Godolphin Luke Gardiner, Efq; M. P. Ireland Mr. John Garrat, Wapping, Briftol Sir Thomas Gafcoigne, Bart. Parlington, Yorkshire

Dr. Gaubuis, Profef. of Medicine at the University of Leyden, 3 Copies

Mr. Thomas Geach, Surgeon, Plymouth-Dock

Mr. Sampfon George, Attorney, Middeton Tyas, Yorkfh. 2 Copies

Rev. Edward Giddy, St. Earth

Mr. Giddy, Surgeon, Penzance

Mr. Thomas Glafs, Exeter

Meffrs. Glover and Son, Abercorn Iron-Works, Monmouthshire

Mr. Richard Goadby, Sherborne, 4 Copies

Sir John Gordon, Bart. Invergordon, Scotland

William Gordon, Efq; Newhall, Scotland

The Governor and Mines Royal Company

Richard Gough, Efq; F. R. S. and Director A. S.

William Graves, Efq; M. P.

Francis Gregor, Efq; Trewarthenick, Cornwall

George Grenfell, Efq; Kentish-Town Hon. George Nugent Grenville, M. P.

Hon. Charles Greville, F. R. S.

Chriftopher Gullet, Efq; Exeter

Mr. Gunning, Attorney, Bath Robert Lovel Gwatkin, Efq; A. B. St. John's College, Cambridge

H

Right Hon. Earl of Hadinton Right Hon. Earl of Home Right Hon. Earl of Hyndford Mr. John Hales, Cowbridge, Staffordshire Roger Hall, Efq; M. P. Ireland, 2 .Copies Mr. Hall, Caftleton, Derbyshire Capt. James Hall, of Swanfea Mr. John Halfe, Truro The late Mr. James Hamilton, Rolls Buildings

Charles Hanbury, Efq; Mr. Hancock, Charing-Crofs William Arundel Harris, Efq; Kenneggy, Penzance Rev. Sampfon Harris, Budock, Cornwall John Harris, Efq; Plymouth William Harris, Efq; Camborne, Cornwall Mr. John Harris, Tolgus, Redruth Thomas Hatton, A. B. Waters-Upton, Salop The late David Haweis, Efq; of Killiow, Cornwall Mrs. U. Haweis, Truro Cæfar Hawkins, Efq; Serjeant Surgeon to the King Chriftopher Hawkins, Efq; Trewithan, Cornwall Sir Robert Henderson, Bart., 2 Copies Lieut. Logan Henderson, of the Marines Mr. William Henderfon, Alloa, Scotland John Henflow, Efq; Mafter Shipwright, Plymouth-Dock James Hefeltine, Efq; G. S. Doctor's Commons James Modyford Heywood, Efq; Maristow, Devon. Richard Hichens, Efq; Trengwainton, Penzance Dr. Higgins, Chemift, Greek-Street, Soho William Hill, Efq; Carwythenick, Cornwall Lieut. Colonel John Hill, of the 9th Regiment of Foot Mr. Elias Hifcutt, Attorney, St. Columb, Cornwall Henry Hobhouse, Esq; Clifton, Glofter. John Hobhouse, Esq; Westbury, Glofter. Timothy Hollis, Efq; London Thomas Brand Hollis, Efq; the Hide, Surry

Rowland Holt, Efq; M.P. D.G.M.

Mr. Henry C. Hore, Affayer, Truro

Mr. Horner, Wells Rev. John Hofken, B. D. Vicar of

Manacken, Cornwall Rev. Joshua Howell, Rector of Lanreath, Cornwall

John

John Hull, Efq; Salt-Office, I.G.W. Dr. Hunter, F. R. S. M. R. John Hunter, Efq; Surgeon, F.R.S. Joseph Hurlock, Efq; John-Street, King's Road

Charles Hutton, Efq; F. R. S. Prof. of Mathematicks at Woolwich

Ŧ

Cyril Jackfon, A. M. late Sub-Preceptor to the Prince of Wales

John Jackfon, Efq; Merchant, Love-Lane, Eastcheap

Sir Hildebrand Jacob, Bart. William James, Efq; M. P.

Rev. Mr. Jenkins, Brazen-Nofe College, Oxford

Sir William Jerningham, Bart. Coffey-Hall, Norfolk

Mr. John, Surgeon, Helftone

St. John's College Library, Cambridge

Mr. Richard Johns, Attorney, Helftone

J. Johnstone, Efg; M. P.

Hon. Thomas Jones, M. P. Ireland Capt. Jones, of the Grantham Pqt. Falmouth

K

Right Rev. Charles Jackfon, Lord Bishop of Kildare, 2 Copies Right Rev. George Lewis Jones,

Lord Bifhop of Kilmore Right Rev. Robert Fowler, Lord

Bishop of Killaloe

James Keir, Efq; Stourbridge John Gardner Kemeys, Efq; Bor-

tholey, Monmouthshire

Mr. James Kempe, Surgeon, Truro Mr. Thomas Kevill, Camborne,

- Cornwall Edward King, Efq; F. R. and A. S.
- John-Street, Bedford-Row King's College Library, Cambridge

William Knighton, Efq; Treleigh, Redruth

John Knill, Efq; St. Ives

L

His Grace the Duke of Leeds,

2 Copies His Grace the Duke of Leinster, 2 Copies

Right Hon. Earl Lauderdale

Right Hon. Lord Lifford, Lord Chancellor of Ireland, 2 Copies

Right Hon. Lord Linton, 2 Copies Right Hon. Lord Lifle

Hon. John Lyfaght, Ireland

- Sir James Winter Lake, Bart. Great Ormond-Street
- Sir James Laroche, Bart. M. P.
- David Latouche, jun. Efq; M. P. Ireland

The Lead Company

Dr. Leake, Craven-Street, Strand

Rev. Francis Le Breton, Dean of Jerfey

Sir Alexander Leith, Bart. M. P.

Sir William Lemon, Bart. M. P. a Plate and 2 Copies

John Coakley Lettfom, M. D. F. R. S. and S. A.

- Afhton Lever, Efq; F. R. S. Leicefter-Houfe
- Dr. Lewis, Chemift, Kingfton, Surry Henry Lippincott, Efq; Stoke,
- Gloucestershire
- Lodge of Love and Honour, Falmouth

Joseph Lucas, Efq;

John Luxmore, Efq; Oakhampton

M

Sir Herbert Mackworth, Bart. M. P. Magdalen College Library, Oxford George Woodward Mallet, Efq; Plymouth

Harry D. Mander, Efq; Piercy-Street, Soho

Mr. Robert Mafon, Redruth

- Rev. Mr. Marshall, A. M. Vicar of Breage and Germo, Cornwall
- Mr. John Martin, Tory, Stithyans, Cornwall
- William Masterman, Esq; Trinity, Cornwall

Mr. William Matthews, Merchant, Green-Lattice-Lane

[**]

Late

Late Dr. Maty, Secretary to the Royal-Society Dr. Meagher, Truro Benjamin Mee, jun. Efq; London Rev. Mr. Michell, Thornhill, Yorkshire Mr. Stephen Michell, Redruth Late John Millet, Efq; Gurlyn, Cornwall Mr. Thomas Mills, Bookfeller, Briftol, 2 Copies Sir William Molefworth, Bart. a Plate and 2 Copies Samuel Moore, Efq; Secretary to the Society for the Promotion of Arts and Sciences Rt. Hon. Humphrey Morice, M. P. Lord Warden of the Stannaries, a Plate and 2 Copies Robert Morris, Efq; Swanfea John Morris, Efq; Clafemont, Glamorganshire Dr. Motherby, Hampstead Dr. Moyfey, Bath William Moxham, Distiller, Bristol John Mudge, Efq; Surgeon, Plymouth Francis Noel Clarke Munday, Efq; Derbyfhire Sir Harry Munro, Bart.

Dr. Mufgrave

N

His Grace the Duke of Northumberland, 2 Copies

Her Grace the late Dutchefs of Northumberland

Sir James Nafmyth, Bart.

Arnold Nefbit, Efq; M. P.

- Robert Lydstone, Newcombe, Efq; Exeter
- Mr. John Newman, Fellow of New College, Oxford
- Late Thomas Northmore, Efq; Cleeve, Devon.

0

Dr. Orme, Great St. Helens Rev. J. Owen, Worcefter-College, Oxford

His Grace the Duke of Portland Right Hon. Earl of Portfmouth Right Hon. Earl Percy Right Hon. Lord Algernon Percy Right Hon. Lady Algernon Percy Sir Herbert Perrot Packington, Bart. R. Palk, Efq; M. P. Paul Panton, Jun. Efq; A. M. Plafgwyn Mr. George Papps, Gwenap, Cornwall Rev. Sir Harry Parker, Bart. D. D. Oxford John Parker, Efq; M. P. Thomas Parker, Efq; Puttenham, Surry, P. G. M. John Parker, Efq; Brownsholme, Lancashire Rev. Mr. Parkyn, A. M. Penzance John Parfons, M. D. Oxford Thomas Patten, Efq; Warrington, Lancashire Late Francis Paynter, Efq; Bofkenna, Cornwall Francis Paynter, Efq; Michell, Cornwall Mr. John Pearce, Merther, Cornwall Mr. John Pearce, Bank of England Rev. William Pearce, A. M. Fellow of St. John's College, Cambridge Meff. Pearfon and Rollafon, Bookfellers, Birmingham Mr. William Peckitt, Glafs-Painter, York Rev. Henry Peers, Vicar of Eglofhayle, Cornwall Thomas Pennant, Efq; Downing, Flintshire Rev. Richard Penneck, A. M. of the British Museum William Pennington, Efq; Bodmyn Mr. Penwarne, Attorney, Penryn Sir Richard Perrot, Bart. St. Peter's Coll. Library, Cambridge Rev. Jonathan Peters, Vicar of St. Clement's, Cornwall Rev. H. Philipps, Vicar of Gwenap, Cornwall Mr. William Phillips, Redruth Mr. Richard Phillips, Redruth Mr. James Phillips, Bookfeller, George-Yard, Lombard-Street, 10 Copies Mr.

Mr. Richard Phillips, Ketley Rev. John Pickering, Vicar of Mackworth, Derbyfhire Rev. John Pickering, A. M. Bodmyn Thomas Pitt, Efq; M. P. Mr. Joseph Plumbley Dr. Allan Pollock, F. R. S. Prof. Fortif. Woolwich Sir Stanier Porten, Knt. Keeper of State Papers Rev. Mr. Powell, Vicar of Bodmyn Humphrey M. Praed, Efq; Trevethoe, Cornwall, 2 Copies John Pratt, Efq; Afkrigg, Yorkshire Sir Charles Price, Bart. 5 Copies John Price, Efq; Penzance, a Plate and 10 Copies Gryffidd Price, Efq; King's Counfel Mrs. Jane and Mrs. Judith Pryce, Smith-Street, Westminster Sir John Pringle, Bart. P. R. S. Mr. John Purnell, Froombridge, Gloucestershire

Q

Queen's College Library, Cambridge Late John Quicke, Efq; of Newton, Devon.

R

Right Rev. John Ofwald, Lord Bishop of Raphoe

Right Hon. Earl of Radnor

Right Hon. Lord Viscount Ranelagh Sir Alexander Ramfay, Bart.

Philip Rashleigh, Esq; M. P.

Rev. Mr. Rayle, Gwedir, Caernarvonfhire

Thomas Reed, Efq; Stithyans, Cornwall

Mr. William Rednap, for the Dove Gang Committee of the Derbyshire Lead Mines

Mr. Richard Reynolds, Ketley

Mr. William Reynolds, Ketley

Rev. Mr. Rhodes, of St. Earth, Cornwall

William Richards, Efq; Halegarrack, Cornwall

Philip Richards, Efq; Penryn

Rev. Henry Richards, A. M. Fellow of Excter-College, Oxford

Mr. William Richardson, Bookfeller, Strand, 2 Copies

Mr. Thomas Roberts, Briftol Rev. William Robinfon, A. B.

Crowan, Cornwall Mr. J. Robfon, Bookfeller, New

Bond-Street 10 Copies

Thomas Robyns, Efq; Trenear, Penzance

Colonel Francis Rodd, Trebartha-Hall, Cornwall

Sir Frederick Lemon Rogers, Bart. I Copy and a Plate John Rogers, Efq; M. P. 2 Copies

Henry Rofewarne, Efq; Vice-Warden of the Stannaries

T. B. Rous, Efq; M. P.

Mr. Thomas Ruft, London

Rt. Hon. Lord Vifcount Southwell Sir Thomas Samwell, Bart.

S

Mr. William Sandland, Cateaton-Street

Rev. Sampfon Sandys, Landuwednac, Lizard

William Saunders, M. D. St. Mary-Axe

John Sawle, Efq; Penrice, Cornwall James Scawen, Efq; M. P.

Charles Scott, Efq; Kenton, Devon.

Simon Scrope, Efq; Danby, Yorkfh. Mr. Ephraim Reinhold Seehl,

Chemist, Blackwall

John Serocold, Efq; Merchant, Love-Lane, Eastcheap

Rev. William Sheffield, A. M. Provoft of Worcefter College, Oxford

Mr. Robert Shore, Smitterton, Derbyshire

Sir George Shuckburgh, Bart. A. B. F. R. S.

John Silvertop, Efq; John Simpfon, Efq;

Sir Francis Skipworth, Bart.

Thomas Sloughter, Efq; Chefter

J. Smeaton, Efq; Engineer

Francis Smedley, Efq; Bagilt-Hall, Flintshire

L. Smelt, Efq; late Sub-Governor to the Prince of Wales

Nicholas Smith, Efq; Condover

John

John Smith, M. D. Profeffor of Geometry, Oxford

Jeremiah Smith, Efq; Fenton, Staffordshire

Mr. Timothy Smith, Swillington, Yorkshire

Francis Smyth, jun. Efq; New-Buildings, Yorkshire

Dr. Solander, F. R. S.

Mr. Soper, Surgeon, St. Columb

Mr. Henry Sotheran, Bookfeller, York, 8 Copies

York, 8 Copies Mr. Robert Sowerby, Crutched-Friars

Mr. Francis Spilfbury, Chemift, Mount-Row, Weftminfter-Bridge

John Stackhoufe, Efq; Pendarvis, Cornwall

Mr. Henry Steeple, Holywell, Flintshire

Philip Stephens, Efq; Commerton Samuel Stephens, Efq; St. Ives

Mr. Martin Stephens, Camborne, Cornwall

Mr. Joseph Storrs, Chefterfield

Edward Stuart, Efq; 3 Copies Thomas Sunderland, Efq; Alverton,

Lancafhire

Mr. Samuel Sweeting, Attorney, Exeter

.9.14 T

Right Hon. Thomas Taylor, Lord Headfort

Thomas Taylor, Efq; Denbury, Devon.

Mr. William Teffeyman, Bookfeller, York

Mr. Francis Thomas, Ludgvan, Cornwall

Mr. Samuel Thompson

Mr. Barn. Thorn, Exeter, 2 Copies Mr. Nathaniel Thorn, Bookfeller, Durham

John Thornhill, Efq;

Sir Samuel Thorold, Bart.

Philip Tingcombe, Efq; Tretheage, Cornwall

Mr. Tiffington, Altreton, Derbyshire Henry Tolcher, Efq; Plymouth

Thomas Toller Trefry, Elq; of Trefry, Cornwall

Robert Cotton Trefusis, Esq; of Trefusis 2 Copies Sir Harry Trelawny, Bart.

Rev. Henry Hawkins Tremayne, Heligan, Cornwall

Sir John Trevelyan, Bart. M. P. John Trevenen, Efq; Camborne, Cornwall

Mr. John Trevethan, Attorney, Redruth

Mr. Trewman, Printer, Exeter

Trinity-College Library, Cambridge John Tucker, Efq; M. P.

Marmaduke Tunftall, Efq; F. A. S. Late Alderman Turner, London Late Richard Turner, Efq; Taviftock

U

Right Hon. Earl Verney, M. P. F. R. S.

- William Veale, Efq; Trevailer, Penzance
- John Vivian, Efq; A. M. Middle Temple
- James Vivian, Efq; Pencallenick, Cornwall
- Mr. Rumbelow Vivian, Surgeon, Falmouth
- Univerfity College Library, Cambridge

Mr. J. Voyez, Sculptor, Member R. S. Artifts, Cowbridge, Staffordfhire

Henry Uflicke, Efq; Nanfolverne, Penzance

Sir Richard Vyvyan, Bart.

Philip Vyvyan, Efq; Tremeal, Cornwall

W

Rt. Hon. Lord Vifcount Weymouth John Walcot, Efq; Bathford, Bath Rev. James Walker, Vicar of Lanlivery, Cornwall

- Capt. Samuel Wallis, Tremean, Cornwall
- Mr. Wallis, Attorney, Helftone Rev. James Walmfley, Rector of Falmouth
- Richard Hill Waring, Efq; F. R. S. Leefwood, Flintfhire

Sir John Borlafe Warren, Bart. M. P. 12 Copies

Dr. Warren, M. R. F. R. S.

Rev.

- Rev. Thomas Warton, B. D. Fellow of Trinity-College, Oxford, and F. A. S.
- Mr. James Watt, Engineer, Birmingham

Richard Way, Efq; Cary-Street, 2 Copies

- Philip Webber, Efq; Falmouth Philip Webber, jun. Efq; Ditto

William Webber, Efq; Great Queen-Street

- Rev. John Webber, A. M. Fellow of New-College, Oxford
- Edward Webster, Efq; White Lead Works, Marybone
- Meff. Wedgwood and Bentley, Greek-Street, Soho

Hon. James Wemyis, M. P.

- Rev. John Wefley, A. M. Rev. Dr. Wheeler, Canon of Chrift Church, R. P. D. and P. Nat. Philos. Oxford
- Rev. Mr. Whitaker, A. M. Rector of Ruan-Lanihorn, Cornwall
- Mr. John White, of the Gold Coin Weight Office
- James White, Efg; Barrifter, Exeter Mr. John Whiting, Sugar Refiner, Ratcliffe
- Henry Wickham, Efq; near Brad-ford, Yorkthire Jacob Wilkinfon, Efq; M. P.
- John Wilkinson, Esq; Broseley
- Dr. Richard Williams, New Inn

- John Oliver Willyams, Efq; Carnanton, Cornwall
- Joseph Williams, Efq; Glanravon, Carnarvonfhire
- Mr. John Williams, Copper Agent, Truro
- Mr. Williams, Bookfeller, Fleet-Street 4 Copies
- Mr. John Williams, Burncoofe, Gwenap, Cornwall
- Mr. Thomas Wilfon, Kenwyn, Cornwall
- Rev. Dr. Winchefter, Rector of Appleton, Oxfordshire
- Dr. Withering, Birmingham
- Mr. George Wolfe, Wellclofe-Square
- Mr. Henry Woolcock, Redruth Sir Richard Worfley, Bart. M. P. James Worfley, Efq; M. P.
- Mr. John Wright, Lombard-Street Right Hon. Owen Wynne, M. P.
- Ireland
- Sir Watkin Williams Wynn, Bart. M. P.

Y

Prince de Youfoupoff, of the Ruffian Empire

- Sir George Yonge, Bart. M. P. Mr. Yeoman, Surveyor, Caftle-
- Street, Leicester-Fields Mr. Charles Yoxall, Southwark

Inv El Tranity College, Oxfordy

Rev. Thomas Watern, B. De Lei- | John Oliver, Williams, Effy. Car.

Directions to the Bookbinder.

| Plate Nº I. | Goon-Laz and the Pink-Mines, &cc. to face Page | 110 |
|-------------|--|-----|
| п. | The Virgula, &c. | 147 |
| III. | The Fire-Engine, &c. | 160 |
| | The Table calculating the Power of Fire-Engines to follow the Plate. | |
| IV. | Section of Bullen-Garden | 172 |
| v. | The Stamping-Mill, &c. | 232 |
| VI. | Furnaces for Affaying, Smelting, &c. | 280 |
| VII. | A Map and Plan of North-Downs Mine | 137 |
| | The Ticketing Offers for Copper Ores | 288 |

Directions to the Bookbinder.

| | . Coan-Las and the Phile-Mines, Sec. to face I | |
|-----|---|------|
| 147 | . The Virgula, Sec. | Ц. |
| öð1 | The Fire-Bagine, Sc., | ų. |
| et | The Table calculating the Power of Fire-Faginer a | |
| 172 | | VL |
| 232 | The Stamping-Mill, Scc. | V |
| 280 | . Fornaces for Affayiog, Smelting, Scc. | |
| 137 | A Map and Plan of North-Downs Mine | .IIV |
| 88e | The Ticketing Offers for Conner Ores | |

PREFACE.

our Mines are mofily well conducted p yet notifnall advantages

THE practical part of the following work was gradually collected when the writer was very young; and what was begun to be written in detached fheets, afterwards became the materials of an interesting treatife. This part, indeed, may justly be deemed the most valuable of the whole, as it tends to inform the publick of matters very little understood or confidered beyond the confines of a Mineral district.

Minerals that are plenty and precious being generally confined to fmall tracts of country and a barren foil, are therefore remote from that publick observation which commerce and agriculture fo defervedly attract : yet it is a matter of aftonifhment, that an object of the first national confequence, in point of time, should fo long remain, even to the present hour, a fecret limited to a few illiterate people. It is well known, that Tin and Lead were the first and grandest staples of Great-Britain, particularly the former, which introduced a trade and navigation before unknown to the difcoverers of our weftern coafts. This trade founded on Mining still subfists, with many practical improvements and difcoveries; and though corn and wool have contributed the largest share of riches and population to these flourishing kingdoms, yet that confideration does not by any means lessen the importance of the Mining interest. When we reflect upon the vaft profusion of Silver, Tin, Copper, Lead, Iron, and Coal, yearly produced from the bowels of our Mines, which exceedingly furpaffes our internal confumption, and therefore must afford a very confiderable branch of commerce; we shall find it difficult to account for that supineness, which has hitherto declined the inveftigation of a fubject of fo much national importance. mod Mingrals, on their de tomours bas

The want of fuch affiftance, in the direction of the ufeful art of Mining, as it is hoped this treatife may afford, has been long complained of. It cannot, however, be denied that A our P

E

C

our Mines are mostly well conducted ; yet no fmall advantages may be derived from reducing the vague practice of common Miners to a regular fcience, and bringing the experience of many into a fingle point of view. Nor will those advantages be confined folely to practical Miners : every corner of this ifland, Ireland, and many of the colonies, abounds with a variety of Minerals, wholly unknown to the poffeffors; and was the knowledge of the indications of Metals, and the mode of working Mines more diffused, new discoveries would daily be made to the great profit of landed proprietors, and the advantage of the publick, by increasing its revenue, and employing confiderable numbers of the laborious poor. As a ftriking proof of the want of fuch a treatife, before the latter end of the laft century, vast quantities of rich Copper Ore in Cornwall were thrown away as useless! Indeed, it may be fafely faid, that eleventwelfths of his Majefty's fubjects are totally unacquainted with any part or branch of our enquiry, that by itfelf, and its great confumption of various materials, brings in fo great a revenue to the crown, and fo much wealth to the community.

F

A

To acquire a competent knowledge in Mines, &c. a long refidence in their vicinity is certainly neceffary; and this advantage, at leaft, I can with truth lay claim to: yet as this is the writer's first attempt in literary composition, it will, for that reason, have many faults; and he must rely on the candour of the publick for the favourable reception of an undertaking that ought long ago to have employed the abless hand. However, I have not omitted to take the opinions of many perfons well verfed in the various departments of this work, which, from the number of natural and practical discoveries it contains, and the vast importance of the general fubject, I may venture to pronounce, with all its faults, a valuable acquisition to the library of every nobleman and gentleman in these kingdoms.

The great parts of this work are arranged in the following order. The first book treats of the origin, formation, and fubstance of Minerals and Metals; the first and second chapters of which inculcate the doctrine of water, as the folvent, vehicle, and cement of Metals and Minerals, or their principles, in proportion to the faturation of the one, and the magnetism of the respective nidules of the other. The theory here given, is, in some instances, established in the process of precipitation. The third chapter, which treats of the fubstances of Minerals, Metals, and and Salts, is dry and tedious; but as it was thought a neceffary addition to the preceding chapters, it could not be omitted. With refpect to the nature and hiftory of Minerals, I confine myfelf to those of Cornwall only; and as they occur in the course of my work, have described each in its incidental place. My readers will easily perceive, that if I had fystematically observed those rules of genera, class, and order, laid down by Hill, Da Costa, Cronstedt, and others, I should have spun out my treatife in a needless detail of matters foreign to the profession for the profession of the pro-

The fecond book treats of the theory and natural hiftory of Strata, Fiffures, and Lodes, with respect to their formation, direction, inclination, interruption, elevation, and depression. The theory advanced in the first and third chapters was adopted by the reverend Dr. Borlase, and as it has been well received by the criticks of his time, it is hoped that it may still pass till a better can be found : and after all the opinions of the feveral naturalists are collated, and the most probable are felected, the matter will still remain a meer postulatum; fo that we would prefume to judge of these only from their visible effects in the Mines of Cornwall. The fecond chapter contains little or no theory, being only a natural history of the contents of Lodes, according to their outward appearance; and any person a little conversant with Mineral Ores, may form a tolerable judgment of their contents from the description here given of them.

The third book contains the practical part of Mining; the methods of difcovering and working Mines, the particular procefs for digging and raifing of Ores, and the machinery for drawing water. Though in this part the reader may find a fund of information that he has never feen opened before; yet it can be confidered only as a fummary of Mining, it being endlefs to enter into all its different modifications. The first chapter treats of the difcovery of Mines by the Virgula, Shoding, and Cofteaning, especially the former; and gives an improved idea of a fcience in difcovering Mines very little underftood out of Cornwall. The merit of the effay on the Virgula Divinatoria is due to Mr. William Cookworthy, of Plymouth; and though the virtues of the rod may not be eafily allowed by the incredulous, yet for my own part, I want no further evidence of its properties than I have already obtained to fix my opinion of its virtues. At leaft, the memoir is curious, and the fubject deferves to be further enquired into. In the method of Shoding, I have

C E.

A

F

I have been more full than any preceding writer; and, I hope, with a judgment that will refcue this fcience from the darknefs with which it was enveloped. The fecond chapter contains an account of the methods of Streaming in its prefent improved ftate. This immediately follows the chapter on Shoding, becaufe of its near affinity to that fubject. The practical part of Shoding and Streaming is founded upon a belief of the Noachian deluge and its effects, which are incontestably verified in Shode and Stream works. In the third chapter, the effectual working of a Mine is exhibited in the finking of Shafts, driving Adits, digging and raifing of Ores, drawing the water, and every other operation under-ground. This is intended to explain the feveral parts of a Mine, and their dependency on each other; and to evince that fuch contingencies muft be in all Mines, although varied in their fituations according to the different circumstances of different Mines. To this is added, a parallel fection of the greateft Mine now at work in Cornwall, to illustrate the whole. The chapter following relates to the management of a Mine when in a proper courfe of working ; wherein fuch maxims are laid down, that a novice in conducting a Mine may underftand fome matters indifpenfably connected with that art. The laft chapter of this book treats of Damps, Dialling, and Levelling, with practical inftances and remarks, fupported by experience, and altogether neceffary.

The fourth book treats of the feveral manuductions ufed in dreffing of Tin, Copper, and Lead Ores, and contains fome brief remarks upon dreffing Gold, Silver, &c. Though the general manner of dreffing Copper Ore was firft taken from the methods ufed in the Lead Mines, yet there are fo great a variety of Copper Ores requiring very opposite treatment in their dreffing, that I hope the fubject will be found greatly improved. The dreffing of Tin is indeed an art confined to the ftannaries only; yet the curious delicate manner in which it is manufactured in the dreffing, may furnish many improvable and beneficial hints for the cleansing of other Minerals from their fordes. I have been very accurate in defcribing the manner of dreffing Tin Ore, as I have had ample experience in that busines; and I doubt not of its proving a useful and general ftandard in that branch of Mineralogy.

The beginning of the fifth book confifts of a memoir upon affaying, and more particularly upon a part of the Docimaftick art, which has never been fo experimentally treated of before, viz. P

Ë.

viz. How to affay Mundicks and Tin for Gold or Silver; by which proceffes the curious may judge how far the Mundicks of one place are fuperior to those of another for the precious Metals, or whether they contain any Silver or Gold. The proceffes for affaying Copper Ores by calcination, and by the regule way, are both infallible, if the operator will be attentive to his busines. These proceffes are little known out of the Cornish affay offices, and have been too long kept profoundly fecret, for purposes which the reader will readily comprehend. The method of affaying Tin Ore is very simple and efficacious, from the easy fusibility of its Metal. An adept in trying Copper Ores will foon know how to manage in affaying Cobalt, by the mode prefented to his view in this chapter.

REFAC

The laft and grand object, is the manufactory of Tin and Copper Ores into their refpective Metals; and I have fet forth, as fuccinctly and clearly as the materials I have obtained would allow, the proceffes of fmelting and metallizing those products, without infringing too much upon the fecrets of private trade. And though I have not forgotten to point out the oppressions of monopoly, yet it is with less feverity than is due to the magnitude of the evil, and its mischievous effects.

The Appendix treats of the great improvement in the fleam fire engine by Mr. Watt; an invention of more confequence to the Mining intereft of Great-Britain, than any difcovery that has been made for half a century; and I hope to fee its univerfal ufe eftablished in a very short time.

As the idioms and terms of Cornifh Miners are moftly derived from the ancient Cornifh Britifh dialect, and therefore not eafily intelligible to gentlemen unaccuftomed to Mining, who may have occafion to converfe or correspond with them; to prevent misconception, I have fubjoined an explanation of those terms in alphabetical order, including the relation they bear to those of the Lead Mines and Collicries.

a CONTENTS.

vise i tow so ethy hitmates and i'm far Cold or Silver; by which provide the curious may judge how far the Mandicks of one phace are faperier to thole of another for the previous. Metals, or whether they contain any Silver or Gold. The proceffes far affiying Cooper'Orea by calcination, and by the regule way, are both infailible, if the operator will be attantive to his bufinkli. These proceffes are little known out of the Carnish affer afficies, and three been too long kept profemally foreet, for purposes which the reader will readely comprehend. The method of afficiency of its Metal. An adopt in trying form the easy fufficiency of its Metal. An adopt in trying to profes the mode preferred to his view in this chapter is any form from the mode preferred to his view in this chapter.

The laft and grand object, is the manufactory of Tin and Opper' Ores into their respective Manday and I have fet forth, as facemently and clearly as the materials I have obtained would allow, the procedies of finelting and metallicing tholesproduce, values intrioging too much upon the fecrets of private made. Find theorem I have not forgotten to point out the oppushions of monopoly, yet it is with lefs fiverity than is due to the marginitude of the cold, and its mitchievorts effects?

The Approdix treats of the great improvement in the framfire engine by Mr. Watt; an invention of more confequence to the Mining intereficief Great-Britsia, than any diffeovery that has been made for half a century; and I heperto fee its univerfal ufe effablished in a very first time.

As the idioms and terms of Coraith Miners are moftly derived from the are four Coraith Britifly dialects and therefore not eatily intelligible to gentlemen unaccurboned, to Mining, who may have occation to converfe or correspond with them; to prevent mitconception, It have foliphined an explanation of these terms of the Lette Mines and Collicities.

Angela has seen to be an angela and the

STNET NOO DOOR STORES STORES

CONTENTS.

INTRODUCTION.

ETALS, of all matter leaft fubject to viciflitude, Page i. Tin trade in Cornwall established twenty-four centuries, and known to the first inhabitants of Britain, ii. From Shode or Stream, ii: Lode works about feven hundred years flanding -Of the antiquity of Tin, iii. Few Veftigia of Tin in Scilly-Islands, iv. Author's opinion, that Tin was anciently exported from Falmouth harbour, fupported by Strabo, Diodorus Siculus, Cornish M. S. v, vi, vii. Copper but lately discovered and how, viii. Tin Ore rich, yet expensive to drefs-Much skill in hydraulicks and mechanicks required to work Copper Mines, ix. Corollary-Reflexion, x. Great increase, annual amount and value of Tin, x. Ditto of Copper Ore for the laft fifty years, xi. Profit and lofs in the Mines like political gaming, xii. Calculation that the nett profit upon $f_{400,000}$ is not 5\$ cent. -The Lords of the Mines the greateft gainers, xiii. Reflections upon the preffure of the times, xiv. Government ought to leffen the impofts upon Mining materials, xiv. A fcale of all the Copper Ores fold for fifty years paft, with the quantity each year, price & ton, average, and amount in sterling value.

BOOK I.

C H A P. I.

The Origin and Formation of Metals and Minerals.

MPERVIOUS caufes of Metals, &c. fpeculative, Page 1. The wifdom of the creation both above and under ground, 2. Use of Metals not revealed before the fall, 2. Tubal Cain the first artificer in brass, 3. Conjectures of the * formation formation of Metals, 3. Alchymical doctrine exploded; becaufe no fermentation out of the vegetable kingdom, 3, 4. True caufe moft obvious and proximate, 4. Author's opinion, by magnetifm, and approximation of particles, fui generis, proved in Copper, by the affinity of vitriolick acid with Iron, 5, 6. Water, thus faturated produces Metal in proportion to the precipitating power of its nidus. Goffan the nidus for moft Metals and Minerals, 6, 7. No tranfmutation of Metals, 7. Yet Metals liable to increafe or decay, according to the folution, retention, or tranfmigration of their refpective principles, ad infinitum: inflanced in Eaft and Weft Huel-Virgin, 8, 9. Matter is fubject to continual modifications, progrefs, decay, and reformation, 9.

C H A P. II.

Water the Vehicle and Cement of Metals, Minerals, and Stones.

F the known properties of water, 10. In its circulation through the earth, a vehicle of Mineral particles, till arrefted by their magnetick nidufes, 10. proved by the waters of Huel-Sparnon and Pednandrea Mines, which are wholefome; and by the infalubrity of North-Downs, Chacewater, and Huel-Virgin waters, 11, 12. Water in the Mines cold and dulcet, fometimes warm, 12. Springs temporary or perennial; in the Miners idiom, " Top and bottom water," 13. The ocean the true origin of perpetual fprings, which acts like a huge forcing engine, 13. conjectured from a confideration of the Cafpian fea, 14. Rivers not always derived from the particular fea into which they return-Inftances foreign and domeftick, 15. Shallow Mines affected by top water only, deep Mines by both, 16. The increase of water in the bottoms of a deep Mine, by an east wind, a mistake, 16. The true cause, 17. Earthquakes from three caufes probably, viz. Water, Mineral combinations, and electrick æther, 18, 19. Reflections on their effects, 19, 20. Of the hitherto inexplicable defideratum of Mine water being lefs under the fubmarine Strata, than in other parts of a Mine, 20. Curious inftance at Huel-Cock, 21. Huel-Cock wrought eighty fathoms beyond low water mark, and within one of the bed of the ocean; yet lefs incommoded by water under the fea, than in any other part of the Mine, 21, 22. accounted for, 22. Of the lapidescent, petrifying, and cementing qualities in water, 23. to be feen in Lime-rock, and cicatrixes

CONTENTS.

cicatrixes of Granite or Moorftone, 23. Inftance of brafs pins, in a petrified folid lump, found under the pavement of Redruth-Street, 24. Earth and clay become folid ftones by lapidefcent juices, and may be foluble again by air, 25. Cryftallizations in the earth, how formed; lapidifick juices, the cement of Metals, Minerals, and Stones, 26, 27. Three degrees of purity in this cement, viz. Spar, Cryftal, and the Pfeudo Adamantes, 27. Spar fcarce in the Mining part of Cornwall, being produced from Limeftone rock only, 28. Quartz and Cryftal the proper names for our Spar—Of Cornifh Diamonds, 29.

C H A P. III.

Of Metals and Minerals more immediately, and the Fluxes for affaying them.

OPPER and Iron most foluble by the air and acids, 29. Gold, Silver, Lead, and Tin lefs fo, 30. Ore and Mineral properly defined, 30. Mineralogy claffed, 30. Of earths; of the Steatites Cornubienfis, or Cornish soap-rock, 31. composed of Talc and hard clay; best composition for China ware, 32. Fine clay and Talcy Granite, or Moorftone, used for Porcelain manufactory-Grouan clay makes fine bricks for furnaces, &c. -Of the crucible manufactory at Truro-The beft crucibles made there with clay and Moorstone gravel, 32. Salts, infpiffated juices, faline, fulphureous, or acid-Vitriol, 33. Of the blue Roman Vitriol made at Treleigh in Redruth, and the process for making it, 33, 34. Asbestos, or earth flax, in Cornwall, 34. Arfenicks eafily made from Mundick, 34. Mundick to be used for preferving ships bottoms from worms, Some Miners in Cornwall employed at fea in the fifheries, 35. or under-ground, 35. No payment, however poifonous, will prevent the Teredo-worm from boring fhips bottoms, 36. The author's preparation highly fubtilized and propofed to be infufed into the timber, 36, 37. Affay fluxes-Nitre-Tartar, 37. Metals wafted by fluxes which may be faved in the large furnaces, 38. Of the Fluxus Niger, 38. Common falt, its use at the furnace-Borax-Sandiver-Kelp-Their properties in fufing of Metals, 39, 40. Sal Ammoniack, common glafs, Slaggs of Metal, Charcoal, &c. 40. Minerals; Mundick, in all our Metal Lodes; difficult to feparate from them, 41. continually forming concretions; beautiful incruftations of them upon hexagonal Cryftals-Proof that Metals and Minerals were not all formed

formed at the creation, as we now find them, 42, 43. Of Cal, Goffan, and Cockle-Cal, a hurtful mixture with Tin-Of our Ochres-Defcription of Cockle, Talc, and Glift, 44, 45. Bifmuth, natural hiftory of, how to affay it, 45, 46. Black-Jack or Mock-Lead is a Zink Ore ; useful ingredient in Brafs, 46, 47. Antimony, its hiftory, fufion, &c. in Cornwall, 47, 48, 49. Cobalt, natural hiftory of, 49, 50. Lapis Calaminaris - Metals, radical characters of - Specifick weight, 51. found pure among our Stream Tin, 52. diffolves in Aqua Regia only, 52. Gold leaf will plate to the three hundred and fixty thousandth part of an inch thick-It never decays, &c. 53. Platina, a Metal lately difcovered, neareft Gold in fixednefs and folidity, but not fo ductile; differs from all other Metals, 54, 55. Quickfilver, often fophifticated-Of the Colick of the Dunmonii, 55. Its volatility-Factitious Cinnabar-No Quickfilver found in Cornwall, 56. what countries produce it-its furprifing infinuation into the minutiæ of the human body, 57. Lead feldom pure, 57. Four forts of Lead in Cornwall, 57. when discovered, of short continuance, 58. Lead anciently known as a ftaple of England, 58. Silver feldom found in Britain out of Lead-Of the Silver Mines in Europe-Of the Mine of Potofi, 59. But four forts of Silver Ore-Silver per fe too foft for use, 60. Copper, foluble in all menstrua-Native Copper very common at fhallow levels-A lump of Native Copper four tons in North-America, 61. Copper Ore in pureft flates, is Statactical, Guttatim, and Machacada-Of green and blue Copper Ores-Grey Ore-Black Ore ought to be cautioufly dreffed, 62. Peacock Ore-Yellow Copper Ores four forts, 63. Thirty thousand tons raised anno 1770-Cornish Copper Ores the fource of great employ, 64. Iron, the product of moft countries-Sundry forts of Iron Ore-Caft Iron-Steel, 65. Iron in all bodies-Moft ufeful Metal to human life, 67. Tin -Tin Ore called Tin-ftuff-Black Tin, 66. Of Native Tin, the lightest of Metals, and the heaviest in a Mineral state-Of Shode and Stream Tin, 66. Bal or Mine Tin-Of Tin Lodes and Tin-stuff, 68. Trials of its purity-Various uses-Pewter -Dying fcarlet, 69. Tin the only trade in Great-Britain two thousand four hundred years ago-Little elfewhere-Of Molucca Tin, 70, 71.

Monthly concritions; beautiful incrudiations of them upon hear-

water, §5. The foregoing hypothefis not without objections

$\mathbf{B} = \mathbf{O} \cdot \mathbf{O} \cdot \mathbf{O} \cdot \mathbf{K}$ and $\mathbf{H} \cdot \mathbf{H} \cdot \mathbf{H}$

CHAP. I.

Of the Strata of the Earth, and the Fiffures in which Metals are found ; their Direction, Inclination, or Underlie, &c.

ORNISH Strata of different denfities, and not ftratified by the laws of gravity, but by those of affinity, 72. explained and accounted for, 73. Soft Grouan Stratum encloses Tin Lodes, 73. Slate-Killas, fix forts-The pale blue Killas most likely for Lodes of rich and lafting qualities-Elvan, two forts, 74. Moorftone or Granite-its composition-Five forts of Moorftone, 75. Ireftone, the hardeft of all Strata, rich Lodes of Copper in it, 76. On the formation of Fiffures in general, 76. their various uses in nature, 77. The opinions of Woodward and Agricola controverted, 78. Of the caples or walls of the Fiffure-On the roughness or smoothness of the walls of Lodes, 78. Breadth of a Lode or Fiffure, various-Length or depth of a Fiffure, unlimited, 79. The direction of Tin and Copper Lodes in Cornwall always eaft and weft, 80. Their deflexion, inclination, or underlie, north or fouth, 80. Of horizontal Lodes or Fiffures, called Flat-Lodes or Lode-Plots-Of the Bunny or pipe of Ore, very uncommon in Cornwall, 81. Perpendicular, horizontal, and the inclined Fiffure, fummarily accounted for, 82. A greater or leffer impetus of the fame caufe occafioned the Underlie, and the flide or heave of a Lode, viz. the fubfidence of the earth, more or lefs at repeated times, 83. Of the efficient caufes of those fubfidencies, 83. The more lax and weaker Strata partially fubfided, and the more compact and ftony formed hills, &c. Incroachments produced fecondary fubfidencies, and the Noachian flood occafioned multiform fractures and diflocations of the Strata-The fame evinced in St. Agnes-St. Agnes beacon a production of Noah's flood-Although now a mountain, it was before the flood the bottom of the fea-Its defcription, 84. That fome parts of the prefent dry land were the bottom of the fea is the opinion of fundry naturalists-The highest mountain in perpendicular height lefs than one-fix-thoufandth part of the earth's circumference, 85. Further fubfidencies caufed by inundations, earthquakes, and the diffolvent powers of fubterranean fire and water,

water, 85. The foregoing hypothesis not without objectionsnot infisted upon; but submitted with great deference to the judgment of the naturalists, 86.

C H A P. II.

Of the different kinds of Lodes in refpect of the Earth and Stones they contain.

OST Lodes are named from the Stone or Mineral they generally abound with-Very different near the furface, and in depth-Why Lodes in general are not rich near the furface, Twelve general different kinds of Tin and Copper Lodes 87. -Goffan Lodes most common-described-a tender red, a tender brown, 88. A dry pale Goffan, a poor Tin Goffan, and a Kal or Kally Goffan-Kal very ferruginous, 89. A Peach Lode, better for Tin than Copper; a Scovan Lode, productive of Tin only; a Caple Lode; a Pryan Lode, very lax and fandy, often rich, 90. A Quartz Lode, very unkindly; a Cryftal Lode, four forts, 91, 92. A Killas Lode-Mundick Lode, when likely, and when not, 92, 93. Black Jack, a Zinc Ore, very shallow, better for Copper than Tin, good for neither-Flookan Lode, likely for Tin or Copper, 93. Flookan in a Crofs-Goffan prevents the circulation of water east and weft-A Flookan eaft and weft parallel Lode heaves an oppofite underlying Lode higher up, 94. A Grouan Lode very foft or very hard, better disposed for Tin than Copper, 94. Different Lodes, their alterations ; which disposed for Tin, Copper, and Lead-Mine Stones have their finufes or joints, 95. Of Stones in Lodes foreign to their nature-The Elvan Stone, 95. The Liver Stone-The Horfe-defcription of-formation, 96. A ftope of dead ground, 97.

C H A P. III.

How Lodes are difordered, interrupted, fractured, elevated, and depressed, by the Intervention of Cross-Gossians, Flookans, Slides, Contras, &c.

A Slide, not the caufe, but the effect of a Heave—A Heave, a falfe term, 97. Crofs-Goffan barren—runs north and fouth—interfects all metallick Lodes, 98. How to find the loft part, 99. Of the Clay or Flookan in a Crofs-Goffan—dams up

CONTENTS.

up the water either fide of it-the caufe of fome fprings, 100. Why metallick Lodes may be rich or fteril near the Crofs-Courfe. which is another proof of the author's opinion of the origin of Metals-Tin and Copper Lodes antecedent to Crofs-Courfes, 101. Mr. Whifton's hypothesis of the deluge by a comet applied as a probable caufe of Crofs-Goffans, 102. their contents, 103. Of Lodes elbowing each other, 103. Of the branches, ftrings, or fmall veins of Lodes-Lodes fqueezed fmall in hard ground, 104. Of metallick Lodes contraing each other-Why Tin Lodes were antecedent to parallel Goffan and Crofs-Goffan Lodes, 105. The inclination or underlie of Lodes towards each other, and the changes and diforders occafioned thereby-Of two Lodes underlying both alike, 106. Of the Start, Leap, or Heave, by a Slide or Courfe-Flookan; or the being " cut " out by a Slide"-Of the fame by a Courfe-Goffan -- The Heave and the Slide in proportion to the fubfidence, 106. This Heave in Coal Mines, "A Trap up, or a Trap down, by a " Ridge"-Three Heaves by three Courfe-Goffans, at Goon-Laz and the Pink Mines, 107. How to find the loft part of the Lode again, 108. Corollaries in proof of three fubfidencies here—Of the common Slide, 109, 110.

BOOK III.

meente ai tras C H A P. I. o delle III

The various, ancient, and modern Methods for Difcovery of Mines, &c. by Shoding, Cofteaning, &c. with feveral very curious Difquifitions, Obfervations, and Experiments, upon the Virtues and Ufes of the Virgula Divinatoria.

PASSAGE from Lucretius—The first difcoverers of Metals, 111. Of accidental difcoveries—Fiery effluvia, 112. by water, if Vitriolick, 113. Agricola upon the Virgula Divinatoria, 113. The corpufcular philofophers account for its operation, 114. Some elucidations from Mr. Boyle, 115. Mr. Cookworthy, of Plymouth, his curious obfervations, 116. Of the occult quality in the operator—Hazle shoots of one year, best, 117. Shape and fize—manner of holding the rod—the mind must be indifferent, or the rod will not answer, 118. Sweat and animal excretions hinder its operation—Of willow rods, rods, &c .- The rod will not be attracted by fubftances connected with the perfon of the operator, 119. How to make and ufe diftinguishing rods, 120. Directions for their practical use in the difcovery of Lodes, &c. 121. Parturition of a metallick Lode, by a Crofs-Goffan, eafily found by the rod-its comparative attraction and repulsion; 122. At any depth, water found by the rod—Inftances of Lodes found by it, 123. Of Coffeaning and Shoding - Shode Stones feparated by the deluge, 124. Defcription of the Bryle of the Lode-Shodes difperfed from the Bryle-The fituation, diffances, texture, gravity, and properties of Shode Stones, 125. Copper and Lead Shode feldom met with ; why-Moorftone and Ireftone Shodes very large and numerous, 126. Of the Greut, (Grit) run and caft of the country-How to proceed by the appearances and fituations of Shode, 127. Alonzo Barba, on Shoding - Instructions for tracing a Lode by its Shode-Some Lodes yield no Shode; why, 128. Lodes often covered with a double or treble shelf -The effects of the flood demonstrated by Shode upon the Cornish Strata, 129, 130. Discovery of Lodes very effectual by Levels, Adits, &c. 130, 131.

C H A P. II.

Upon Streaming, Drefling, and Smelting of Stream Tin in the Blowing-Houfe or Blaft-Furnace.

T H E effects of a deluge most apparent in Stream Tin works, 131. Of taking the Set or Grant—Sinking the Hatch or Shaft—Various breadths, depths, and thickneffes of Stream Tin Strata, 132. Of the level, the overburden, and difcharging the water by hand or water wheel pumps—Of the Tye, 133. Great deftruction of land, by Streaming, which might otherwife anfwer for draining of land, 134. Of Dreffing —Of the Gounce or Strakes—Stamping and Dillueing, 135. Of Blowing, or Smelting the Tin—Of the caftle or furnace the wheel, bellows, float, &c.—Excellence and value of Grain Tin, 136, 137.

P. A. H. D. I. excretions - muler its creation - Cr Willow

C H A P. III.

Of Bounds, and the Manner of taking a Set or Grant for Mining; of finking Shafts, driving Adits, digging and raifing of Ores, drawing the Water, and working the Mines.

F Bounds and the cutting of them, 137. Their antiquity-Charter, 33d Edward I, anno 1305-Quotations from ancient MSS. 138, 139. Of the Tollur and renewing of Bounds-The Lord and Bounder's fhares-May drive Adits through others bounds-Of the fet and difh, or dues, 140. Deep Mining not ancient-Of the Coffin and Shammels, 141. Proper place of a working Shaft or underlier, Whym Shaft, and fire engine Shaft, 142, 143. Of cutting the Lode and turning house-Of finking other Shafts and stopeing the Lode, 144, 145. Of the Adit or Level, 145. Dimensions of the Adit and Adit Shafts-Of fallering the Adit for air, 146, 147. Great difference in the charge of driving Adits, 148. Of Adits as feeking Adventures, 149. Of drawing the water by the hand pump; Whym and barrels; defcription of the Whym-Of the Rag and Chain pump, 150. Defcription of the water wheel and bobsthe cheapeft of all engines-its real and comparative power to a fire engine, 151. Cornish streams of water very small, but of great value, and made the most of, 152. Of the fire engine-Weight of a given fmall column of water-Neither men nor horfes could draw it, 153. Description of the fire engine-The boiler, house cylinder, pifton, great bob or lever, pump rods, &c. 154. Their diffinct and relative uses-Great improvement of being made to work itfelf, 155, 6, 7, 8, and 9. Of the Sumph or fink of the Mine, which should be in the engine Shaft-Of the crofs cut, 160. Of turning houfe, driving and stopping on the Lode, and finking of Dippas, 161. Of Dyzhuing and Hulking the Lode, 162. Of Stulls-doubly useful-Cutting a Plot, 163. The Little-Winds or underground Shaft-The footway and Sallers, 164, 165. Binding the Mine; Collaring of Shafts; pillars and arches of the Lode, 166. Judgment required for binding the Mine-Shutting Attal -Of a new Adit, holeing to the old Gunnies or house of water, dangerous, 167, 168. Of Forking the water, and clearing the old Mine, 169. Explanation of the workings of Bullen-Garden Mine, 170, 171, 172.

CHAP.

C H A P. IV.

General Obfervations on Mines and the Management of them.

INING, cafual-Of the Purfer or Book-keeper, 173. Majority of fhares have the management-A Mine called an Adventure-Of In-adventurers and Out-adventurers-Of Captains and other fuperintendants-Observations, 174. Of the furgeon of a Mine, 175. Obfervations, 176. Propofals for a county hospital, 177. Of working the Lode by double pick-men, 178. Relieving the place-Winding the work, 179. Of finking, driving, and ftopeing by the fathom; illustrated by examples, 180. Of the cubick fathom, and the fuperficial fathom, 181. The fingle Gunnies, the double Gunnies illustrated, 182, 183. Strictures on working by the fathom or Tub, i. e. Lump; 184, 185. A calculation of the quantity of Lode annually broken-Above 2,000,000 tons of Lode and Strata broken yearly, 185,186. Setting a Mine upon Tribute-First, of a Tin Mine-Of dividing, redividing, and caffing lots upon Doles, either in Waftrel or Several, between the Lords, Bounders, Adventurers, and Tributors, 187, 188. Second, of a Copper Mine-Terms of taking a Mine upon Tribute, 188. Third, of taking Pitches upon Tribute, 189. Tributors mixing their Copper Ores-The increase or decrease by private famples, illuftrated, 190, 191. Rich Copper Ore has been digged, raifed, and dreffed for fixpence in the pound fterling-Tin for nearly the fame-Calculation for taking a Tin or Copper Pitch upon Tribute, 192, 193, 194.

on ni of blood C H A P. o V. o domocrat 10

Of Damps in Mines, and of Levelling and Dialling Mines, Adits, &c.

O N the infalubrity of Mineral effluvia, and their production of epidemick fevers, 195, 196, 197. Of Damps, 198, 199. Inftances of the mortiferous effects of Damps, 200. Of Air-pipes, Sallers, and Shafts, to convey air and prevent Damps, 201. On Dialling in Mines; very curious and indifpenfably neceffary, 202, 203. Dialling for a Shaft on the Adit-end, 204. Ditto for an underlying Shaft and various parts of a Mine, 205 to 212. Of Levelling, what, how ufeful, &c. 213.

BOOK

Droffing of Lead Ore nearly the firme as Copper, 243. Of Peafy, Bing, and Smitham ; by Cobbing, Buckering, and Jiz-

BOOK IV.

CHAP. I.

The Method of Sampling and Vanning of Tin-ftuff, and of the Stamping, Burning or Calcining, and Dreffing the fame; with the Manner of Dreffing the Leavings, Loobs, &c.

F Spalling and dividing the Tin-ftuff, and taking the fample, 215. Vanning the Tin-stuff-What is a Van and its value, 216, 217. Of Tin in the Bal, 218. Of ftamping the Tin-ftuff and fizing of it, and the ancient way of dreffing Tin, 219. Description of a stamping mill, its tackle, and appurtenances, 220. The pit and flime pit-The buddle and buddling, 221. Toffing and packing, and Dillucing, 222. Pit-works and skimpings, 223. Of the crop and rough Tin, and brood in Tin, 223. Defcription of the calciner or burninghouse, 224. Of burning or calcining the Tin, 225. Dreffing the leavings, 226. Trunking the tails, trunking and framing the flimes, 227. Of the kofer and cazing, 228. Of the Loobs, ftamping the tails, and dreffing upon tribute, 229. Of burnt leavings, their value for Copper-Of vitriolick water, from lotions of burnt leavings-its use for precipitation of Copper, 230. The rife and progrefs of precipitating for Copper, 231, 232.

feoritying the regulus of Mundick, 251. Intention of this process explained, 252. Cornilli clima-ware crutibles, recommended for retainin.II laf. 9 [A at H th Dr. compositions 257.

The various Manuductions used in dreffing of Copper and Lead Ores, and Sampling Copper Ores for Sale.

THE utenfils for dreffing, viz. griddle, ftrêke, &c. 234, 235. Dreffing by a large fieve, or griddle—by Picking, Cobbing, and Bucking, 235. Of dreffing common yellow Ore —Dredged Ore—Copper and Tin together, 236. Of the Halvans and Henaways, 237. Of Jigging—Dreffing by the ton— Ore may be too curioufly or remiffly dreffed—how, 238, 239. Calcining of Copper Ore, very proper to evaporate the Mundick, 241. Of running poor Ores into regule at the Mine, 242. Dreffing Dreffing of Lead Ore nearly the fame as Copper, 243. Of Peafy, Bing, and Smitham; by Cobbing, Buckering, and Jigging, 244. The method of fampling Copper Ore, 245.

C H A P. III.

A Summary of the Dreffing of Gold, Silver, and Semi-Metals, &c.

G OLD dust dressed in bowls-Brazillians frame Gold upon the hairy part of an ox-hide, 246. Quickfilver ponderous, and will bear water-Semi-Metals and Mineral falts dressed by water, 247.

George Co H A P. I. quital bas e how off

On the Art of Aflaying Ores and Minerals; defcribing the Utenfils and Fluxes for Aflaying.

DROEM, 248. The Fluxus Niger, and White Refining Flux, how to make, 249. Of the furnace for affaying and tefting, 249. How to difcover the contents of a Mineral in the liquid way, by a menftruum, 250. To affay Pyrites, Marcafites, or Mundicks, for Gold or Silver, 251. Method of fcorifying the regulus of Mundick, 251. Intention of this procefs explained, 252. Cornish china-ware crucibles, recommended for retaining glass of Lead-their composition, 253. They muft be guarded-Of Cuppellation, 254. Of the making of Cuppels-their ufe, 255. Procefs to difcover whether the product of the affay contains Gold, and the quantity, by precipitations from folutions in aqua fortis, 256. Of proof aqua fortis, 257. How to affay Tin for Gold, 258. This process elucidated-Method to try the first fcoria for Silver-explained, 259. The fame process applicable to Copper or other Metal, 260. How to affay Copper Ore-Of calcining the Ore, 260. Of fcorifying, 261. That operation explained-Of refining the impure Copper, 262. Often repeated-Of reducing the fcoria for refining the Prill-A nice operation, 263. To affay Copper Ore the regule way, 264. How to calculate the value ot

C O N T E N T S,

of a ton of Copper Ore by the affay, 264, 265, 266. To affay Lead, 267. the operation explained, 268. To affay Tin Ore —Of feparating the fcoria of Pillion Tin, 269. To affay Cobalt, by the blow-pipe—of calcining, making the regulus, and refining thereof—Regulus of Semi-Metals, the efficient caufe of their colours, 270. To affay Bifmuth, 271.

C H A P. II.

Of Smelting of Copper Ores in the great Furnaces called Copper Works.

F the conftruction of furnaces and the Materials thereof, 271, 272. The calciner, the reverberatory furnaces, 273, 274. Procefs of calcining, 274. Of the operation furnace, and repeated fmeltings therein, 274. Of the Metal calciner, and the operation there—Of the Metal furnace, and the operation there—Of roafting—Of the coarfe refinery—Of the ultimate refinery of the Metal, 275. very expensive to bring into fine Metal, 276. Remarks, 277. Hiftory of fmelting Copper Ores in Cornwall and Wales, 277, 278. Propofal to fubject Copper Mines to ftannary laws—Further hiftory and remarks on fmelting Copper Ore in Cornwall, 279, 280.

C H A P. III.

Of Smelting Tin Ore, or Black Tin, in the great Furnaces at the Smelting-Houfe.

O F the ancients fmelting Tin with wood, and the introduction of pit-coal, 281, 282. Of the furnace — the charging, fluxing, and tapping the furnace—Sizing the fcoria —Stamping and dreffing them, 282, 283. Of the large float, and remelting the Tin, and its final lading into blocks for coining—Of the remaining drofs—its further purification—Of the flaggs called Hard-heads, 284. The requifites of a good Tin fmelter—Obfervations and reflections, 285.

CHAP.

CONTENTS.

C H A P. IV.

Of the Sale of Copper Ores; and of Black Tin at the Smelting-Houfe, and after it is fmelted and coined in Blocks.

O F the ancient method of felling Copper Ore in Cornwall, 286. Of the prefent manner by ticketing, 287. eafy and concife, 288. Obfervations and reflections, 289, 290. Of felling or bartering black Tin for white—Form of a Tin bill, or promiffory note for Tin, 291. Of negociating or felling the bill—terms, 292.

CHAP.

INTRO-

raied when throughers coafts of Conwall, Hull fix hundred

OTTOUCORFИ

A S all ages from the foundation of the world, have been productive of continual improvements, and different modifications of matter; fo likewife every kingdom and province, has experienced the vicifitude of time and things, and that rotation to which all matter is liable. However, amidft all the changes of fublunary affairs, each country refpectively has been ever remarkable for its peculiar produce, trade, and commerce; and we may fuppofe from the nature of particular things, which are folid and durable, that the conflituent principles of Minerals and Metals, although fubject to a degree of fluctuation common to the mundane fyftem, have undergone the leaft variety of any matter. Hence it is we find, that moft countries, which have been remarkable, time out of mind, for fupplying the world with certain Minerals and Metals, refpectively maintain to this day a fuperiority for their fingular products.

Among fuch, the ancient kingdom of DUNMONIUM, which fignifies Hills of Tin Mines, and takes its name from thence, may with great propriety claim a diffinction in the annals of Metallurgy; but more eminently ought that part of it called Cornwall to be diffinguifhed, as having, perhaps, yielded more Tin in one year, than Devonfhire has done in half a century. I may yet proceed, and infer, how fuper-eminently this little province of Great-Britain deferves to be ranked amongft the firft principles of this ifland, as a nation and people, whofe very name, according to the ancient authority of Bochart, and the later opinion of Boerhave, is derived from Bratanack, which, in the Phenician language, fignifies The Land of Tin.

Tyre and Sidon were fituate in Phenicia, a part of the ancient Paleftine; and were the first maritime powers that we read of, either in facred or profane history. Tyre (the grand fea-port and mart of Phenicia) was taken and entirely demolished by Nebuchadnezzar, in the thirty-fecond year of his reign, and in the year 573 before Chrisft; fo that the latest date of their trading here, cannot be less than four and twenty centuries b

fince. I believe it is agreed by all writers, that they were the first who used to frequent this island for commerce; that they traded upon the western coafts of Cornwall, full fix hundred years before the coming of our Saviour; and that their navigation to it, was for the fake of our Tin. They confidered this traffick as a point of fuch confequence, that they erected forts and castles on our coasts for the protection and prefervation of their commerce; and a great number of the proper names of men and places in Cornwall, are plainly derived from the Syriac tongue.

The learned doctor Borlafe inclines to an etymology from a Hebrew root, whole termination Tania of Grecian extraction, gives another idea of the name in queftion : but if we admit the Phenician language to be immediately derived from her neighbour, and the mother of tongues, we may incline very eafily to confider our county, as the parent of one general name for the whole ifland ; and that the antiquity of our Tin trade has been eftablifhed upon mercantile principles, for at leaft two thoufand four hundred years paft.

I hope the reader will not judge it improbable, if we fuppofe that the firft inhabitants of Cornwall and Devon, after the flood, were well acquainted with Tin in its richeft Mineral ftate; for it requires no uncommon degree of intellectual examination to comprehend, that, in the earlieft ages from that grand epocha, our richeft fhode and ftream Tin muft have been found plentifully differinated upon the furface of our vallies, and the fides of our hills and mountains. Thofe fragments and nodules, by their colour, fhape, and gravity, muft have attracted the notice and confideration of the firft natives, if they did not allure the attention of thofe immediate emigrants who were "fcattered " over the face of the earth, when the fons of men multiplied " in the land." We have, therefore, much plaufibility on our fide to conjecture, that Tin was known as a Metal among our progenitors, fo long as four and thirty centuries ago.

They could not obferve the fingular fhape and weight of fhode and ftream Tin, without confidering the contents as a Mineral, which by its fuperior gravity would afford fome metalline fubftance; efpecially, when by a comparison with the Mineral Ores of other Metals, known long before the flood, they must have had all the reason in the world to conclude upon its metalline confistence. Information, or perhaps experience in

ii

in the methods of extracting Metal from other Minerals, muft have directed them in what manner to purge our Metal from its native drofs. The richnefs of the Mineral, and its natural eafy fluxility in the fire, foon confirmed their conjectures; and the beautiful colour, and innocent properties of the Metal, no doubt rendered it as valuable in their effimation as Silver and Gold; until, by great abundance, which renders all things cheap, it funk in the fcale of comparative excellence with thofe Metals.

Tin, in its Mineral state, being totally unknown to all other countries but our own, affords ample reason to affert, that we fupplied all the markets of Europe and Asia with that commodity in early ages. Accordingly, we read of Tin in Judah so long back as the reigns of Uzziah, Jotham, Ahaz, and Hezekiah; (Ifa. i. 25.) and also in the writings of Homer, who flourisched 907 years before Christ:

" In hiffing flames, huge Silver bars are roll'd,

" And flubborn Brafs, and Tin, and folid Gold.

" A darker Metal mixt intrench'd the place,

" And pales of glittering Tin th' enclofure grace."

Pope's Hom. Iliad, L. 18.

From hence we would infer, that all Tin produced in the primitive ages of the poft-diluvian world, was from ftream or fhode; perhaps many ages before deep Mining was at all known. We have authority to fay, from Mr. Carew, and a M. S. of Serjeant Maynard, which we have feen, that the working of Lodes was unknown to our anceftors in the first ten centuries after the incarnation; fo that we may reafonably conclude, our Lode or Mine works are not of 700 years ftanding.

It has been hitherto an object of enquiry, from whence our Tin was fhipped in the time of the Phenicians : fome fay, from the Caffiterides or Scilly Iflands; Bolerium, or the Land's-End; others fay, from St. Michael's Mount; and others, from Oflium Kenionis Valubia, or Falmouth.

The ignorance of true geography and navigation in the times of Timæus, Strabo, Diodorus Siculus, Polybius, and all the ancient historians and geographers, was fo great, and their defcriptions fo obfcure and contradictory, that it may ever remain a matter of conjecture and controverfy, whence our Tin was exported for Phenicia Phenicia or Rome, by the records they have left behind them. It feems probable, that they included the promontory of Bolerium among the Caffiterides, and denominated all the fouthweftern coaft of Cornwall as part of them; which being the first land discovered by the navigators of those days, gave one general appellation to the whole.

The veftigia of any Tin Lodes, Mines, or workings, in the iflands of Scilly, are infufficient to convince us, that they only gave this beautiful Metal to the world : the remains of any fuch workings are fcarcely difcernible; for there is but one place, that exhibits even an imperfect appearance of a Mine; 'and fo neceffary an appendage to a Mine as an adit to unwater the workings, is not to be feen in all the iflands. If, in those days, the Metal was produced from ftream or fhode ftones only, we muft undoubtedly have difcovered, in latter times, those Lodes or veins from whence they were difmembered by the deluge. They must have been wrought for Tin fince the earlier ages; and fome remains of fuch Lodes would now be vifible on the fea coaft or cliffs, if many fuch had ever been : we are, therefore, ftrongly induced to believe, that the Mineral Ore of Tin was anciently procured within the four weftern hundreds of Cornwall, and there imelted into white Tin, by charcoal fires, as the want of a proper bitumen in those days, and the entire demolition of all the woods near the Tin Mines, very plainly evince.

Befides, unlefs we make great allowances indeed for encroachments of the ocean fince thofe early ages, the iflands of Scilly are merely in their prefent flate a clufter of barren rocks, the principal of them meafuring but three miles long and two wide. Whence fhould all this Tin arife? Likewife the flate of population then could not admit of emigrations from the infular continent for digging, raifing, and fmelting a Metal, which the mother ifland produced in fuch vaft profusion from her own bowels.

Without partiality to any particular opinion, we must own the harbour of Falmouth feems to us the most commodious, both for natives and foreigners, to have carried on the business for exportation of this grand monopoly, which supplied all the Mediterranean markets : and we are not singular in this thought, but are very plausibly supported by a learned collator of our own country, in whose MS. we find an ingenious etymology

iv

etymology and topographical agreement in relation to the matter before us. (Hals).

" This harbour of Falmouth has been famous over Europe and Afia ever fince the ifland was first known, though but darkly diffinguished by the Greeks and Romans under feveral appellations; for inftance, by one (in Greek) The Mouth of the Dunmonii Island : for neither Greeks nor Romans knew whether this province of the Dunmonii was an ifland of itfelf, or part of the infular continent of Britain, till the time of the Roman emperor Domitian, when he circumnavigated the whole ifland with his fleet. Befides, it was the cuftom of the Jews and Greeks, to call remote and strange lands, Islands, and the natives, Islanders : to which purpofe we read, Ifaiah lxvi. 19. " Tubal, Javan, and the ifles afar off," which were the continent of Greece and Spain." Alfo, Genefis x. 5. and elfewhere, by the name of the ifles are meant the iflands, and in general all the provinces of Europe. And it is observable, that where the prophet Isaiah foretels the calling of the Gentiles, he makes particular mention of the iflands, (chap. xli. xlii. xlix. li. lx.) which many interpreters have looked upon as a plain intimation, that the Chriftian religion fhould take deepeft root in those parts of the world, which were feparated from the Jews by the fea, and peopled by the posterity of Japhet, who fettled themfelves in the iflands of the Gentiles. So that the iflands, in the prophetical file, feem particularly to denote the weftern parts of the world, the weft being often called the fea in fcripture language. But to proceed :

" Strabo calls this mouth of the Vale river, Oftium Kenionis, and more properly Valuba, or Valubia; that is, the wall, defence, point, or promontory, of the faid Vale, now St. Anthony's Point; or Val-Ubii, from the colony of the Ubii, a people of Belgia, who planted themfelves on the Vale river before Cæfar's days. (From which Ubii, might come Cornubi-enfis.) Further, Diodorus Siculus tells us, that all Tin was fetched out of Britain : as it is in fome authors, after the Greek verfion, from Niess Inta, KI OKTA (Nefos Ikta, Ki Octa) which feems to fay in British, first, the Good Lake, or Haven Island, and the fecond (what we now call Bud-Ok) a Bay of Oak Ifland; and, indeed, the memory of fuch Ike feems yet preferved in the prefent names of Car-ike road, the chief part of Falmouth harbour, from whence, to this day, the major part of our Tin is still exported; and Arwynike, and Bud-ike lands, by which the

T

the faid harbour is bounded. Now, this word Ike, I am informed, is derived from the fame Japhetical origin as the Greek ize, (Eko) venio; to come, arrive at, or enter into a place; and, therefore, as aforefaid, in Cornish British, it means not only a haven of the fea for traffick, but a place where a river of water hath its current into the fea; from whence, perhaps, the Latins had their Ictus, to fignify the course of a river. And from this etymology we may the better understand the words of Diodorus Siculus, from the Greek rendered into Latin, thus : " Britanni, qui juxta Valerium Promontorium, incolunt, mer-" catoribus, qui eò Stanni gratia navigant, humaniores reliquis " erga hofpites habentur. Hi ex terra faxofa, cujus venas " fequuti, effodiunt ftannum; quod, per ignem eductum, in " quandam infulam ferunt Britannicorum juxta, quam Ictam " vocant."

"The Ifland which he calls Ictam or Icta, adjoining thus with Britain, is certainly that which is now called the Black Rock Ifland in Car-ike road aforefaid ; which, as he faid, was then an ifland at flood or full fea, though at low water paffable from the main land. There is also a Cornish MS. of the Creation of the World, a Play, brought into Oxford in 1450, and which is still extant in the Bodleian library there; which will at the fame time ferve to evince, that the now Black Rock of Falmouth was in old time the Island, the Ikta of Diodorus Siculus, from which Tin was transported into Gallia: a few words of it therefore here follow faithfully transcribed, with their translation : they being fpoken as by Solomon, rewarding the builders of the universe (a very great abfurdity in the poet) page 151; which was then, perhaps, a true description thereof :

harbour, firsm whence, to this day, the major pare of our Tin

- "Whyr gober eredye

vi

- "Warbarth gans ol gweel Together with all the fields of " Bohellan
- " An Ennis, hag Arwinick, The Ifland, and Arwinick, " Tregimber, hag Kegillick. Tregember, and Kegillick.
- chauter."
- " Banneth an tas wor why; Bleffing of the Father on you; "Why fyth vea gwyr gobery. You fhall have your reward.

Your wages is prepared

- Bohellan
- " Hag goad Penrin entien And the wood of Penryn entirely,
- "Anthotho gurry the why Of them make you a deed or hido bill beer all charter. mon analong ada

hand reored a and Arweike, and Bud ike lands, by which

Leland the elder, in his Itinerary, tells us, that this river was encompafied about with the loftieft woods, oaks, and timber trees, that this kingdom afforded, temp. Hen. VII, and was therefore, by the Britons, called Gaffi-tir, and Caffi-ter; that is to fay, Woodland. From which place and haven, the Greeks fetching Tin, called it and the Ifland, fo often here mentioned, in their language, Caffiteros. In further praife of which famous port, may the reader accept the following lines:

In the calm fouth Valubia's harbour ftands, Where Vale with fea doth join its purer hands; 'Twixt which, to fhips commodious port is fhown, That makes the riches of the world its own. Ike-ta, and Vale, the Britons chiefeft pride, Glory of them, and all the world befide, In fending round the treafures of its tide. Greeks and Phenicians here of old have been; Fetching from hence, furs, hides, pure corn, and Tin, Before great Cæfar fought Caffibelyn."

10 amontat berhaud as Hals's Paroch. Hift.

We may, hence, conclude it very probable, that this part of Great-Britain, was the first reforted to by the most ancient maritime powers in Europe and Afia, on account of its valuable, beautiful, and precious Metal; and therefore gave a name to the whole island, which, with fome little variation, it retains to this day, and proves the antiquity, locality,* and superiority of our product, and its universal supply for the use of mankind.

more. It

Such an abundance of Copper Ore, which the Mines produce at this time in Cornwall, is a clear evidence of the fertility of our county in that Metal, preferable perhaps to all the reft of England for quantity, quality, and employment. Former times might have been equally celebrated for our production of this Metal with that of Tin, had its proximity to the furface been fo great : but this rich and ufeful Metal is placed by divine appointment more remote from the reach of human induftry ; and fo deeply concreted in the bowels of the earth, as to elude the fearch of man, without the help of mechanicks and philofophy :

* Tin is a Metal become very neceffary in common life, and yet in fome meafure the rareft of all others. There are but few Tin Mines in Germany; nay, in refpect of other Metals, few in Europe. All in Germany, as far as I know, are thole in Mifnia, Bohemia, and Carinthia; and formerly in Fitchelberg at Wonfiedel. Whole kingdoms, as Sweden, Denmark, Norway, &c. have no fuch Mines, but are fupplied with Tin from England. Auth. Preface to Henckell's Pyritologia.

douoda.

no

no wonder, then, we are not renowned for difcoveries of this Metal in the diftant ages of antiquity. When arts and fciences were in their infancy, it was impoffible to lay open the deep treafures of the terrene fyftem. Men, money, and materials, in former times, were more fcarce: and the increafe of population and fpecie in latter days, have progreffively and mutually operated, to lay open and difcover the deep receffes of the earth, and the hidden treafures of the ftupendous contrivance in the matter and formation of our globe.

The fuperficial fite of one Metal, and the central tendency of the other, give us different ideas how they are to be fearched after and wrought; and those ideas can no way concatenate, but wherein those Metals may be discovered, cæteris paribus, equally central or fuperficial.

In fending round the treafures of its tic

It is very feldom that Tin continues rich and worth the working, beyond fifty fathoms deep; and it is abfolutely certain, that Copper is not often wrought in great abundance, till paft that depth, to an hundred fathoms or more. It is alfo a fact, that most Mines with us, both of Tin and Copper, being richer in quality near the furface, and by that circumftance attended with less expense in the working, do for the most part reward the adventurers with very ample gain.

and therefore gave a name t

It fhould, therefore, feem eligible to beflow our attention on those fkin-deep adventures, preferably to the deep Mines; but this is by no means the cafe in practical Mining: for, if a Mine, when she is first discovered, throws up a large profit to the adventurers, and fails foon after to their loss and detriment; they nevertheles purfue their object, under the most unpromising circumstances, with unremitting ardour, patience, industry, and resolution, fearcely parallel in any other unfortunate undertaking under the fun. Every little stone of Ore brings along with it new hopes, and fresh vigour. It fans the glimmering flame of adventure, which had been kindled before by the fire of a certain Provincial Spirit, that feems to animate the natives of Cornwall, and to deferve that fucces which they cannot always command.

Neither is it wife to rely on the fuccess of shallow Mines, though their profits may be fudden; or to defert them because their depth may prove unfavourable for some time after; for it is experimentally true, that most Mines of confiderable depth, though

viii

though vaftly expensive, and the Mineral of lefs intrinfick worth, do, in their fuperlative quantity, certainty, and fteadinefs, make complete and fubftantial amends for the great labour, and perfevering affiduity of their proprietors. In fupport of which I may venture to affirm, that fix Mines produce fix parts in eight of all the Copper Ore of the county at this time.

Tin in its metallick state, being to Copper but as fixty to a hundred, is notwithftanding more rich in its minerallick Ore than Copper, as it comes from the Mine; therefore they require different management in the dreffing, and cleanfing them for The former from the fmallness of its particles, the furnace. and extreme hardness of the stone in which it is frequently found, requires to be triturated or pulverized as fmall as the fineft fand, to go through repeated ablutions, calcinations, &c. and be taken up with the utmost nicety and precision; which renders it of lefs nett value to the Miner on account of fo much trouble and expence in the minerallick manufactory thereof : but as it affords fo confiderable an employment for the children of poor labourers, from fix years old and upwards, they are generally engaged in that branch before they commence underground Tinners, and from the age of puberty are indifcriminately denominated Tinners by that means.

Among the working Tinners, this darling Metal holds her empire in the heart; probably becaufe of its locality, and the privileges, immunities, and ftannary laws, whereby they are diffinguifhed, fupported, and protected, as a feparate body of people.

Copper, as I have before faid, being placed in the more interior ftrata of the earth, requires great fkill in hydraulicks, and mechanicks. The appropriate qualities, gravitation, and denfity of the elements, ought to be nicely weighed in the fcale of found judgment. The expence of coal, candles, timber, leather, ropes, gunpowder, and various other materials, added to the labour of men, women, children, and horfes, occafion fuch a vaft monthly charge, as will not eafily be credited by thofe who are unacquainted with Mining. It is well known, however, that fome Copper Mines now extant, have each fupported, for feveral years paft, a monthly expence of two thoufand five hundred pounds, including the land owner's fhare, which is generally a fixth, feventh, or eighth part, in fpecie, of the whole proceeds.

From

ix

From a comparative view of the charges in working of Tin and Copper Mines, we may draw this corollary, viz. The former is wrought upon more dependent principles than the latter, which cannot be embowelled in great quantities, without the help of foreign auxiliaries, fuch as coal, and very large timber particularly. The Mining intereft of Cornwall, therefore, deferves great attention from the government, the nobility and gentry of the united kingdoms, as tending to a confiderable national advantage in the confumption of fo many materials neceffary for the conduct and maintenance of the Mines; whereby great trade is kept up, large duties to the community are paid, and a conftant uniform nurfery for feamen is eafily and cheaply preferved, as our quota, of additional fupport of the trade, navigation, and fecurity of thefe kingdoms.

With much fatisfaction we can reflect upon the fingular nature of our ftaple commodities, they being attainable at the certain lofs of none but those who feek a recompence from the purfuit. Now in fome kinds of trade and bufinefs, what is the profit in one man's hand, is frequently fo much lofs to fome other individual, from whom it is either immediately or laterally derived. It is an axiom in trade, that " One man's lofs is another man's " gain ;" but in the cafe before us, we take from no perfon's bag, but ftrive only to obtain the treasure of the deep, which in its hidden flate yields neither glory to God nor fervice to man : " And all this out of a narrow flip of land ufually of the moft " barren hilly kind, without diffreffing tillage, pafture, and " the like, fcarcely worth the remarking; and very far fhort of " the improvements in rent for those lands which are in the " vicinity of the Mines." (Borlafe).

Mr. Scawen, of Molinek, was vice-warden of the Stannaries in Charles the fecond's time; and in a note of his, which the writer has feen, complains, that the Tin revenues were then fmall; but, in the preceding reigns of James the firft, and Charles the firft, the amount of Block-Tin yearly, was from fourteen hundred to fixteen hundred tons. It was alfo found by the laft two farms in queen Anne's reign, and the beginning of George the firft, that Block-Tin, one year with another, amounted to fomething more than fixteen hundred; fo that, in the fpace of one hundred and ten years, its mean proportion was equal to fifteen hundred tons # annum. Since the foregoing time, we obferve a gradual increase for thirty years following; for, in the year 1742, a propofal was made by the Mines Royal Company

x

XI

Company in London, to raife one hundred and forty thousand pounds to encourage the Tin trade by farming that commodity for feven years at a certain price. A committee of Cornish gentlemen were appointed to confider of the proposals; and they reported, "That the quantity of Tin raifed yearly in "Cornwall, at an average for many years last past, hath been "about two thousand one hundred tons; and refolved, that "three pounds nine shillings for grain Tin, and three pounds five shillings & hundred weight for common Tin, are the lowest prices for which such Tin will be fold to the con-"tractors, exclusive of all coinage duties and fees."

The rapid increase of the produce of our Tin Mines for the last thirty years, is fcarcely credible: it is, however, a fact, that we have coined three thousand fix hundred tons of Block-Tin in one year; and, for the last twenty years, the annual average has been about three thousand tons; which is double the quantity coined annually but fixty years ago, and one-third increase for the last thirty.

No lefs extraordinary has been the vaft addition to the fales of Copper Ore within the laft twenty years; efpecially as Mining for Copper, only commenced with the prefent century; the little which had been raifed before, being adventitious, and accidentally met with in purfuit of Tin.

According to the following accounts, which are faithfully transcribed from the Copper Ore buyers books, we find the quantity fold, from 1726 inclusive to the end of 1735, was fixty-four thousand eight hundred tons, at an average price of feven pounds fifteen fhillings and tenpence & ton, amounting to four hundred and feventy-three thousand five hundred pounds, which muft have been yearly forty-feven thousand three hundred and fifty pounds. From 1736 inclusive to the end of 1745, feventy-five thousand five hundred and twenty tons of Copper Ore were fold at feven pounds eight shillings and fixpence average price, the amount five hundred and fixty thousand one hundred and fix pounds in the grofs, and fifty-fix thousand and ten pounds yearly. From 1746 inclusive to the end of 1755, the quantity fold was ninety-eight thousand seven hundred and ninety tons at feven pounds eight shillings the ton, the amount feven hundred and thirty-one thousand four hundred and fiftyfeven pounds; annually feventy-three thousand one hundred and forty-five pounds. From 1756 inclusive to the end of 1765, the

the quantum fold made one hundred and fixty-nine thoufand fix hundred and ninety-nine tons, at the average price of feven pounds fix fhillings and fixpence, amounting to the fum of one million two hundred and forty-three thoufand and forty-five pounds, and one hundred and twenty-four thoufand three hundred and four pounds yearly. Laftly, from 1766 to the end of the laft year, two hundred and fixty-four thoufand two hundred and feventy-three tons of Copper Ore were difpofed of at fix pounds fourteen fhillings and fixpence Ψ ton, amounting in all to one million feven hundred and feventy-eight thoufand three hundred and thirty-feven pounds, which muft have returned one hundred and feventy-feven thoufand eight hundred and thirty-three pounds every year of the laft ten.

In order to form a more comprehensive view of the progress fo lately made in Mining for Copper, we have prefented the reader with a comparative fcale of the above Ores, &c. where he may fee for himfelf, the advance and improvement, which have been made in the fcience of Metallurgy in this part of Great-Britain. And when we reflect upon those great and fudden improvements in the art of Mining, we may juftly give ourfelves all the merit, which we really deferve for our fuperior excellence to all the reft of our fellow fubjects in this fingular branch of knowledge. We do not know how much our gratulations may be damped, when we further observe, that (from fome caufe which we cannot perfectly account for at this time) the intrinsick value of our hard gotten commodities, has decreafed in fome ratio to the advance in quantity, which ought to be a matter of very ferious enquiry with all the gentlemen of Cornwall, whom it fo nearly concerns, and from whom we may expect that redrefs by their united efforts, which the declenfion of our Mine trade fo greatly requires.

It is the popular opinion, that no real furplufage beyond the charges of Mining do arife to the adventurers in general; and that in Tin particularly, the credits are unequal to the outgoings. Neverthelefs, we fee, in our county, that many men have made opulent fortunes by their fuccefs in Mining; therefore it is difficult to account for the truth of this matter, unlefs we fuppofe the profit of the great Mines to be funk in the unfortunate adventures, and like national lotteries, the individual profit to be taken out of the general lofs. It is indubitable, however, that the publick is manifeftly enriched by the great trade and circulation of money, confequential to this peculiar bufinefs. Whether

xii

INTRODUCTION. xiii

Whether this equipofe in the profit and lofs, is a fact, or only a falfe allegation, I will not take upon me to fay; but if they be not tantamount to each other, we verily believe upon the whole, the gain is far fhort of that recompence which is due to the refolution and fedulous purfuit of the Mine Adventurers in Cornwall.

Supposing the proceeds in Tin and Copper to be annually four hundred thousand pounds, and the separate gain being aggregate; upon a dividend of twelve and a half \notin cent. it will come out fifty thousand pounds, which is only a profit of oneeighth upon the certain risk of so large a fum: but those who are conversant in Mining, we are well affured, would be very happy if they could promise themselves only seven blanks to one prize, which from unlucky experience we know to be not the case, and that nineteen blanks to a prize, will more nearly quadrate with the truth of the matter, by which our former dividend is reduced to five ψ cent. and the gross gain to only twenty thousand pounds ψ annum.

This, however, makes fome profit appear; but how fmall, if true! how inadequate to the fum laid out and expended ! This fhews the infatuation, and delufive hopes of political gaming, under which stigma it apparently lies. We shall forbear any further reflections upon the fubject, left we incur the blame and reproach of our neighbours and countrymen; but as we write for the publick eye, we find it neceffary to relate facts as they occur, whether they are unpleasing to the interested or not. In purfuance of which determination, we hope the landholders will hold us excufable, when we affert upon the cleareft conviction, that they contribute by their heavy exactions to deprive the industrious adventurers of too large a proportion of that profit, which ought to be applied for the encouragement and reward of their arduous and expensive undertakings. At a medium, the Lords of the foil have one-feventh part clear from all expence : now the one-feventh of four hundred thousand pounds, being fifty-feven thousand one hundred and forty-two pounds, it appears, by a ftriking comparison, for whom the Mines are wrought, and who are the principal gainers thereby; and very completely accounts for the great complaifance, candour, gratitude, and generofity of those gentlemen, to the feveral Adventurers in their refpective eftates.

At

At this time, when all the neceffaries of life are high in value, the price of all manner of materials advanced, the wages of labourers from a natural confequence proportionably increased, the price for Tin funk down from three pounds ten shillings to three pounds, and Copper Ore fallen more than thirty Ψ cent. below the true standard, have we not great reason to fear the event of such combined and adverse causes to the prosperity of this county? Is it not alarming? And how shall we account for all that supineness which is manifested by those, whose interest and business it should be to mitigate the recited distresses of a laborious and useful community?

Government would reap a very fruitful harveft annually, from a fuitable encouragement of the Mining intereft in Cornwall. We believe, if the managers of publick affairs would leffen fome of the heavy duties upon our materials, and wholly remit others, fuch indulgence would operate as a bounty, and greatly multiply our contributions to the national revenue, by animating the Mine Adventurers to rework feveral deep expensive Mines, now dormant through the great preffure of weighty impofts, upon the back of many natural difficulties and obftructions.

The drawback upon coal ufed in our finelting-houfes and fire engines, has been attended with fuch happy confequences for the publick, that we may venture to affirm, not one-fifth of the fire fleam engines now working, would ever have been erected without fuch encouragement. Thirty-fix years ago, this county had only one fire engine in it : fince which time above three fcore have been erected, and more than half of them have been rebuilt, or enlarged in the diameter of their cylindrical dimensions.

We shall leave the publick to reflect and animadvert upon this notorious truth.

all expense : now the one-fevenin of four hundred thoutand

and very completely accounts for the great complationee, can-

A dyentarers in their respective ellates.

xiv

2A

An Account of all the Copper Ores fold in Cornwall the laft fifty Years; their Tonnage, Amount, Price, and Value.

| Date | | dittoAverage Price ₽ Ton | | | Amount | Average Annual Tonnage | Average Annual Amount | |
|--------------|---------|-----------------------------|----|----|-----------|------------------------------|-----------------------------|--|
| 1726 1735 | 64,800 | £7 | 15 | 10 | £473,500 | 6,480 | £47,350 | |
| 1736 1745 | 75,520 | 7 | 8 | 6 | 560,106 | 7,552 | 56,010 | |
| 1746 1755 | 98,790 | 7 | 8 | 0 | 731,457 | 9,879 | 73,145 | |
| 1756 1765 | 169,699 | 7 | 6 | 6 | 1,243,045 | 16,970 | 124,304 | |
| 1766 1775 | 264,273 | 6 | 14 | 6 | 1,778,337 | 26,427 | 177,833 | |

| Date | Ann. Tonnage | Date | Ann. Tonnag | e Date | Ann. Tonnage |
|------|--------------|------|--|--------|--------------|
| 1726 | 5,000 Tons | 1743 | 7,040 Tons | 1760 | 15,780 Tons |
| 27 | 6,700 | 44 | and the second sec | 61 | |
| 28 | 6,800 | 45 | 6,700 | 62 | |
| 29 | 6,870 | 46 | | 63 | |
| 30 | 6,900 | 47 | 4,900 | 64 | |
| 31 | 7,000 | 48 | | 65 | 16,774 |
| 32 | 7,290 | 49 | and the second sec | 66 | |
| 33 | 7,000 | 50 | | 67 | |
| 34 | 6,000 | 51 | 11,000 | 68 | |
| 35 | 5,240 | 52 | 12,050 | 69 | |
| 36 | 8,000 | 53 | 13,000 | 70 | |
| 37 | 9,000 | 54 | A Decision of the second se | 71 | 27,896 |
| 38 | 10,000 | 55 | | 72 | |
| 39 | 11,000 | 56 | | 73 | |
| 40 | 5,000 | 57 | 17,000 | 74 | |
| 41 | 5,500 | 58 | | 75 | |
| 42 | | 59 | | 1 | Autom de hur |

e

| Average Annual Amount | Average Annual Tonnage | Amount | | | | TenVeari Tomuge | Date |
|-----------------------------|------------------------------|------------|-----|----|----|--------------------|-------------|
| 6471350 | 5,480 | £473,500 | .01 | 5 | 22 | | 1720 135 |
| 56,010. | 7.550 | 560,106 | 6 | | | | 1736 |
| 731145 | 648.6 | 731,457 | 0 | | | 987,90 | 37.46 |
| 408,481 | 16,970 | 1,243,045 | ō | ò | | 650'ega | |
| 177,833 | 26,427 | \$1778:337 | 0 | 41 | | 2641273 | 1766 |

An Account of all the Copper Ores fold in Cornwall the laft' hity Years ; their Tonnage, Amount, Frice, and Value.

| Ann. Tonnage | Date | Ann. Tonnage | | Ann. Tonnage | Date |
|--------------|------|--|------|--------------|------|
| 15.780 Tons | 1760 | Tons Tons | 1743 | 5.000 Tons | 1726 |
| 17,004 | 19. | | ++ | 6.700 | |
| 15.054 | 62 | | | 6,800 008,00 | 28 |
| 17,898 | 63 | | | | 29 |
| 27,4.89 | | | 47 | | 30 |
| 16,774. | 65 | | 84 | | 31 |
| 21,2 21 | | 7,200 600 1 | 144 | | |
| 18,500 | 67 | -9,400 | 50 | | |
| 23,671 | 189 | 11,000 | 125 | | 34 |
| 26,655 | 69 | 12,050 | . 50 | | 55 |
| 30,776 . | 70 | 13,000. | | 8,000 | |
| 27,896 | 71 | 14,000 | . 54 | 9,000 | |
| 27,654 | 721 | 14,240 | | | 38 |
| 27,765 | 73 | | | | 39 |
| 30,253 | 74 | | | | |
| 29,950 | | 25,000 | | 5.500 | |
| | | a the second sec | | | |

GENERAL TREATISE

OF THE FORMATION OF

the carth ; yet the minuteft of his works, for their exquisite

symmetry and delicacy, are equal evidences of the houndlefs

UPON

MINERALS, MINES,

Illuifrates; " Ubi vifum protendir? Ubi guflatum applicative vi Ubi oderatum infernit? Ubi vero teoculeatam illum, " Ubi oderatum infernit? Ubi vero teoculeatam illum, " portione maximam vocem ingeneravit? Oui fubtilitate per G. M. I. N. I. N. G.

" reciproca geminarit arta $\mathbf{W}_{\mathbf{O}}$ fodiendo eccuminatum pariter " forbendo que fift. I ofum $\mathbf{X}_{\text{fiet}} \mathbf{O} (\mathbf{O}_{\text{inv}} \mathbf{B})$

If Pliny had been acquaired A with Juictofcopick differences, where would he have found words to express his admiration at

Of the Origin and Formation of Metals and Minerals.

" exceed the bigness of those creatures, who were to exceed

ROM the invifibility of the original caufes of Minerals and Metals, every fyftem and theory, framed to account for their production, must be speculative and controvertible. The mundane theories of Burnet, Woodward, Whifton, De la Prime, Scheuzer, and others, though they have all their probabilities, are all liable to many objections. Indeed, to fearch into the fecret caufes of feveral appearances in nature that are evidently exifting, and obvious to our fenfes, both in her grofs and minute operations, requires fo much accurate labour, found learning, and folid judgment, that as it would appear prefumptuous in me to obtrude any particular theory of my own, I fhall only offer my opinion in the following fheets, with all imaginable deference to the judgment of the candid It is very probable that the nature and ule of Met. Asilduq

Though the flupendous views we have of divine architecture, fill our fouls with admiration and aftonifhment at his power who framed the heavens, and laid the foundations of 123 23. the

not revealed to Adam in his flate of innocence:

OF THE FORMATION OF

the earth; yet the minutest of his works, for their exquisite fymmetry and delicacy, are equal evidences of the boundless skill of the divine Artist, who hath furnissed us with no less matter of meditation and wonder in the conformation and instinct of the most contemptible infect, than in the attributed fagacity and unweildy bulk of the elephant.

Well might the immortal naturalift fay, "That in nothing "more is feen the workmanfhip of nature (God) than in "the artificial composition of these little bodies," which in his contemplation on the body of a gnat he fo elegantly illuftrates; "Ubi vifum pretendit? Ubi guftatum applicavit? "Ubi oderatum inferuit? Ubi verò truculentam illam, et portione maximam vocem ingeneravit? Qui fubtilitate pennas "adnexuit? Prælongavit pedum crura? Difpofuit jejunum "caveam uti alvum? Avidam fanguinis, et potifimum humani, fitim accendit? Telum verò perfodiendo tergori quo fpiculavit "ingenio? Atque ut in capaci cum cerni non poffit exilitas, ita "reciproca geminavit arte, ut fodiendo accuminatum pariter "forbendo que fiftulofum effet." (Pliny.)

If Pliny had been acquainted with microfcopick difcoveries, where would he have found words to express his admiration at Dr. Hook's affertion; "That if a large grain of fand was "broken into 8,000,000 of equal parts, one of them would "exceed the bigness of those creatures, who were fo exceeding fmall, that millions of millions might be contained in "one drop of water!"

If we defcend from the furface of the earth, we fhall likewife find in her bowels endlefs flores of foffils, petrifactions, minerals, and metals, to fupply mankind with the means and materials of every ornament and conveniency: in which we may, as through a glafs darkly, behold the fecret operations of him that worketh all in all, both in the heart of man, and in the bowels of the earth ! " Great and marvellous are thy " works, O Lord God Almighty ! In wifdom haft thou made " them all—the earth is full of thy riches !"

It is very probable that the nature and use of Metals were not revealed to Adam in his state of innocence: the toil and labour necessary to procure and use those implements of the iron age could not be known, till they made part of the curse incurred by his fall: "In the sweat of thy face shalt thou "eat

METALS AND MINERALS.

3

" eat bread, till thou return unto the ground ; in forrow fhalt " thou eat of it all the days of thy life." (Genefis.) That they were very early difcovered, however, is manifeft from the Mofaick account of Tubal Cain, who was the first instructer of every artificer in Brafs and Iron; and being the fon of Lamech, who was the father of Noah, must have been fuch an instructer Anno Mundi 1,200, or thereabout. Whether this is the fame perfon as in the Heathen mythology is called Mulciber, or Vulcan, who was the god of fubterranean fire, and efteemed the prefident over Metals, it is not effential to our purpofe.

It has been long difputed whether Metals are generated, or were all originally produced at the creation : whether they admit of germination, or augmentation, like animal or vegetable bodies, or whether they proceed from an accumulation and cohefion of metallick particles; or by what other means they were formed and produced.

The doctrine of the alchymift maintains, that they proceed from a certain Primum Ens, or first feed of Metals, which they fay is a kind of moift vapour or Gas, that changes the earth and juices it meets with in a vein into a mineral body or fubftance; and thence converts the Minerals into Metals or Ores by a continued fermentation and elaboration in the Mines, caufed by the Archeus or heat that acts on the veins, as it proceeds from the center of the earth ; it afferts alfo, that different Metals are produced conformable to the time and degrees of fermentation which the Mines have undergone; and partly by the purity and fuitablenefs of the veins, or the earth in them, which they suppose are as matrixes to contain and nourish Metals in embrio; fo that in the fpace of a thousand years, it feems, a Metal is generated and perfected de novo, according to the concurrent caufes, fuch as the impregnation of the Archeus, or the like. But this doctrine of Mineral fermentation is very properly denied to have any exiftence, by the accurate Boerhave, who, in his Hiftory of Fermentation, declares it to belong only to the vegetable kingdom; for he fays abfolutely, " This inteffine motion can be " excited in vegetables only;" and for Minerals, he does not remember that any fermentative motion has been obferved therein: fo that I think we may with full propriety express what is meant in the term fermentation, by effervefcence, which different admixtures of Mineral particles may momentarily excite; perfection, either quicker or flower, as they are of a and

and which really conveys a feparate fenfe and meaning, from the true natural operation of ferments.

Others will have it, that all Metals and Minerals were at first created in the very fame flate and nature in which they are always found, without undergoing any kind of alteration. The most common opinion among the Miners in Cornwall is, that crude immature Minerals do nourifh and feed the Ores with which they are intermixed in the Mines; and that the Minerals themfelves will, in process of time, be converted into Ores productive of those Metals, to which they have the neareft affinity, and with which they have the greateft intercourfe. This, however, is but the common opinion. Those of most experience feem to have a contrary notion of the matter, and yet differ among themfelves. We apprehend the beft and most plaufible reasons that can be advanced, are those which are neareft at hand, are most obvious to our fenses, and are deduced from observation and experience; and therefore, without animadverting on the different opinions abovementioned, we shall proceed to communicate our own thoughts on this controverted fubject.

It is reafonable to conclude, that Metals were made and implanted in veins at or very foon after the creation of the world. Tin Ore will peculiarly evince the juftness of this conclusion; for it is frequently found, in its richeft and pureft flate, in large fpots and bunches in blocks of ftone of the moft hardened confiftence, fuch as Granite, Elvan, and the like, which have been above the furface ever fince the first induration of folids, have experienced no revolution, nor been water-charged with metallick particles, unlefs from the clouds of heaven. Perhaps it has been primarily fo with most other Metals, as their ufefulnefs was discovered to man before the methods of finking deep into their proper niduffes were at all known. In other countries, where Metals may be more generally diffused, it has probably been found as I fay; and from the beginning, these metallick diffributions may have experienced a decay and alteration by the action of the different elements upon them, according to their fpecifick induration or laxity.

I have before obferved, that Metals are fubject to a degree of fluctuation, in common with all matter; and that they approach to, or recede from, their ultimate period, or degree of perfection, either quicker or flower, as they are of a greater

greater or lefs folid and durable frame and conflitution. In favour of this opinion, it is found, that the Ores of Copper and Lead, though rich and folid in nature, yet by a long infolation, or expofure to the fun and weather for fome years, lofe much of their Metal : and alfo, that those Mines which abound with a rich mature Copper Ore, do, near the furface, at least immediately over the body of the Ore, commonly contain a ruft, tincture, or fpume of Copper, refembling Verdigrease ; which feems to be an Ore in a declining flate, being elevated by an effervescence in the bowels of the Mine from that fulphureous body of Ore which often lies under it, and to which it did belong at first, and was united with it, till fome intervening cause occasioned fo visible an alteration in the Ore of one and the fame Mine.

It feems to me that in every Metal there is a peculiar magnetifm, and an approximation of particles fui generis, by which its component principles are drawn and united together, particularly the matters left by the decomposition of the waters passing through the contiguous earth or strata, and deposited in their proper nidus; till, by the accretion of more or less of its homogeneous particles, it may be demoninated either rich or barren.

had held diffolved ; and which, on being to difen

That Ores, and even virgin Metals, are or may be formed in this manner, feems manifeft from a method now in ufe, of extracting Copper from waters ftrongly impregnated therewith : Iron which has lain fome time in fuch water, is found on examination to be greatly corroded, and to have Copper formed in its ftead, either adhering to the Iron, or funk to the bottom of the veffel, in form of ruft, and fometimes even in fmall grains of a complete metallick appearance.

acids, which are already faturated with kindred par

This Copper and ruft on being fmelted with a reducing flux, fometimes produce above three-fourths of their weight pure Metal. The water generally ufed for this purpofe is that which is left by lotions of black Tin, intermixed with Copper, after it has been calcined in the proper furnace, commonly called a Burning-Houfe. The Copper contained in this water, is kept in folution by an acid; and this acid having a greater affinity with Iron than with Copper, on the immerfion of Iron, quits the Copper to join with the Iron; by which means a precipitation enfues, in the manner juft mentioned. This procefs may at any time be evinced by the following experiment. Diffolve C

OF THE FORMATION OF

thin plates of Copper in Aqua-fortis, and you will have a clear liquor of a fine blue tinge : on applying to this thin plates of Iron, the acid, quitting the Copper, will precipitate it in the manner before defcribed, as Copper would have done by Silver, had it been first diffolved in the menstruum; and as fixed alkali will do by the Iron, after it has dislodged the Copper.

From this we may reafonably infer, that water, in its paffage through the earth to the principal fiffures, imbibes, together with the natural acids and falts, the mineral and metallick particles, with which the different ftrata are impregnated; and meeting, in those fiffures, matters which have nearer affinities with the acid, of course difengages it, in whole or in part, from the metallick and mineral particles, which it had held diffolved; and which, on being fo difengaged, by the natural attraction between its parts, forms different ores, more or lefs homogeneous, and more or lefs rich, according to the different mixtures, which the acid had held diffolved, and the nidus in which it is deposited. The acid, now impregnated with a new matter, paffes on ; till meeting with fome other convenient nidus, it lodges in that, and thereby acquires a fresh impregnation, perhaps at laft totally unmetallick; or, for want of meeting with a proper nidus, appears at the furface, weakly or ftrongly tinctured with those principles it had laft imbibed. e or may be formed in

By means of thefe acids, the Miners are often put to an extraordinary expence for Brafs pumps inftead of Iron; for many of the Mines have water fo fully imbued with acid, that the Iron working-pieces, in which the pifton of the pump works, will be entirely corroded therewith in fix months; and a great expence and lofs of time will be incurred, if the pumps are not previoufly furnifhed with Brafs working pieces, as on them the acids, which are already faturated with kindred particles, have little effect.

Thefe, I prefume, are plain demonstrations: whence it appears, that Goffan, which is an ochreous Stone, ruddy, and crumbling like the ruft of Iron, much of which it really contains, is a proper nidus for most kinds of Metals and Minerals; Iron having, even in this its mineral state, fo strong an affinity with the acids, as to decompose them, when faturated with other Metals, Semi-metals, &c. on which decomposition, the precipitated matters become Ores of different kinds, and even virgin Metals, as before defcribed.

7

In Mr. Gellert's tables of affinity, Zinc is indeed placed in the first degree, and Iron in the second; but this, which refers only to their metallick state, does not affect what I have above advanced of the mineral: yet, in the mineral, Zinc is scarce ever free from Iron; the vast quantities of Black Jack which this county produces, being, by means of this mixture, rendered mostly unfit for use.

We have, indeed, feveral kinds of Goffans, from the different appearances of which, experienced miners form very ftrong and well grounded conjectures, of what they will produce when they come to be wrought : but more of this when I come to define the nature of Lodes, in refpect of the earth and ftones they contain.

The different alterations of fubftance before defcribed, are deemed by fome a genuine tranfmutation : but they carry the argument too far, who fuppofe that Minerals or Metals are entirely changed from one kind to another, as Mundick into Copper, Lead into Silver, Silver into Gold, &c. For when Metals or Ores do once arrive to their utmost perfection, which probably they were endued with from the beginning, and which is always effential to them, though fubject to divers impediments and revolutions; it is not eafy then to conceive, how they can by any means affume an entire alteration or renovation, fo as to be tranfmuted from one Metal to another, by any degree of elaboration in the earth.

If this transmutation was a fact in nature, from the divers. alterations which we may reafonably fuppofe to happen in our foluble Minerals, fuch as Copper Ore for inftance, we might expect to meet with the most perfect Metals in our Mines; and our richeft Tin Mines, by the elaboration and melioration of them in the course of two thousand years, might at this time be productive of Gold and Silver enough, to furnish a fum ten thousand times ten thousand greater than our national debt. But the wildom of God, for the benefit of his creatures, has ordained, that things of this kind fhould remain enfhrined in their own nature : and Tin, though united by a diffeminated quantum of Gold, will not part with its noble cement, notwithftanding the chymical analyzations of an illiterate impoftor to extract a pound of Gold from every block of Tin. No, the goodness of Providence has fixed unalterable limits to the perfection of each particular Metal, to render the whole of greater fervice

fervice to mankind; the inferior Metals, Iron efpecially, being of more general utility than Gold, Silver, and even precious Stones.

If it be faid, that the impurities of the earth in our Mines, is the caufe that nature is debilitated and fruftrated in her endeavours after tranfmutation; it is anfwered, that, notwithftanding this impediment, fuch a long elaboration and maturation in the earth, in fo great a feries of years, would neceffarily and inevitably exalt the bafe Metals into fo high a degree of purity and goodnefs, that they would, by this time, be greatly enriched with Gold or Silver; and though they contain Stones and Earths of various colours and degrees of purity, yet there is no effential difference between them, from one containing a nobler Metal than another; which would fearcely be the cafe, without fome ftronger evidence of exaltation, notwithftanding all the oppofition that nature could meet with in the Mines, provided fhe was endued with a power of converting the bafe Metals into thofe of a fuperior kind.

We may likewife conclude from the premifes, that the opinion of thofe, who hold that Metals in the earth continue in the fame ftate as at first, is erroneous; because the migration and egrefs of Metals and Minerals, is obvious enough in the investigation of Mineral Spaws or Springs.

Many of our Mines furnish Stones, perhaps of but an ounce weight, in which may be difcerned the pure Ores of Tin and Copper, Copper and Lead, Zinc or Mock-lead, and Mundick, each in a feparate flate from the other, (by the intervention of Goffan, Cal, Flookan, Spar, and Chryftal.) How fhould this natural class and order of Metals, &c. be effected, but by the agency of water to bring, and the power of attraction to arreft, fuch and fuch particles, and deposit each in its proper matrix or nidus? May we not, therefore, fuppofe, that Mines which are very rich at one given time and place, may in feveral centuries after be impoverished in that place; and other parts of those Mines, which were then barren, may be now plentifully flored with Metal, according to the folution and transmigration of their respective principles, which are deposited in some other magnetick nidus; whole power of retention, in process of time, may be again decayed, those principles again depart, and again be arrefted ad infinitum? This may account for the uncertain diftribution of Ore, in one and the fame Lode; which may be very

METALS AND MINERALS.

very rich in this age, and in the following not worth any further purfuit. And this may alfo be the caufe of the old Huel Virgin's producing near half a million fterling; and the eaftern Huel Virgin's never yet producing three hundred pounds, though of feventy fathoms depth, with eight thousand pounds charge upon her, and still within forty fathoms of a gulph of Copper Ore in the fame Lode.

here's with fome, and binds them tore This hypothefis, which is formed on my own observation and judgment of Metals, may not be relifhed by those, who have adopted the ancient opinion of the production of Metals and Minerals by vegetation; nor by thofe, who fuppofe Metals to continue always in the fame flate. But though I am not fond of fingularity, I cannot help differing from the common traditions, for the reafons I have given ; which, I hope, are fo plain and natural, as to fatisfy the reader, that there is no need of having recourfe to the center of the earth for a folution of this matter. In inquiries of this nature, every one has a right to be guided by his own experience and judgment. And though the fubject, at beft, is fo obfcure and difficult, that it can never be clearly put out of difpute, yet I think, I have evidenced the proposition upon which I first fat out; namely, that all matter is fubject to rotation and vicifitude, to continual different modifications, improvements, progrefs, decay, and reformation; and that, at the fame time, the primeval principles and particles thereof remain naturally the fame in fome part of the univerfe, unless difunited by the contrivance, and for the use of man, on whom all things here below have been bountifully beftowed by him, who is the Author and Giver of all good things both in heaven and in earth and a leave the measure affinite the did which they have the measure affinite the second secon

the ingrefs and egrefs and regrefs di di ApAvHi D waters ; and thus the

Of Water, the Vehicle and Cement of Metals, Minerals, Stones, &c.

I SHALL now endeavour to confirm what has been faid, by examining what the effects are, that proceed from the caufes I have fuppofed : and to fhew the propriety of my fuggestions, it will be necessary to examine into the properties of Water, as universally admitted by the most approved writers on that fubject.

Next

OF WATER, THE CEMENT

Next to Fire, Water is the most penetrative of all bodies ; by which quality it is fitted to enter into the composition of all Animals, Vegetables, and Foffils : by this, alfo, joined with its fmoothnefs, it is fitted to convey the nutritive matter of Foffils, Stones, Minerals, and Metals; paffing fmoothly on, it never ftops the pores, but leaves room for fubfequent fupplies. Yet Water, which fo eafily feparates from most bodies, firmly coheres with fome, and binds them together in the most folid maffes. It is by the glutinous nature of Water alone, that our houses fland : for take Water out of wood, and wood becomes rotten; out of brick, tile, and ftones, and they become duft. It is evident that Water fubfifts in Metals; for the filings of Tin, Copper, and Lead, yield Water plentifully by diffillation. " All Foffils, and even Metals themfelves, are capable of dif-" folving in Water, and indeed are naturally mixed therewith ; " and this holds of all concreted faline, vitriolick, and metal-" lick juices, of which Water makes a principal part, ferving se to dilute, move, change, increafe, and incorporate them " with each other." (Boerhaave.)

As it is evident, therefore, that the Waters flow from the circumjacent earth, or ftrata, into, and through the Mines, from one vein or fiffure into another, and fo on throughout in conftant circulation, till they are difcharged upon the furface, for their ultimate conveyance into the fea; fo they ferve as a vehicle to protrude and convey the acids, falts, and minute loofe particles of Ore or Metal they meet with, into their proper matrixes or veins, where they are deposited by the decomposition of the acid, and attracted by the Metals, Minerals, or Juices, to which they have the nearest affinity; and in process of time are accumulated into large heaps or quantities, while the other earthy or ftony parts of the vein are carried away by the ingrefs and egrefs of the pervading waters : and thus the Ores, or Metals, are continually complicated, congealed, and cemented, by the decomposing and magnetick quality in the Mines; to which the agglutinating petrifying nature of the Waters, doth not a little contribute.

But if these properties in the Mines be enervated or destroyed, then their particles will be difunited and separated fo small, as to render them capable of being protruded and forced away by the Waters into the contiguous strata; while the impurer parts of other places are impelled by the Waters into the Mines, where they subside or lodge, in the room of the Ores or Metals that were

OF METALS, MINERALS, &c.

were thence difplaced. We are fentible that the Loadstone, which has fo wonderful an attraction, may lose its virtue; and therefore it ought not to be thought strange, that Mines should be subject to the like alterations, from the intervention of accidental causes.

The confideration of the nature of mineral spaws and springs, will fenfibly inform us, that there is fuch a continual percolation of Minerals and Metals, or their falts or principles, through the pores and channels of the earth ; and the goodness and providence of God are paternally apparent in their falubrious effects upon the impaired conflitutions of mankind. But there is a far greater difplay of his benevolence to us in particular; for this town and neighbourhood are entirely fupplied with pot Water from mineral fprings, and those of the most deleterious miasma : nay, for the most part, our Water for culinary uses, is taken up at the low-floven, or tail of the adit, immediately where it difcharges from those Mines which are not working; and have run half a mile or more over a bed of Copper, Mundick, and every other congeries of mineral poifons. This is a fact fo notorious, that I can produce many thousand attestations to confirm my affertion. To what caufe fhall we afcribe the falubrity of Pednandrea, and Huel-Sparnon Waters? Those Mines have been wrought at a confiderable depth by the power of three fire engines, and have produced vaft quantities of Tin, Copper, Mundick, and fome Lead; yet, at this time, when those Mines are not working, and the Water is clear, we use it for all purpofes indifcriminately, without the leaft tinge, or the leaft incruftation upon our household utenfils; and in twenty-four years acquaintance with the practice of medicine, I have not met with any one patient, whofe diforder I could attribute to the most triffing unwholesomeness in our Mine Waters.

If the reader will advert to the true caufe of thefe different effects in one and the fame fluid, he may find it in what has been before faid; and will prefently join in opinion with me, in the properties attributed to Goffan Lodes : and this will be a further demonftration of the decomposition of those Waters into their primitive purity and innocence, by contact with this ferruginous medium. Again, as a proof of a proof, feveral Mines, whose adits are fo much deeper as to be under the Goffany bed of Ores, do produce Water fit for no use but driving mill or engine wheels. Such Water is quite noxious, and palpably vitriolick to the tafte, particularly at the Mines of North-Downs, Downs, Chacewater, and Huel-Virgin. I know that fome may fay, if this be the cafe, thefe Mines will be again renovated. Probably this, in a certain degree, will be the cafe : but let it be remembered, that where the nidus with the decompofing matter is taken away, the Water from the circumjacent ftrata, inftead of percolating through the vein, falls into a congregated fluid of its own kind. Indeed, where any of the vein is left in whole, as we call it, we fee no reafon why it fhould not have the fame effect there as formerly; nay, we are of opinion, that where a Mine has been wrought till the Lode has proved barren in quality, and is left off from extreme poverty, if the vein continues, and is endued with the fame decomposing and attractive qualities as the part formerly wrought originally might have been, fuch Lode may probably be converted into Ores, by the Water now percolating through it, and faturated accordingly. for the molt part, our Water for culinary ales, yland

The Miners often feel a palatable difference in Water under ground, at a great depth; for if they tafte a clear ftream of Water, as it flows down upon the walls of the Lode, it is either very cold or almost lukewarm, or infipid or fweet. In Copper Mines particularly, we fometimes find the Water full as warm as new milk in one part of the mine, while it is very cold in another; nay, in feveral of thefe, particularly in Huel-Mufick and Huel-Rofe, the writer has flood with one foot in the warm, and the other in the cold Water, and has divided and diverted them different ways. In the former of these Mines, the discovery of this warm Water, has always immediately preceded a confiderable enlargement of the Lode, and richnefs of the Ore. In the latter, the caufe is not fo abfolutely determined; as the Lode from which it is known to proceed, has not been difcovered at that depth; but where it has been fo, it greatly abounds with fulphureous Minerals.

at the low-floven, of tail of the adit,

On the other hand, the Water which flows through a bed of Tin, is generally very fine, foft, and infipid; efpecially if the Lode or ftrata are of the Grouan or Elvan kinds, and the Tin rich in quality and homogeneous. Our clean Pryan Tin Lodes likewife yield a foft alkalefcent Water, that, I am fatisfied, would be of fingular fervice to all perfons afflicted with acidities in the primæ viæ.

Springs are either temporary or perennial: fome fay, that they originate from vapour, rain, or dews, collected on the fides

13

fides of mountains, and are thence commissioned into the bowels of the earth, in form of fprings; others, that they proceed from the deep abyfs; and others, that they are filtrations from the fea, into which all the rivers run, as into the place. from whence they came, per modum circulationis. For, " all " the rivers run into the fea, yet the fea is not full; unto the " place from whence the rivers came, thither they return again."

The theory of Meff. Marriotte and Perault, that fprings have their origin from rains, hath been examined and confuted by Mr. de la Hire. Dr. Halley's hypothefis, of their being produced by vapours, though the most popular, is in a manner overturned, in our opinion, as well as the former, by Mr. Derham's perennial fpring in the parish of Upminster, and various others in different parts. Of those who have mentioned that, which we conceive to be the only true origin of perpetual fprings, THE OCEAN, none have, to our knowledge, affigned the quo MODO or proper caule; and therefore leave it undetermined, or rather give up their unsupported argument in favour of Dr. Halley's more plaufible and commonly received, though more erroneous, hypothefis, of its being effected by the condenfation and precipitation of vapours and dews from the tops of mountains.

The ftrefs of our argument and the novel part of our hypothefis, is, that in the formation of perpetual fprings, they not only derive their Waters from the fea, by ducts and cavities running from thence through the bowels of the earth, like veins and arteries in the human body; but that the fea itfelf acts like a huge forcing engine, or hydraulick machine, to force and protrude its waters from immenfe and unfathomable depths, through those cavities, to a confiderable inland diffance.

One of the hydroftatical laws of fluids, being, that their preffure is in the ratio of their perpendicular altitudes, how very great, how immenfe must that preffure be, in the unfathomable parts of the fea! and, indeed, in those parts, which, as Varenius affirms, have been fathomed to the depth of four miles and a half ! Only conceive (if poffible) a forcing engine, or the beft hydraulick machine, acting with a force equal to this immenfe preffure, upon a body of water, in order to carry it to any diftance whatever, or raife it to any conceivable height ! Imagine then, with what inexpreffible force the water from fuch a preffure, must be protruded through those cavities, ducts, and hollow

E

OF WATER, THE CEMENT

hollow paffages, from the bottom of the fea, through the bowels of the earth, to various parts of its furface, where they difcharge themfelves, as through fo many tubes or pipes, and form perpetual fprings; fome rifing, either from a duct of lefs perpendicular depth, where the prefiure is not fo great, or otherwife more perpendicularly than others ; confequently, in either cafe, at a less diftance from the subaqueous mouth of the duct; whilft others, running more horizontally, or derived from a greater depth, where the preffure is proportionably ftronger, or, perhaps, from the duct tending for a confiderable length towards the center of the earth, are forced to a greater inland diftance, in the confined tubes or veins of the earth, before they emerge to the furface, which we apprehend they do from various orifices and branches, like capillary tubes from a principal artery : the preffure of the fluid acting in this inftance, as in all others; and the immenfity of that preffure in the fea feeming to justify our calling it a huge forcing engine, and comparing it to an hydraulick machine, whole power we can eafily conceive to be fufficient, from the convexity and globular form of the fea as well as the land, to force its Waters through the aforefaid capillary tubes to the tops of the higheft mountains, even without the aid of attraction, which, not improbably, may in fome cafes contribute fomewhat towards their afcent.

That which gave birth to our conjectures, and led us into thefe reflections, was the confideration of the Cafpian fea, as having no visible outlet; most of whose rivers, which difgorge themfelves into that grand refervoir, we conceived as deriving their origin from the fea itfelf, being forced, by the preffure of the atmosphere and watery fluid, through subterraneous ducts and channels to certain diffances, where they emerge in fprings and bubbling fountains; and increasing as they approach nearer to the fea, by the acceffion of other Waters from other ducts, are fwollen into confiderable rivers of fresh Water, affording a conftant fupply to keep that grand refervoir "without o'er-" flowing full ;" which frefhnefs, we confider, and fuppofe it is generally confidered, as effected by the falt water being filtrated and ftrained through a confiderrble body of earth in its passage from the sea to the fountain head. As a justification of this fuppolition, we beg leave to mention, the brackifhness of, those fprings, which is frequently complained of near the fea coafts; and which is undeniably occafioned by their vicinity to the fea, whofe Waters are not filtrated through a fufficient body torreflirre, muft be protruded through those cavities, ducls, and

of earth, totally to deftroy their faltness, and render them quite fresh.

We do not, however, fuppofe, that all the rivers which empty themfelves into the Cafpian or any other fea, are always derived from that particular fea into which they return : for inftance, we conceive the head of the Wolga river to be more probably derived from the Frozen-fea, to which its fource is much nearer than to the Cafpian-fea; and which feems even neceffary, in order to fupply that quantity of fluid, which muft be conftantly evaporating from its furface, for the fupply of dews, rains, &c. for an extensively furrounding country. Again ; it is probable, that the Nile takes its fource from the Eaftern-ocean or Red-fea, rather than from the Levant or Mediterranean into which it runs: alfo, that the river Amazones, takes its rife from the Pacifick-ocean, and not from the Atlantick-ocean into which it flows: and fo of various other foreign rivers, which, though they may take their origin as we have here fuppofed; yet we further suppose, that as they arrive nearer to their mouths, they may be and are confiderably increafed, and receive large additions, by the like ducts and channels, from that fea likewife into which they run.

To illustrate this hypothefis, we shall mention one instance more in our own country, of the river Tamer, which divides Devonshire from Cornwall ; whose head rifes, we suppose, from the Briftol-channel, within five or fix miles from Hartlandpoint; and after running near an hundred miles due fouth, empties itself into the English-channel at Plymouth; whilft the river Torridge, which rifes on the fame common, and within the diftance of a few cloth yards from the Tamer, after a courfe of upwards of fifty miles, difgorges itfelf again into the Briftolchannel in Barnstaple-bay, not twenty miles N. E. from its head, awold briw oils , in

Let us adduce the rife of these two rivers, as positive proof against Dr. Halley's ingenious hypothesis. " Their heads are " two perpetual fprings within a few yards of each other, on the " pretty level fummit of a vaft high common, one of the higheft " in all the neighbourhood ; where there are no rocks or crannies " for the vapours or dews to gleet down by, nor any mountains " or caverns above it to collect a body of water; nor any one " circumftance favourable to his hypothefis." Letter from Chriftopher Gullet, Efq; of Exeter. conceivable

The

IS

OF WATER, THE CEMENT

The Waters with which our Mines abound, are derived both from temporary and perennial fountains; and are very properly diftinguished with us, by the names of Top and Bottom Water. Shallow Mines have very little Water, more than comes from the furface; and it is temporary, according as the feasons vary; fo that, without a competent power to draw out the Water from the workings, the adventurers are generally obliged to ftop them, or "Knock the work," as the phrase is, foon after the autumnal equinox; otherwise, which is frequently the case, they expose themselves to a great expense, disappointment, and loss.

Our very deep Mines are fubject to Water from both the fources before mentioned; for in the drieft feafons we know of, they have a conftant ftream ab interno, which requires much expence and addrefs to keep under: but in the depth of winter, when all the earth is drenched as it were with moifture, we are vifibly affected by the concurring ftreams both of Top and Bottom Water; notwithftanding all precautions are ufed, to take up the fuperficial ftreams, by launders or grooves cut in the walls or fides of the Lode, to convey them either into the adit or tye lift of pumps, by which the burthen is eafed for the engine, and the bottoms are freed from fo much Water.

The deepeft of our Mines are not much affected by the influx of Top Water, before the depth of winter; as it takes till that time, to fill the interflices of the earth or flrata, and protrude its redundant flream to the deep bottoms. Our most experienced Miners will fay, that "A dry easterly wind raises the "fprings;" but although it may appear fo to our outward fenses, yet a little application to the folution of this phenomonon, will show the conclusion to be false.

During three parts in four of the year, the wind blows from the intermediate points of the weft and the fouth; and coming over a large tract of the Atlantick-ocean, and confequently fraught with much wet, difcharges its moifture, as foon as the current of air, which fufpended the clouds, is diminifhed and broke by the cliffs and hills. It was an obfervation made by our Saviour, that the weftern winds brought rain in Judæa: Luke xii. 54. The fouth wind coming from the coaft of Africk, had the fame effect in the Adriatick : Horace Lib. i. Ode 3. The weft wind is often fo fierce and raging after acquiring ftrength in the Atlantick-ocean, that it is fcarce conceivable

conceivable with what fury it attacks the coafts of Britain; and it is very well known, that it commonly blows above half the year (which was alfo obferved by Julius Cæfar) and that very violently, efpecially in the autumn; whence our Michaelmas ftorms and rain. Philos. Trans. No. 352.

In thefe inflances, the frequent rains are the confequences of winds, paffing over a large tract of water; and this may lead us to the reafon, why the winds come fo much from the fouth-weft in Cornwall, that we have known them blow from that quarter the four laft months of the year, almost without intermission, attended by violent floods of rain, which took all the time before mentioned to arrive at the deep bottoms; about which feafon, at Christmas, or very foon after, the wind shifts to the opposite point of the compass, and generally brings along with it the little frost and cold this country is subject to; mean while, the Waters are determined to the bottoms of our deep Mines, merely by the time they have had to fink down through the earth. The impatient observer wonders at this flow descent of the Waters; and when the wind shifts to the eastward, he very injudiciously attributes the effect to a wrong cause.

s under ground, or Waters, forcing w

We confeis, the above feems to us a very natural and plain explication of the affair ; but as we have not that deference for our own opinion, as always to prefer it to others, we are ready to acknowledge ourfelves open to conviction, if a better reafon shall be advanced at any future time. And as a hint to our readers, we defire they will confider, how far the denfity and confequential prefiure of the atmosphere may contribute to this appearance more than a hundred fathoms underground. It is true, the Mines are continually fraught with a kind of warm vapour, which may be feen to arife from every fhaft, when the air is cool, clear, and denfe; and it may be fuppofed, that, as it afcends through the natural and artificial outlets of its womb, it is more or lefs condenfed by the external air, in proportion to the rarity or denfity thereof. But if this folution appears plaufible to fome, we defire to be informed, why this fhould not be more apparent, when the wind blows from the north ; and why this vapour, if not of the dry kind, fhould not be condenfed in the fhafts and gunnies (hollows) of a Lode, after the manner of rain, as other vapours are, and, therefore, be as diftinguishable in its production, as in its existence ?

From

OF WATER, THE CEMENT

From the foregoing proofs, that rain Water penetrates to the depths of the earth, we may be fatisfied, that the opinion of De la Hire, Calcott, and others, who fay, rain Water does not fink two feet below the furface, is altogether erroneous; for if it does not enter into the bowels of the earth, what elfe fhould occasion fo vaft an increase thereof, at, or foon after, its discharge from the clouds? So apparent is this fact, that if the great increafe and collection of Water from the heavens, before mentioned, be obstructed in its circulation, and collected into large bodies, by the peculiar matter or form of its recipient, it may, and has many times appeared to be the caufe of local earthquakes ; which, we apprehend, may proceed from the Water of higher grounds, that gets underneath a flimy vifcous earth or clay, until the force of the confined Water moves it upward, and carries the earth along with it in its paffage and irruption ; of which we may produce an inftance, at Kappanihane in Ireland, A. D. 1697; another of Pilling Mofs, in 1745; and a more recent one, in the late accounts we have had, of Solway Mofs in North-Britain :

- As if on earth, a set condition will be

Winds under ground, or Waters, forcing way, Side-long had pufh'd a mountain from his feat, Half funk with all his pines.

MILTON.

As for those earthquakes, which are more general, tremendous, and deftructive; it is probable they are caufed by the combination of different falts, juices, fulphur, or some other inflammable matter, that rarifies and agitates the air, in the deep caverns of the earth ; whereby a convultion is caufed, which fometimes breaks out in flames at the furface; and fometimes fhocks and gives the earth a tremulous motion, without any visible fire, perhaps for want of fufficient matter to ignite. For, if you add twenty pounds of fulphur to twenty of iron filings, and mix thefe with water, fo as to form a paste ; in fix or feven hours after they have been buried a foot and half under ground, the earth will begin to tremble, crack, and fmoke, and fire and flame will burft through ; fo that there wants only a fufficient quantity of this matter, to produce a true Etna. If it was supposed to burst out under the sea, it might occasion a new island : and we believe Delos, Rhodes, and fome other iflands were produced by the fame, or fuch like fubmarine volcano. (Pliny) An ifland in the Archipelago on the coaft of Natolia,

Natolia, in 1707; another among the Azores, in 1720; and four islands in a lake, in the Manilla, A. D. 1750; are productions in the prefent century, from the same cause. Dr. Worthington advances, "That the sole cause of the formation " of mountains, was an universal earthquake."

The immenfe congregation of Iron, Sulphur, and other combuftible materials, with which our mining diffrict is fo replete, would naturally incline us to believe our fituation more obnoxious to fubterranean throes, than any other part of Great-Britain. But, by the mercy of our GRACIOUS PRESERVER, we have hitherto felt nothing peculiarly to alarm us, on account of our fituation. Many are of opinion, that our numerous fhafts, adits, and other apertures, are the principal outlets, through which the mineral effluvia of our Lodes exhale and efcape, without prejudice to the lives and fafety of the inhabitants.

Another prodigious, general, and effective caufe of earthquakes, is an electrick æther in the atmosphere, according to the opinion of the learned Dr. Stukely; and from this force, extended to a confiderable diftance, through various fubftances, of different textures and densities, we may attribute the deftruction of no lefs than thirteen great and noble cities in Afia Minor, in one minute's time, in the year of our Lord 17. Another earthquake in Peru, anno 1586, extended 900 miles; and we may add that memorable earthquake in our own days, upon the 1ft of November 1755, which deftroyed Lifbon, and was felt over almost half the habitable globe.

We may apply either of these causes, under such certain fituations and circumftances, as may incline our judgment to preponderate. But may not all of them operate for the fame effect? We think they may: and who can fay, it is not fo? For with Job we may fay, " Lo, thefe are parts of God's ways; " but how little a portion is heard of him? And the thunder " of his power who can underftand ?" Omnipotence being the directing caufe, all things are equally accomplifhed by the natural inftruments of his power : and when we hear the thunder of his voice, and fee the mightinefs of his power, the dreadful, though partial convultions, of an angry, yet merciful God; ought we not to meditate upon the hitherto harmlefs, though alarming tokens we have had of his indignation, tempered with love? Of all the natural warnings of his difpleafure, those of carthquakes are most terrifick ; coming like a thief in the night, when

OF WATER, THE CEMENT

20

when the fons of men know not of it! We may flee from the peftilence, the famine, and the fword; we may avoid the dangers of the fea, and provide againft fire; we may fecure our habitations from lightening, tempefts, inundations; we may, by the affiftance of fkilful applications, and the wifdom of the phyfician, baffle the attacks of difeafe, to the prolongation of our lives. But no flight, no prudence, no philofophy, no delay, can obviate this defolation: for, it is as the prefence of God! How thankful then, ought we to be! how humbly fhould we walk before him, who hath hitherto fpared us, in the midft of his judgments! O Lord God; for the abundance of our fins, thou art greatly to be feared; and yet we fee that in great mercy, thou prefideft over all thy works!

Though it is remarkable, that the Water of a Mine, at or near the fea cliffs, is very easy and small, especially when the Mine is funk under low Water mark, or works under the fea; vet it is abfolutely certain, that it is lefs in proportion to the ground discovered under the level of the fea, than above. How this should be, is one of the most puzzling questions that can be put to the Miners, who, to a man, ingenuoufly confefs their ignorance of the true caufe of it. The gentleman and the philosopher are equally at a loss to account for this fact, except Mr. Bennallack, who fays, " That in the places where he has " had opportunities of judging properly, the only apparent " caufe is, that the ftrata being more compact, and confe-" quently more free from those fundry kinds of fiffures, which " " the Miners in general call Cafes, there are not the fame con-" veyances for the Waters of the furrounding country to flow " into the Mine." In Huel-Towan in the parish of St. Agnes, where they are not many fathoms under low Water mark, the facts of the Water being lefs, and the ground more compact, are inconteftible; nor, in that place, does any other matter appear conducive to it. We believe this may be one natural caufe in fome particular places, but it cannot be always fo; and we likewife believe, that there may be other contributing matters, which may be different, in different fituations. We will have reourfe to the most fimple and plain enquiry into the form and texture of the earth, in the folution of this phenomenon, diffinct from our knowledge of the preffure and gravity of fluids: but before we proceed, we beg leave to illustrate our fubject, by a very remarkable hiftory of a cafe in point.

The

The Mine of Huel-Cock in the parish of St. Juft, is wrought eighty fathoms in length, under the fea, beyond low Water mark; and the fea, in fome places, is but three fathoms over the back of the workings; infomuch, that the Tinners underneath hear the break, flux, ebb, and reflux of every wave, which, upon the beach overhead, may be faid to have had the run of the Atlantick-ocean for many hundred leagues ; and, confequently, are amazingly powerful and boifterous. They alfo hear the rumbling noife of every nodule and fragment of rock, which are continually rolling upon the fubmarine ftratum ; which, altogether, make a kind of thundering roar, that will furprife and fearfully engage the attention of the curious stranger. Add to this, that feveral parts of the Lode, which were richer than others, have been very indifcreetly hulked and worked within four feet of the fea; whereby, in violent ftormy weather, the noife overhead has been fo tremendous, that the workmen have many times deferted their labour under the greatest fear, left the fea might break in upon them. This proximity of the fea over the workmen, without their being incommoded by the falt Water, is more wonderful, than the account which Dr. Stukley gives, of his defcending into a coal pit at Whitehaven one hundred and fifty fathoms deep, till he came under the very bed of the ocean, where fhips were failing over his head; being at that time, deeper under-ground by the perpendicular, than any part of the ocean between England and Ireland. In his cafe, there is a vaft thickness of ftrata between the Mine and the fea; but, at Huel-Cock, they have only a cruft between, at most; and though, in one place, they have barely four feet of ftratum to preferve them from the raging fea, yet they have rarely more than a little dribble of falt water, which they occafionally ftop with oakum or clay, inferted in the crannies through which it iffues. In a Lead Mine in Perran Zabuloe, formerly wrought under the fea, they were fometimes fenfible of a capillary ftream of falt Water, which they likewife prevented by the fame means, whenever they perceived it.

Now, a very large proportion of our Mine Water is temporary; and, as I have faid before, is denominated Top Water, which in great part finks into the Mine immediately where it falls, by the peculiar loofe texture of ftrata where Mines are, which muft be cavernous and fiffured, to conftitute and form those receptacles of mineral particles called Lodes, and their lateral branches: confequently, the ready access of this Top Water, muft be very fensibly perceived by the Miners; and G more

OF WATER, THE CEMENT

22

more especially must the difference be seen, when compared with a part of the same Mine under the sea, entirely free from such Water. The submarine strata of our Mines, must be totally impervious to any Waters, which fall into the sea. It cannot be otherwise. So that such parts of the Mines, are quite free of any Water locally above them.

The next paradoxical confideration that occurs, is to account for the abfence of the fuperfluent falt Water, from the fubmarine workings.

We have observed a kind of flime or mucus upon some marine strata, which is fo glutinous as to fill up every pore and cranny of the rock that is covered with it. This glutinous flime, we take to be a marine foil or earth, for the vegetation of grafs, ore weed, and other fea plants; the fea is replete with it: every fhip at the end of a long voyage has her bottom covered with it, and a marine grafs vegetates therein. This vifcous matter thickens by degrees, as if purpofely defigned to hinder the Water from penetrating into the earth; which it most effectually does, according to my judgment of the matter. Upon a rough beach, this flime may not be equally deposited, by means of the conftant friction of rocky fragments under the action of the tide; and other parts may be covered with loofe fand and pebbles, which afford no bed or reft for this foil. In fuch cafe, it penetrates through the furface, and finds a quiet depository, in the small clefts and interffices of the strata, below the force and action of the fea; and in time, probably, incruftates and fills up those very minute fiffures, with a petrifactive gluten, if it is at all charged with fuch principles; and we have neither theory or reafon to diffent from that opinion, as we think it must partake of every principle which is foluble by Air, Water, and Salt.

Thus have we demonstrated, that Top Water does not specifically defeend into the Mine where it falls upon the fea, and confequently that part of the Mine cannot be incommoded thereby like other parts; and that the minute pores and fiffures of fubmarine strata are almost totally impenetrable by falt Water, through means of the petrifactive tenacious gluten, with which they are smeared. The facts, added to the compact, or close conformation of strata in some parts of the earth under the sea, will ferve, as we prefume, for a proper solution of this difficult problem.

That

That there is a petrifying quality in the earth or its juices, is manifeft to those who are conversant in Mining, and confider the nature of the Stones which are dug out of the ground; for they frequently meet with large folid rocks, composed of feveral fmall Stones united together, of different forms, colours, and properties, with respect to the fame individual Rock or Stone; which is a manifest indication, that its different parts were originally loose and diffinet from each other, until they were conjoined into an entire folid mass, by fomething of a petrifying principle, which cemented them together. It is more than probable that Stones, like Salts, and most Fossils, are the productions of a sufferended lapidifick matter in a fluid, which gradually hardens into Stone, by the evaporation of its finer parts.

Mons. Tournefort obferves, "That in the famous labyrinth "of Crete, feveral perfons had engraved their names in the "rock, of which its walls are formed; and that the letters fo "engraven, inftead of being hollow, as they were at firft, ftood "out from the furface of the rock." This can no otherwife be accounted for, than by fuppofing the cavities of the letters filled infenfibly with matter iffuing from the fubftance of the rock, even in more abundance than was needful to fill them. Letters cut hollow in a living rock of Limeftone, fill up, in a courfe of years, with fpar; and what were made in Creux, are found in Relief. This has been feen in Gothland, by the eminent Swede. The fpar ftands higher, as the time is more diftant; and has been feen, in fome places, a quarter of an inch above the level of the furface. (Hill)

Thus is the wound of a knife healed up, much as the fracture of a bone is confolidated, by a callus formed of the extravafated nutritious juice, which rifes above the furface of the bone. Such cicatrixes have been obferved to be formed on other Stones, which were reunited, after they had been accidentally broken. The many inflances we have of those cicatrixes in Granite or Moorftone, upon the furface of every karn or rocky hill in Cornwall and Devon, will clearly put this matter out of difpute; as our Stone-masons always chuse fuch for splitting in the very cicatrix, which generally is about a quarter of an inch above the other superficies of the store; and splits with more ease, than any other part of the same block, because it was before sparated, and had been again reunited by its petrifactive gluten. Hence it is manifest, that the same juice which nourist them, ferves

OF WATER, THE CEMENT

ferves to rejoin their parts when broken. We find, that Water is fo full of ftony matter, and fo ready in part to turn into Stone, that it fills every crack and crevice of the moft folid rocks with Stone of the most pure kind, Spar or Chrystal. If Water contains a quantity of ftony matter, then Water is able, in fome flow way and in the courfe of nature, to diffolve this ftony matter, though we cannot make it do fo in any of our operations. If Water can diffolve flony matter, Water may take it out of one place of the earth, and carry it to another. It will perhaps appear, that the original power of encrufting and petrifying lies in the earths and clays themfelves, a thing few have thought upon; and that the Water ferves as a vehicle to carry the ftony matter out of one place into another. All this being underftood, it feems natural to fuppofe, that not only the petrified fubftances found in the earth in fome places, but even the beds of Stones themfelves, owe their origin to thefe particles contained in the earth, and to the agency of Water, which can diffolve, remove, difperfe, feparate, and bring them together again in various forms and combinations. If Water can diffolve these particles of stony matter, Water can in the same manner keep them fuspended for a time, and let them gradually feparate and congeal afterwards. Water, therefore, can act, when it is thus loaded with particles, as a cement or agglutinating liquor to bind them together, or to introduce changes in them. For inftance, Water can fill the pores of clay; and if fuch Water fill the pores of a bed of this earth, and afterwards draining gently away, leave that frony matter behind, it does, in that cafe, cement that bed of clay into a bed of Stone. (Owen).

This petrifactive quality, which ferves to conjoin and cement Stones together, we must allow capable of inclosing, within itfelf, fundry extraneous bodies, which it may be in contact with, fuch as bones, fhell-fifh, and many other things, of which natural hiftory has given us fuch very ftrange accounts. I shall add a particular domestick instance, of which we have been very credibly informed : namely, that fome few years fince, at this town of Redruth in Cornwall, fome labourers being put to clear and level the ftreet for a pavement, they found a piece of hard Stone in the ground, with abundance of common fmall pins of Brafs, interfperfed in and throughout the Stone, in fuch manner and form, that all those who faw it afterwards, were convinced, it was not done artificially, but that the Stone was formed and produced by petrifaction, fubfequent to the time the pins were dropped into the ground. Dr. Plot, in his Natural Hiftory

25

Hiftory of Staffordshire, fays, " That near Newcaftle under-" line, there was found a Stone with a man's skull, teeth and " all, inclosed in it !"

From what has been faid, I prefume it may not be abfurd to infer, that every earth or clay, in fome places, may be converted to Stone in procefs of time, at fuch a depth where it is undifturbed, by being never lacerated nor molefted; and alfo where it abounds with an uncommon quantity of juices, of a lapidescent quality: but this property being extenuated or deftroyed, the earthy Stones may, not improbably, again return to their primitive earth or clay. Thus we fee fome forts of Stone, when dug out of the ground, and exposed to the air for a confiderable time, do moulder again to earth, at least in appearance; while others, of an earthlike quality, are indurated, and become more compact and durable, by lying above ground. Hence fome have imagined, that all the terreftrial globe, and every individual inanimate thing contained in it, is nothing elfe but Water, rendered folid by petrifaction.

Thales, the Milefian, held Water to be the first principle of all natural bodies, of which they confift, and into which they refolve. He endeavours to establish this opinion, by arguments drawn from the origin and continuation of moft things : first, becaufe the feminal and generating principle of all animals, is humid; and fecondly, becaufe all kinds of plants are fo much nourifhed by Water, that when they want moifture, they wither and decay. Some have not hefitated to father this philofophy on Mofes. The great prince of philosophers, Aristotle, with Lucretius, Theophraftus, and Leonardus, were of the fame opinion. Nay, Hippocrates lays great ftrefs upon it; and of later days the great Sendivogius, with the most learned of the Spagyrifts, who own that Water is an universal principle.

This Cryftalline or lapidifick juice, Mons. Geoffroy fays, is more heavy and fixed than fimple Water; and confequently is not evaporated with it, but is left behind : and thus the formation of Crystal is perfectly like that of the Crystals of falts. For these Crystals only arise with those regular figures they affect, as when a Water impregnated with falts is flowly evaporated at perfect reft in a moift place. The evaporation of the Water is neceffary, that it may not keep the falts too far afunder; and the flownefs of the evaporation, that the falts may have time to take that arrangement, which agrees beft with their

OF WATER, THE CEMENT,

their refpective figures. The application of this to Rock Cryftal, is obvious: it is only needful to conceive, that a Water charged with a quantity of Cryftalline juice, had infinuated itfelf through the clefts of fome Rock, where the aqueous part gradually evaporated.

An unfaline Cryftal earth, though not in fuch plenty as a faline, is yet as intimately mixed in Water, nay in the fulleft degree of clearnefs paffes through the clofeft ftrainers; confequently, the cryftallization of falt is here not improperly alleged for a model or pattern. (Henckell.)

It must be confidered, that this Crystalline juice is not equally diffused in all parts of the Mine; fo that Rock Crystal would not arife in all places, even fetting afide the necessity of other concurrent circumftances, which do not often meet. If the Water impregnated with Crystalline juice happens to penetrate a mais of earth, which is the most usual cafe, it will connect and bind together the parts thereof by means of this juice; and afterwards, in proportion as the watery part evaporates, the compound will grow harder, and at last become Stone. Add to this, that it will approach nearer to the nature of Cryftal, that is, it will be more hard and transparent, according as the quantity of that juice is greater; and at the fame time have a finer grain, according as the molecules of the earth are fmaller and more homogeneous. Of this kind are Marbles and Alabasters; in some of which, one may discern threads or veins, as transparent as if they were wholly Cryftal. The Stones most opposite hereto, and most imperfect, are Chalk and Boles, which are little elfe befides earth ill bound together, with a very fmall proportion of Crystalline juice, which leaves them still friable. Between these, it is easy to imagine, there are infinite degrees. In a structory tant myo odw

Camillus Leonardus fays, that "Stones which abound moft "with the terrene, are thick and dark; neither are they free from Water." And Ariftotle, in his book of Minerals, exprefly fays, "Pure earth doth not become a Stone, becaufe it makes no continuation, but a brittlenefs; the prevalent drinefs in it, permits it not to conglutinate; and fo by the aqueous mixed with the terrene, Stones are made." By the aqueous, he means an unctuous or vifcous humidity, proportioned with a terrene; and according to the difpofition or proportion of

26

113.12

27

of fuch humidity with the dry terrene, divers and various Stones are produced.

The particular circumftances which attend the formation of Stores, vary the effect of these general principles divers ways. For inftance, if a portion of this juice, diluted in Water, happens to be furrounded with carth, and the juice be not in quantity fufficient to petrify the whole earth as faft as the Water evaporates; there will arife a mafs partly cryftalline and tranfparent, and partly opaque, diffimilar, and earthy : and fuch we prefume is the difference of the Caples of our Lodes, and the contiguous strata; the former being fometimes more compact and firm by its contiguity to the juice percolating the vein, and the latter lefs fo, by its proportional diffance from the Lode If the fame Cryftalline juice be in the middle of the mafs, only the middle will have a Cryftalline appearance and firmnefs; fuch as the huge rocks of Crystal (Quartz) we often fee rife out of a vein or lode, which commonly implies a failure of Metal in that part of a Mine. mi of annu bans, and burns to im. anomy avity

This Cement may be divided into three degrees of purity : the firft a coarfe Quartz, which is the moft impure, and covets no particular form ; the fecond is Cryftal, which forms hexagonal columns, cufpides, and pyramids, and is the connecting bafis of Slate, Killas, Granite, or Moorftone, &c. But if by a ftill greater degree of purity, the Stone becomes fpecifically heavier, of better luftre, and refifts fire almost to immutability, then it is called a Diamond ; and the Ruby, Sapphire, Amethyft, &c. are but this Diamond tinged and reduced, as to luftre and hardnefs, by fome metalline tint.

What is vulgarly called Spar with us, and which is fo plentifully feattered upon the furface of every heathy common, is not the real Spar; and is, by most Lithologists, better known by the German name of Quartz, for want of a proper English appellative. Spar, by itfelf clear and unmixed, is very rarely found in this county. Indeed, the reafon of its fcarcity is, becaufe we have little or no calcarious ftrata to produce it. The late Sir John Hill, in his hiftory of Spar, which he divides into eighty-nine species, fays, that Limestone is only coloured hardened Chalk, and Marble is the fame. Marble is a purer Limeftone, and Limeftone a courfer Marble. Water being faturated with the principles of Sulphur, and with Chalk, keeps on its gradual courfe horizontally through the lime rock, till

OF WATER, THE CEMENT

till it meets a fiffure, a perpendicular crack or opening, dividing one part of the rock from another. Here it ouzes forth; and meeting with a lighter air, fufpends and evaporates flowly.

We have faid before, that flow evaporation, and perfect reft, are the requifites of Cryftallization. The Sulphur and pure Chalk thus united, form one folid body; which cryftallizing gradually, fometimes appear in regular rhomboidal particles; and is the fubftance properly called Spar. That the Spar formed in the fiffures of rocks, is thus wafhed out of Limeftone itfelf, is certain; becaufe none but Limeftone rocks have Spar in their fiffures. Rocks of a Cryftalline matter, or formed of a vitrifiable Stone, have always Cryftal, but never Spar, in their cracks or fiffures. It grows continually; for wherefoever there is a crack in a Limeftone rock, new or old, Spar always fills, and overruns the furface. Therefore the calcarious nature of Spar, is of its effence; and no form, nor all the other characters in the world, could conftitute any production a Spar, that wanted this. It always ferments with acids, and burns to lime.

The formation of Spar is yet a fubject of enquiry. Its atoms are all Spar; each particle, into which we can without violence divide it, is the fame in all refpects as the whole: and as the Foffil world admits of no generation by egg or feed, it feems moft probable, that all the variety of forms, in which we behold this Protean Mineral, are owing to no caufe but the arrangement of rhombs, into as many forms as they are capable of producing. It fills the cracks of its own rocks, and of no other; for Cryftal columns rife from Cryftalline rocks; and from Metalline maffes fractured grows Mundick; each feparated from the great mixed body we fee fplit, and each formed into figures by its own laws.

The obvious fcarcity of Spar in this county, is abfolutely proved in the almost total absence of Limestone, whence it is mineralized; neither have we yet seen a perfect Sparry Rhomb in Cornwall.

It may be difficult to perfuade the vulgar Cornish, that we have little or no Spar in our Mines; but that fo it is, every unprejudiced observer may be convinced by the testimony of his own senses. They denominate every species of Quartz and Crystal indiscriminately, except the Pseudo-Adamantes, Spar; so that in their opinion almost all the streets in the county are paved

20

paved with Spar inftead of Quartz; and with them every Cryftalline rock under-ground bears the fame name. It is time, however, that this confusion and misnomer of Fosiils should be abolished, and such mistakes and false distinctions laid aside for the fake of order and propriety. Be it, therefore, henceforth remembered, that all those masses of white and yellowish Stones fcattered upon the furface of our lanes and commons, which are only used for paving and hedging, are Quartz, and have no Spar in them. If they were truly of a Sparry texture, they would fave us much expence and labour for Limeftone, which is now imported from Wales and Devonshire; befides the cheap and ready manure they would afford, for the cultivation of our land.

Plain Cryftal hardens into any figure, of which its own gravity, and the matter in which it forms, will admit; and we find it veined in all our Killas, Caple, and every part of our ftrata, that is generally and vulgarly denominated the Country by our Tinners; yet it is perfect Cryftal, breaks irregularly, yields fire plentifully, is very hard to the graver, and will not ferment with Aqua Fortis. It will fometimes form itfelf in hexagonal opaque columns, cufpides, and pyramids, of an uncommon large fize, but of no value.

But if those pyramids are of a fine pellucid Water, they become the Pfeudo-Adamantes of the purer kind, and are thence eminently called Cornish Diamonds; and are by Dr. Grew, and others, reckoned fuperior to the Briftol Stone, and every other diaphanous Crystallization in Great-Britain.

C H A P. III. d bas ; salled stand

or Concretes, which yield Sulphin, Wittiok, and other

Of Metals and Minerals, and the Fluxes for affaying them.

THE inferior Metals, especially Copper and Iron, are the eafieft of any to be diffolved by most acid menstrua, their parts being very different, unequal, and heterogeneous in themfelves, and more fusceptible of any outward force or impreffion. We take this to be the caufe, why thefe two Metals are more fubject than others to be corroded and injured by exposure to the air, which abounds with volatile acid falts, and thereby-

thereby becomes a menftruum, that readily adheres to, refolves, and corrupts those tender imperfect Metals; whereas Gold and Silver, whole parts are most folid, denfe, and homogeneous, receive little or no damage by contact of the acid falts. Lead and Tin likewife, not being eafily refolvable by Aqua Fortis or any water of that kind, are not near fo foon prejudiced by the faline pungent particles of air, as Copper and Iron are; which probably happens, because they have a greater degree of fimilarity of parts better united; or becaufe they contain fomewhat that approaches to the nature of Sulphur, whole property it is to refift all acid menstrua.

The word Ore, as also the word Mineral, in the largest acceptation, comprehends any impure Concrete or Foffil, that contains either a Metal, Semi-metal, or Mineral juice ; but if the fpecies of the thing fignified, be added to the word, then the particular fenfe or meaning of the expression is limited and denoted. Thus it is usual to fay Copper Ore, Lead Ore, &c. The Ore of Antimony, The Minerals of Copper, of Lead, and the like; fo that the words Ore, and Mineral, are only fynonymous terms, that imply any kind of Mineral Foffil without expressing its nature. Neverthelefs, a barren Mineral Foffil, which yields no produce in the fire, cannot well be termed an Ore, though it is called a Mineral; for it is improper to fay, the Ore of Mundick, &c. Cuftom however prevails fo much in the terms of our Miners, that they often call fuch Minerals as they know are of no value, by the name of Ores; and, therefore, to be more clearly understood in what follows, by the word Ore, I mean only a Foffil or Concrete, which produces real Metal, as Gold, Silver, Copper, Tin, Lead, Iron, and alfo Quickfilver; by the word Mineral, I confine myfelf to the more crude Foffils or Concretes, which yield Sulphur, Vitriol, and other fuch brittle bodies; and by the word Semi-metal, I mean Antimony, Bifmuth, and Cobalt. I prefume it neceffary to make this diffinction, to prevent the perplexity in which those who are but little acquainted with the fcience of Metals, are often involved.

All things in the bowels of the earth, which occur to the confideration of a Mineralift, are reducible to the following claffes : first, Earths and Stones ; fecondly, Concrete Inspisiated Juices or Bitumens, as also those which are liquid; thirdly, Semi-metals; and fourthly, Metals. We shall speak of each of these in their proper order. or andro and Beidul stor ora

exposure to the air, which abounds with volatile acid faits, and thereby

Firft

First, of Earths; of which there are many forts of different colours and natures, whether simple, or compound; and are to be effeemed among Ores or Metals, no further than with regard to the plenty or fearcity of Metals or Minerals they feem to indicate; or elfe as indications which may be the best method to extract the Metal that is intermixed with them : but I shall not here profecute the inquiry into this subject, because I shall have occasion to take particular notice of it hereafter.

We shall likewife fay nothing of many remarkable Earths and Boles, as they have little or no connexion with Mines or Metals; fuch as Bole Armoniack, Terra Lemnia, Fuller's Earth, Lac Lunz, Spanish Bole and Terra Sigillata, except the Steatites or Soap Stone, which is in fuch plenty, and to diversified and beautiful, at the Lizard Point, as to have invited many Fossilists to infpect its fituation, colours, quantity, and properties. The varieties of this Foffil, at the Lizard only, are divided by Dr. Borlafe into ten, whofe No. 1 which is the Steatites quæ paratonium antiquorum, No. 13 of Da Cofta, and the argella albiffima ponderofa tenax p. 17 of Hill, is found in veins about two fingers breadth at Gew-Grez cove, where it is carefully felected from the other forts, barrelled up, and almost wholly engroffed by people employed under the managers of the Porcelain Manufactories. But the No. 14 of Da Cofta, which he defcribes as taken by himfelf from our foap rock, he eminently denominates Steatites vera; which I think he ought to have ftiled the Steatites Cornubiæ, as he recommends it to the China manufactories lately established in this kingdom, and doubts not but we fhall be able to furpais the manufactories of all other European nations, fince none have those Steatitiæ in fuch plenty and fo fine. It is remarkable, that letters written with Soap-ftone upon glafs, though infenfibly fixed, are not to be moved by washing, but always appear upon being moistened by the breath.

The curious memoir in the transactions of the Royal Academy of Sciences at Paris, for 1727, communicated by the learned and indefatigable Monsieur de Reaumur, fully informs us of the art of making Porcelain, and the true substances used for that purpose by the Chinese: he has in that memoir judiciously considered China as a Semi-vitrification, and on the principles of burning the ware to that exact state, he has established the perfection of the art. Now as all Earths vitrify, it is evident no true Porcelain can be made only of Clays, but other neceffary

fary fubftances are required to hinder their perfect vitrification ; and for fuch fubftances they can have recourfe to the Talky clafs, the Foffils of which almost evade the force of fire, and on that account furnish us with the finest and best ingredients. On this principle it is evident, that no fpecies of clay whatever, can be finer or fitter for the making up of China than thefe hardened Talky Soap Clays, wherein nature has blended the neceffary Foffils, Talk and Clay, ready for our ufe. Even a very fine common white Clay, properly tempered and mixed in fuitable proportions with our moift Talky Granite, or Moorftone, impalpably triturated, may furnish us with the properest materials to be had for a China manufactory. It remains, however, ftill to be obferved, that the Clay for China must be very fine, extremely white, and cleared from every heterogene foil; for which reafon, in St. Stephen's and Breage parifhes, they pass it through many lotions with clear water, before it is put into cafks to be fent off. Where we have feen a natural or adventitious mixture of Clay and Granite, with us, commonly known by the name of Grouan Clay, it has always anfwered for bricks to build fire places and furnaces with, equal to Stourbridge and other Clays; infomuch that plenty of it has been fent to Briftol, and the Welch Copper-works, for the purpofes before mentioned; befides that famous yellow Clay in the parish of Lannant, which has produced fuch an handfome income every year to Humphry Mackworth Praed, Efg;. The manufactory, which was fet up within these few years at Truro, for the making of crucibles, is a very notorious proof of the ftrength of our Clays, when mixed with Granite, to refift the most intenfe fire : no other crucibles are now used by our affayers ; and the inventor has received the appointed premium for the difcovery, from The Society for the encouragement of Arts, Manufactures, and Commerce. These crucibles have not one leaky neft among fifty; and the foreign pots, which were used till lately, had fcarcely fifty found crucibles among a hundred; fo that if the proprietor knows how to advance his intereft, he may export great quantities every year for foreign use, and fave a confiderable fum to this kingdom, which formerly went out of it for this neceffary article in metallurgy.

Stones are either common, or precious. There are alfo feveral forts of Stones peculiar to Metals, which are frequently met with in Mines, that, by their colours and confiftence, often denote either a profitable or barren Mine; fuch as Spar Stones, Quartz, and Fluors refembling Cryftal, by the Germans YTER termed

AND THEIR FLUXES.

33

termed Fluffe, from their propenfity to melt in the fire, which are no bad fymptoms of Metals, except those Stones be hard, opaque, and untractable. There are feveral other kinds of Stones worthy of notice, which we omit here, and refer to their proper places, when we shall speak of the different kinds of Lodes with respect to the Earth and Stones they contain. Of precious Stones, there are great diversities of kinds, colours, and value; yet there are few met with by Mining in Europe, of any great intrinfick worth : the knowledge of precious Stones, however, is not properly the bufinefs of a Miner.

Secondly, by Infpiffated Juices, and Mineral Waters, we mean all Mineral Suftances, dug, or flowing out of the earth, either in a coagulated or liquid form. Of the latter fort we shall not speak further at prefent, but shall divide those of the first kind into three forts, viz. Saline, Sulphureous, and Acid. Of the first are Sal Gem, or Sal Fosfile, Nitre, and the like; of the fecond, are most kinds of Bitumens, as Naptha, Afphaltos or Pix Judaica, Petroleum, Sulphur, Pit-coal, &c. Laftly, the acid forts are Vitriol, or Copperas, of which there are great varieties, produced either by nature or art. Native Vitriol is made in the bowels of the earth of an aqueous liquor impregnated with an acid falt, and of a cupreous or martial Mineral, frictly united, both to a combustible fulphureous fubftance, and to another body of a more fixed terreftrial nature. (Boyle). The common green Vitriol or Copperas of the fhops, is an artificial production; great quantities of which, are manufactured by my friend Ephraim Reinhold Seehl, Chymift, at Blackwall and Deptford.

Dr. Rouby, a curious foreigner, fet on foot a manufactory of Roman or Blue Vitriol, at Treleigh in Redruth, about five and twenty years fince; which dropped, only with a lofs of ninety pounds, by means of fome difputes and difagreements among the perfons concerned. It was collected from the waters which were left from the lotions of Black Tin, after it had been calcined in the burning-house, for the discharge of its Mundick. This water, being ftrongly impregnated with vitriolick particles, after it had been decanted clear from its dregs, was kept constantly boiling, by a gentle fire, for feven or eight days, in a leaden boiler; when being evaporated to a pellicle, it was drawn off, and fet to crystallize in proper veffels. The time for cryftallization, was generally three or five days, according to the different degrees of impregnation of the water; eight tons

tons of which, well faturated with vitriolick particles, would yield a ton of very fine blue Vitriol, far fuperior to the Hungarian, or any other I have yet feen ; at that time, worth about eighty pounds, and the expence of making about fifty. The materials are fo plenty with us, that we could undertake to fupply the whole world with this merchandife from Cornwall, by a cheaper process than the foregoing. But the domestick demand for this falt, does not exceed twelve or fourteen tons # annum; and our remote diffance from the centre of the kingdom, will occafion fo great a charge in commission, freight, carriage, &c. that it will hardly be worth the trouble and expence of apparatus and making. Befides, without a patent for the fole making and vending thereof, it would foon be in the hands of too many perfons, for the continuance and profperity of the undertaking. Add to this, that they now make it at Birmingham of what they call pickle, and render it at nearly half the price they formerly fold it for : and we imagine, that the continent may be fupplied from the Cyprus and Hungarian Mines with an inferior Vitriol, of courfe cheaper, and what may anfwer their purpose almost as well.

There are also other forts of Copperas, which are diffinguished by their different colours, as Chalcitis, Melentaria, &c. which are only different degrees of the fame recrementitious Mineral, and are now very little regarded. Other acid Foffils, are native or rock Alum, or common Alum, which is made by art; but the Alom de Pluma, Alumen Plumofum, feems rather to be the Amianthus, Afbeftos, or Earth Flax, whose fibres endure the fire and will not burn. The last, however, is rather a Stone than a Mineral; and has been found in the parishes of Landawednack and St. Clare in Cornwall very fine and perfect. Dr. Grew in his Museum of the Royal Society, fays, "There is a "kind of Afbeftos, which grows in veins in a Clay and Mun-"dick Lode, between beds of a greenish earth, in our Cornish "Mines;" but we never yet faw any thing of the kind in them.

The fublimate of our white Mundick, if carefully fwept from the funnels of our burning-houfes, and well feparated from the bituminous foot and fmoke mixed with it, may produce, by confined fufion, fome of the beft white Arfenick ; and the more yellow Mundick may give a fine delicate ftraw coloured fort. If it is not fufficient of itfelf, an addition of one tenth Sulphur, will perfectly do it ; and by a further addition of Sulphur, a very

AND THEIR FLUXES.

very fine red Arfenick may be obtained. But, if I am rightly informed, the most profitable torture this Mineral can undergo, is the ruducing of it into a beautiful Ultramarine, which is more valuable than Gold itself.

The Society for the Encouragement of Arts, has repeatedly offered premiums for the best composition to pay over ships bottoms, in order to defend them against marine worms, which abound fo much in fome parts of the Eaft and Weft-Indian feas, that veffels new off the flocks, have been frightfully bored in their first voyage. Our county being altogether maritime, and the Mines being fituated in the most narrow part of it, between the two channels, many of our adroit Tinners are equally converfant with naval and fubterranean affairs. So true is this, that in St. Ives and Lelant, during the fifting feafon, they are wholly employed upon the water, to the great hinderance of the adjacent Mines; and when the fifting craft is laid up againft the next feafon, the fifhermen again become Tinners, and dive for employment into the depths of the earth. We have more than one inftance, of a common labouring Tinner, after he has many years worked under-ground, becoming fo complete a failor, as to be entrusted with the command of a large veffel to the Baltick, the Levant, or any other part of the globe. This may feem ftrange to fome of our readers; but if it were much to our prefent purpofe, we could make it appear, that there is in fome parts of the two employments a great analogy, notwithftanding the elemental difference. It is a maxim among us, that a good Tinner makes a handy Sailor.

It is not, therefore, to be wondered at, that many of our Tinners and Sailors have reciprocally attended to the object of the above-mentioned premium : the poifonous qualities of our Mundick have engroffed their attention accordingly; and they have complied with every direction in regard to the payment of timber with this poifon, but all to no purpofe. We have tried it in a preparation of our own, fubtilized in fuch manner, as to be free from those cracks after it is laid on, to which the Mineral, by its fpecifick gravity, when mixed with pitch and tar, is fubject. It will be needlefs to defcribe how we have tried it upon fome of his Majefty's packet boats at Falmouth, as the experiments did but partially fucceed to our wifh : fuffice it to fay, that no payment, however deleterious to animal life, will answer our expectations, unless it can be laid on in fuch manner, and of fuch confiftence, as to be equally fmooth and free

free from the leaft crack or feparation; and be of fuch impenetrable hardnefs when dry, as to equal Metal, which alone is proof against the piercing auger of the Teredo : even petrified wood may be bored by the jaws of this worm, which we are told will penetrate Stone itfelf. Mons. de la Voye speaks of an ancient wall in the Benedictines abbey at Caen in Normandy, fo eaten with worms, that a man may run his hand into most of the cavities. (Philo. Trans.) Hence we will take upon us to fay, that no payment whatever, even the most poifonous, will effect the refiftance required ; for the worm first of all introduces its auger, which is a callous, fhell-like, infenfible inftrument, through the matter which is laid upon the wood, and continues working, till it has made a deep imprefiion into the fubftance of the timber, when it takes a turn, and works along with the grain of the wood, which it then feeds upon, and not before : whereby we fee, it has efcaped beyond the defigned caufe of its deftruction, before the vital or animal part of it comes into action; fo that we may be affured, that no payment will fecure our fhips bottoms, but impenetrability itfelf. of a common labouring Tinner, after he has

A quantity of the preparation here fpoken of, was fent fome time ago to an eminent fhip-builder at Rotherhithe, who returned for answer, " That he was very well fatisfied, the com-" polition would fulfil the most fanguine expectations; but, he " thought it not the proper bufinefs of a fhipwright, to advance " or encourage any fuch undertaking, however laudable in the " eye of the publick ; and he fuppofed every other artificer in " his way, would be of the fame mind :" and in confequence of this reafoning, a few hundreds weight of the preparation were thrown into the Thames. We likewife recommended a trial of it to another ship-builder in this county, who ingenuously faid, " That he would first wait fome trials of his own upon Mun-" dick very finely pulverized :" but he would not regard, or did not underftand, my reafons against the bare poslibility of his fuccefs.

The effect, however, that cannot be obtained by external application in the payment of a fhip's bottom, may be produced by previoufly faturating the planks of which the bottom is formed. The planks that are laid upon the bottom or fide of a thip, are first feasoned in hot water, in order that they may be flexible, and yield to the form and shape of the mould, upon which they are laid. It is, therefore, only neceffary to infufe and mix with the boiling medium, a quantity of the abovementioned

ic in a preduction of our own, fubbilized in fach ma

AND THEIR FLUXES.

mentioned composition, which is one of the most active, impalpable, and fubtil mineral minimæ, specifically to be obtained; and will infinuate itself and enter into the pores and vascular conftitution of the timber, which being thus wholly faturated will have all the power and aculeated exertion of the most effective poison; so that if the Teredo penetrates through the outward part of the wood, whenever he turns to feed upon the grain of it, he will be immediately deftroyed. This digression will, we truft, be excused by many of our readers, on account of the importance of the fubject to commerce and navigation.

We fhall now go on to obferve, that thofe rapacious poifonous Minerals are often intermixed with Ores and Metals in the earth, though not fo often diffinguifhable; and from thence in a great meafure proceed that afperity and volatility which often happen to Ores in the fire, and which an unfkilful refiner is not capable of underftanding and correcting. We fhall, therefore, in few words, endeavour to give an account of thofe fluxes, which are moftly ufeful in the fmall examen of Metals by fire; in which bufinefs the affayer or artificer ought duly to know and confider the different properties of acids, alkalies, and neutral falts; and how they act with each other and agree with Metals.

Sal Nitre, or Salt Petre, is a native Salt; and is almost peculiarly the product of the East-Indies, from whence our East-India company import amazing quantities. They have in a great meafure monopolized this article; and its vaft confumption in the manufactory of gunpowder, &c. must render it a very important branch of their trade. It is alfo factitious, and may be made at home from the offals of flaughter-houfes, ftables, &c. It is a neutral hermaphroditical Salt, being neither a true acid nor alkali, though it is eafily convertible to either : it feems partly acid and very volatile, yet partly fixed, and is a great purifier of coarfe Metals, and will alfo deftroy and devour them, if not warily and judicioufly handled : it is intended further to liquify the fluxes with which Gold, Silver, and Copper are reduced and purged in the affay or crucible ; which it does when exposed to the action of fire, in a pure and dry ftate, and foon flows with those bodies like water; whence it comes to be used in Metallurgy as a flux for those Metals.

Tartar, Argol, is a hard brittle faline fubftance, with which the fides of wine cafks are incrusted; and is red or white, according to the colour of the wine that produces it. An ingenious L author

author fays, "It has Bacchus for its father, fermentation for "its mother, and the cafk for its matrix." It confifts of a peculiar fixed fharp Salt, not improbably inclining to urinous or lixivial Salts. This Salt in Tartar is exceedingly ufeful in fluxing and depurating fome Metals, efpecially Copper. Tartar alfo contains a vegetable Sulphur, which is very powerful in reducing and embodying the burnt or vitrified calx of Copper; for which reafon, it is juftly efteemed the principal ingredient in the affaying that Metal. It is very good likewife, as well as Nitre, for purifying coarfe Silver, and for making Silver tough and malleable.

The most imperfect Metals, and the Semi-metals, melt more eafily by adding falts to them, than they do of themfelves. However, they always lofe a great deal of their fubftance by this means, which happens efpecially with regard to Copper, whereby an advantage to the buyers of Copper Ore, who imelt in their large furnaces without those devouring and destructive fluxes, must necessarily arife. For if I buy five hundred tons of Copper Ore by a fample of one ounce, which I have tried with fome very fmall lofs of Metal by the abforption or rapacity of my faline flux; furely, the amount of Metal which will be faved upon fo large a quantity of Ore being fmelted without fuch lofs, must be very confiderable. Certain it is, that no lofs can happen to the buyer who purchases by the produce of his fample ; for it is impossible for the fample to yield more Metal than it contains; and the wafte upon fmelting a large body of Ore, is comparatively fmall, cæteris paribus, to that of the fample.

But, in order to prevent this lofs of Metal in fome degree, you may add fome kind of fat body, that will fave it from destruction, and reduce the Metal. The flux proper for this operation is very well prepared by Cramer; and from its colour is there called Fluxus Niger, or Black Flux : but we intend to give it as our best reducing flux, according to our own method of preparation, in our chapter upon affaying. Tartar, being burnt alone, in veffels clofely fhut, or detonated with Nitre, is most quickly alkalized, and thus retains a confiderable part of the Oil, which it contains abundantly, and is fixed enough : for this reafon, it very eafily turns into a reducing flux. This flux, therefore, on account of its alkaline falts, diffolves Earths and Stones, and changes them into an imperfect glafs, by a moderate melting fire. But the Oil being of a more fixed nature,

nature, ftill remains concealed therein, and is requifite both to preferve Metals from being deftroyed, and to reduce fuch as are already deftroyed.

Different combinations of the above falts are used by different affay-mafters with us, for trying of Copper Ores; but the Black Flux, or the White Flux, (which shall be given hereafter, and which some call their Refining Flux) with careful management, and proper attention to the crucible during the process, will equally answer the purpose notwithstanding the appearance of mystery which our affayers assure.

Rock Salt, or Sal Gem, Sal Foffile, and Common Salt, are all of a mild nature, though they become acid menftrua by diftillation. Common Salt is of great utility in the refining of Copper in the affay, becaufe it fwims on the matter in fufion; in pouring out of which, the Salt firft flows out, and greafes the lips of the crucible, if we may ufe the expression, infomuch, that the Metal may be poured forth, without sticking to the fides of the vessel. It is likewife useful to prevent the deflagration of the Metal in fusion, which otherwife may be burnt and deftroyed; therefore it is always at hand with our affayers to fprinkle into the crucible, when a flame isfues from the liquified contents, which it immediately damps and puts out.

Borax, Chryfocolla, Gold Solder, may be termed the Gum of Metals, from its ulefulnefs in foldering them. It is a neutral falt, almoft infipid to the tafte, of a very mild nature, and not corrofive; and though it flows not exceedingly liquid in the fire, yet it makes Metals eafily fufible. Its chief intention in affaying, is to fuftain and fufpend the recrements of Metals in their impure fcoriæ; or to throw fuch drofs upon the furface in a vitrified form; whereby they are purified from their heterogeneous matter. Borax is an artificial depuration from a certain mineral juice called Tincal by the Arabians; and fome German authors, fay, "That a native Chryfocolla or Borax, is dug out " of Copper Mines;" but we never knew of its being found with us.

Sandiver, Scoria Vitri, is the fæces and dregs of glafs. It is an Alkali, yet feems not void of Sulphur; for an ebullition enfues when it is melted with Nitre, and it is ufed, though feldom, in affaying of Copper; but it is excellent to collect burnt Silver, and Silver filings, to a body; yet it always makes the the Silver foul and brittle, which therefore is further cleanfed by melting with the proper reducing flux.

Alga Marina, Kelp, Kali, Fucus, or burnt Ore-weed, contains much falt, of an alkaline quality; as do all forts of burnt weeds, and Flemifh pot-afhes much more, being better prepared. Kelp is the ftaple commodity of the Scilly-Iflands, where great quantities are made in the months of June and July. All those kinds of lixivial falts, are not very corrofive, and are proper in fome cafes for proving of Copper Ore.

Sal Ammoniack, Sal Arenarius. In former ages, a genuine native Sal Ammoniack was brought from a certain place near the temple of Jupiter Ammon, whence it took its name; and was faid to proceed from the urine of camels fed only on green vegetables : but the falt we now have, is factitious from the foot of camels dung burnt; after which it is fublimed into cakes. It is exceffively volatile, and is chiefly ufed in making Aqua Regia, which its diftilled volatile fpirit ferves to mortify, whence it becomes a precipitator of Gold. It is of ufe alfo in foldering; and in tinning of Copper and Iron vefiels, by making the Tin adhere to them.

Common glafs is fometimes ufeful in trying of Copper Ore; for, in melting, it is of a thick ropy confiftence, and therefore ferves to entangle and fulpend the impurities of the Ore, fo that the Metal is better difengaged from its incumbrances and dregs, or purged and feparated from its defilements. For thefe reafons, feveral forts of Earths, Spars, and Fluors, with Iron Slags and Ores, may in fome cafes be ferviceable ingredients as fluxes for Copper Ore, by their ropy and abforbent qualities. We know an inftance immediately at hand, where the very Slag of Slags is re-melted with impure Copper Ore for thofe purpofes.

Charcoal, Carbo Ligneus, is endued with a vegetable Sulphur, and is therefore often of great confequence for reducing to a body the Ores of Tin, Copper, and Lead, being ufed as a flux and fuel both. Culm, fo called, is the popular flux for affaying of Tin after it is dreffed. Pit Coal is entirely improper for any reducing flux.

Thirdly. We come now to fpeak of Minerals and Metals more particularly; and shall endeavour to diffinguish most of them,

41

them, as they are met with in this county, by their various names and uses. We will here fub-divide Minerals, first, into those of an impure fort or kind, and of no value for Metal; and, fecondly, into those which are of use, and yield some produce in fusion, fuch as Antimony, Calamy, and other Semi-metals. By the first fort of Minerals, we understand all Cachymiz, Marcafites, Pyrites, or Fire-stones; which feveral names are well comprehended in the word Mundick, whole great Emporium is Cornwall. We shall here but lightly touch upon the natural hiftory of this Mineral Glebe, having already given our thoughts upon fome of its properties and ufeful applications. The figures of Pyrites being extremely various, the following are the principal : Pyrites Idiomorphos, which is fpherical, and hemispherical; in this last form, it is generally found radiated and lamellated, oval, cluftered, criftated : angular, confifting of four or fix fides; and this laft cubical, or teffellated, oblong, rhomboidal, cellular or honey-combed : fiftular or piped : all of which are common to Cornwall. (Henckell's Pyritologia.)

It may be generally divided into three fpecies, viz. Marcafita Argentea, Aurea, and Alba Ponderofior. It may be alfo claffed under numerous fpecies of Pyritæ, fuch as the Gymnophyris, Pyritrichum, Pyritrichiphyllum, Pyricubium, Pyripolygonium, Pyroctogonium : but as all thefe names will only ferve to confound the bulk of our readers with technical difficulties, it is fufficient to fay, that the forms and colours of this Mineral are innumerable.

We find it very plentiful in Lodes of Tin, Copper, and Lead; with which it is fo intimately mixed, that it commonly impoverishes the value of each of its companions, notwithstanding every known method is used by fire, water, and various manuductions, to feparate and cleanfe them from it. Though it is fo generally diffributed in those Lodes, it does not incorporate with Copper Ore; but is disjunct, yet not entirely feparable. But from Tin, its union is fometimes infeparable by water; especially if the Tin is of a lax, fandy, pryany, or clayey texture. Its connection with Tin in the hard Stone, is often the fame, if the Stone is of a peachy nature, and where the moleculæ of both Minerals are equal. In either ftate it being fpecifically heavier, no lotions will ferve the purpose for difunion, but the most perfect uftion must be complied with to evaporate part of it, and reduce its ponderofity within the power of future ablutions to carry off : when we come to defcribe the method M

method of dreffing Tin, we shall explain the process for burning it. After all that can be done, Mundick is such a mortifying inmate, as by its communication corrupts the goodness of the Metal, and renders it harsh, brittle, and ill coloured.

Many are the Lodes of pure folid Mundick, without any mixture of Tin, Copper, or Lead. It may in general be faid, that Pyritæ are to be met with in as many different forms and pofitions, as other Minerals are : fuch as vein-wife, when the Ore ftretches downwards, oftner floping a little, feldom quite perpendicular. Squat-wife, or in a horizontal position; that is, if not always quite level, yet hanging much, and dipping a little. (The fame as a true Lode plot) (Henckell). But as these Lodes of Mundick are not found to produce our Metals, after fome little trial they are not deeply enquired into, and are foon relinquished. If they were patiently funk upon, they might poffibly produce Tin or Copper in depth; and it is a general maxim among the Miners, " That a large Lode of " Mundick commonly rides a good horfe :" indeed, we know feveral inftances of very large Mundick Lodes, anfwering the purfuit of the concerned with abundance of Copper Ore in depth : from whence many writers have maternalifed this Mineral for Copper, which is baftardifing the daughter, whofe real mother is Goffan; and yet Mundick does partly contain the feed or vitriolick principle of Copper, and therefore it may with propriety be termed the father, and Goffan the mother, or matrix, to fecundate the feed.

Mundick is continually forming concretions ; and, perhaps, none of the Foffil kingdom will fupply us with more recent and visible proofs of the like activity, in the fame fhort fpace of time : we think, we have feen it make confiderable advances, in three or four years. Poldyfe Mine has lately furnished the curious with many specimens of Crystals of all fizes and shapes ; particularly of an hexagonal column, terminated with hexagonal pyramids at both ends, four, fix, and eight inches long, to fix in the circumference. Some of these Crystals are beautifully correct and clear; others have one or two planes tinged with a brownish ochre, two or three of the planes, both columnar and pyramidal, are granulated with very minute glittering fparkles of Mundick, variegated like the rainbow; the opposite fides are coated half an inch thick, with high bliftered incruftations like grapes; others, are totally capped with Mundick at one pyramid, and quite clear at the other; many of them fo beautiful

AND THEIR FLUXES.

beautiful and fplendid, as to exceed the Iris, or the peacock's tail.

In these incrustations, we see the various degrees of approximation of matter fui generis; and from thence must conclude, that those Pyritæ are modern to the Crystals upon which they are formed, in direct opposition to those Mineralists, who fay, all Metals, Minerals, and Foffils, were formed at the creation, as we now find them. " A circumftance not the leaft remark-" able, is, that Ores are found upon Sinter or Dropftone, in " the fides and roofs of old Mines; a proof of their temporary " existence, and that they are not coeval with the world. In " fhort, Mundick is a thing that has grown, ftill grows at this " day, and will continue to grow on Drufe, (a honey-combed " Stone) fo long as the interior parts of this mais of earth are " fubject to those motions and diffolutions they hitherto have " undergone." (Henckell's Pyritologia). Neverthelefs we have met with one of these Coevalists, (otherwise a very sensible man) who infifted upon it, that those Mundick concretions were immediately formed at the creation, upon the Cryftal, while it was in a liquefcent flate; and at the fame time denfe enough to fuftain, and fupport the ponderous Mineral, that it might not fall into, and deftroy the geometrical configuration of the Cryftal.

We have likewife many specimens of Mundick, which are wholly coated over with Cryftal : and a large opaque mais of Crystal, shall contain a very rich piece of Copper Ore in the middle of it, almost totally impervious, till fractured by the fledge. Again, there are large rocks of Copper Ore, fometimes found, in all appearance as if they were folid; on breaking of which, a cavity is found in them, containing a loofe Pyricubium, or exquifitely gloffy cube of Mundick. All thefe are fimiliar proofs of the doctrine, which we laid down in the first place. Another example whereof, we have in Ilva, an ifland adjoining unto Tufcany, full of Iron Mines, which when they have dug as hollow and as deep as they can, the circumjacent earth falls in, and fills them up again ; and in the fpace of fifteen years at most, they work those Mines again, and thence draw out abundance of Metal, which this new earth hath been converted into, and which can be attributed to nothing but to the perpetual accumulation of this and other Minerals, (Alonzo Barba).

radt of Gald and Silver Tately, Olinsmet, Gliff, Cathleers and

Other crude Minerals of no effeem, are those of a ferruginous quality, which the Miners diffinguish by the names of Goffan, Cal, (more properly Gal) Cockle, &c. Our Goffan Lodes often produce Tin at a fhallow level in tolerable plenty; and chiefly that Goffan which is of the most ferruginous stamina, and we believe from thence denominated Gal, which is old Cornish British, and fignifies ruft; and being really an inferior Iron Ore, anfwers in name to its appearance. The Germans call it Wolffram, and define it a kind of Manganefe. In this kind of Goffan, after the Tin is feparated from all other impurities by repeated ablutions, there remains a quantity of this mineral fubstance, Gal; which being of equal gravity, cannot be feparated from the Tin Ore by water; therefore it impoverifhes the Metal, and reduces its value down to eight or nine parts of Metal for twenty of Mineral, which without this brood, fo called, might fetch twelve for twenty. Afterwards it is coveted by fome of the Smelters, to mix in their large furnaces, where it acts in conjunction with fome forts of Tin as a defirable flux; and increases, though it may depreciate, the lump of Metal.

The general definition of Ochres in Cornwall, may be thus fpecified : the rufty Ochre of Iron called Goffan ; the green and blue Ochres of Copper, Verdigreafe ; the pale yellow Ochre of Lead, of a Goffan appearance, but like Calamy ; the brown and blackifh yellow Ochre of Tin, called Goffan, Cal, Gal ; and the red Ochre of Bifmuth. Thefe Goffans or Ochres, are commonly called the Feeders of their refpective Metals ; and where they are found, the Metals are generally, and very juftly fuppofed to be not far off.

Cockle (the Skiorl of the Swedes, and the Schorl of the Germans; in Englifh, Shirl) is a brown or blackifh gloffy ftony matter, intermixed with Tin Ore in fpots and veins; often fhining and refembling the Cryftals of Tin Ore, from which by its weight, it cannot be well feparated; and in the Stone is not unfrequently miftaken for it, to the difappointment of the Tinner, when it comes to the teft of the fire. This Cockle composes a part of the most beautiful charge of our Granite or Moorftone; in which it is fo variegated with black and white Talck, that when the fun fhines upon it, the beholder is dazzled with its fplendour.

Talck, which is the Lapis Specularis, and has the feveral names of Gold and Silver Talck, Glimmer, Glift, Catfilver, and Black

Black Talck, is very plenty in Moorftone as before; but of fuch fmall diameter as to be no way valuable, unlefs in the Stone, for its lucid appearance. There is another fort of Talck common to our Tin veins, a bluifh Iron Ore. If Talck gets among Tin, it is a very deceitful brood, as it imitates the colour of the Tin with which it is in conjunction; and when ftamped, it preferves its foliaceous laminated form, whereby the water in the buddle flips over its leafy fubftance; but if it had been more granulated or angular, the water might poffibly have more force upon it, and feparate it from the Tin, on account of its peculiar levity. In this fituation, it is known among the Tinners, by the name of Clift, Glift, or Glidder. However, Talck and Cockle, feem to be of the foliaceous ftony kind, and are mentioned here only as troublefome companions with the Ore of Tin.

Fourthly; Semi-metals. Hill fays, " The Tin Mines of " Cornwall afford great quantities of Bifmuth, though it is " very little known there." This is a great miftake ; for Bifmuth is very well known here, and our Tin Mines never yet afforded any quantity worth the faving. That we have Lodes of Bifmuth, and those of Cobalt and Bifmuth together, is very true; but hitherto of little worth. According to the opinion of foreigners, no place exceeds Cornwall for variety and plenty of Minerals. "Beecherus refert de Cornubia, in dedicatione " alphabeti fui Mineralis, fe credere nullum terrarum locum " reperiri, qui minerarum multitudine et varietate antecellat." This fhews how great reafon we have to lament our ignorance in the examen of other Minerals befide those which produce Metal. If those of our county, who have leifure and ability to look into the contents and properties of our various Foffils, would employ their talents for that purpofe, we fhould not long remain in our prefent darknefs; a little time would bring to our knowledge the value and usefulness of much neglected treasure. Even ignorant pretenders to docimaftick operations, might in time blunder out fome curious difcoveries; and accident might effect, what prudence may not accomplish. Unfortunately for us, none pry into the concealed contents of our numerous Foffils; for the attention of the natives is principally engroffed by Tin and Copper.

Bifmuth in the flate of Ore, is ufually of a bright filvery white, and of an obfcurely and irregularly foliaceous flructure. Sometimes it appears granulated; and at others, the granules are large, and the maffes coarfe; in which cafe, every feparate N granule

granule appears of a cubick form. It is fubject to fewer variations in its Ore, than most other Minerals; but is fometimes turned yellow by an over proportion of Sulphur; and fometimes is very deeply tinged with the matter of common Mundick, and is often mistaken for it. (Kunkel, Boerhaave).

It is eafily feparable from its Ore, and may be made pure by merely melting the Ore alone in a crucible in a moderate fire : when it is in a more impure flate, it is procured by an addition of the reducing flux before mentioned ; but if the fire be too fierce, the Bifmuth will be loft.

A fmall portion of Bifmuth increafes the brightnefs, hardnefs, and fonoroufnefs of Tin. The ufes of Bifmuth are, for making Pewter with Tin; for foldering fome Metals; for printers types; foils for mirrors; for anatomical injections; for imitating Silver on Wood; for purifying Gold and Silver by cupellation; and for rendering fome Metals fitter for being caft into moulds, as it increafes their fufibility.

Zinc; the Ore of which is Lapis Calaminaris. Great quantities of Tutenag were till lately imported from the East-Indies ; but the late Dr. Ifaac Lawfon obferving, that the flowers of Lapis Calaminaris were the fame as those of Zinc, and that its effects on Copper were also the fame with that Semi-metal, never remitted his endeavours, till he found the method of feparating pure Zinc from that Ore. Cadmia, or Lapis Calaminaris, is a fpungy fubftance, of a lax and cavernous texture, yet confiderably heavy. It is found in maffes of various and irregular figures, with rugged and uneven protuberant furfaces. When most pure and perfect, it is of a pale brownish gray colour; but its lax and fpungy textures, make it very liable to be fouled by extraneous matter, and thence it is often found yellow or reddifh. It is moderately hard, but will not give fire with Steel; it will not effervesce with Aqua Fortis; and it calcines in a fmall fire to a pale red. In fact, the Ochre of it is a Goffan; and though the above defcript is the true and genuine Mineral of Zinc, yet that Semi-metal is not confined to that Ore alone, but is mixed in great abundance in its diffeminated particles among the matter of the Ores of other Metals, particularly of Lead.

Mock Lead, Black Jack, and Blende of the Germans, is really a contaminated Zinc Ore, (and fome of it even very little fo)

AND THEIR FLUXES.

47

fo) and would anfwer every purpose of it, if it was not in general so united to the principles of Iron and Arsenick. It is the most plentiful Mineral we have next to Mundick, and has of itself diffinet Lodes; but it is most commonly mixed with Mundick in some of our Copper Lodes, before they are wrought to any great depth. It has been much used for the making of Brass, instead of Calamy: several ladings have been shipped off for that purpose, at the price of forty shillings down to a moidore P ton; which might pay for the dressing of it, as the Burrows, or heaps of refuse in some Copper Mine Bals, will supply great quantities of it.

To extract the Zinc, the Calamy muft be finely pulverized, and well mixed with one eighth part of charcoal duft, and put into a clofe retort, to prevent the accefs of air, which would inflame the Zinc as it rifes. The retort is to be placed on a violent fire, fufficient to melt Copper. After fome time, the Zinc rifes, and appears in the form of metallick drops within the neck of the retort, which, when cool, you break to take out the Zinc.

Lapis Calaminaris with Copper, makes Brafs; Zinc with Copper, makes Princes Metal, or Bath Metal; and improves Tin in whitenefs and hardnefs, in the composition of fome Pewter.

Stibium. Antimony. This Semi-metal in its Mineral Ore, is of a dark lead colour, ftaining the hands black; and is generally full of long fhining needle-like ftriæ; though often of an exceeding fmall clofe grained texture, hard, brittle, and very heavy. It is found in different parts of Europe, as Bohemia, Saxony, Transilvania, France, and even in England in fome confiderable quantities, though as far as we yet know, confined to the counties of Cornwall, Devon, and Somerfet; from the north-weft quarter of the latter, only a few specimens; from different parts of Devon fome tons; and formerly from Cornwall, in quantities of twenty, and even thirty tons. In the laft three years this county has produced about one hundred and twenty tons from one Mine called Huel Boys, in the parish or Endelian; viz. in the year 1774, nineteen tons, at f. 13 \$ ton; in 1775, forty tons, at f. 13 10; and, in 1776, thirty-fix tons, at f. 14 14 \$ ton. The expence of getting this Antimony, exclusive of driving an adit to the Mine, has been lefs than one third of the amount of its produce. The remainder

remainder of the one hundred and twenty tons above mentioned, is chiefly the product of a Mine near Saltash, belonging to Mr. Thomas Reed and partners.

The direction of the antimonial veins, is moftly from north to fouth; but there are now and then fome fmall quantities found in veins which run different courfes, and which, from their fuperior product of other Minerals, are denominated according as the different Metals predominate. Antimony lies in its veins or Lodes extremely unequal, but generally more fo length-wife than in depth. It is not uncommon to have the vein two or three feet wide, and in driving as many, not only the Mineral, but even the vein itfelf will be fearce perceptible. We have not known any of this Mineral wrought more than fourteen fathoms deep. The Mine of Huel Boys above mentioned is about twelve fathoms, and in the bottom promifes continuance.

Foreign Antimony does not come to us in the ftate of its Ore, but what is, however, called Crude Antimony; which is obtained from its earthy and more flubborn mineral particles, by a kind of eliquation, in the following manner. The Mineral is put into earthen pots pierced in their bottoms with fmall holes; these pots are placed in a furnace, where they receive the neceffary heat for the fusion of the Antimony; but much lefs than is fufficient to fuse any other of its mixtures, except Lead, with which it is often combined, and which even this fufion will be fufficient to melt with it into the fame mass. For this reason, Crude Antimony ufed medicinally fhould undergo an examination, to difcover whether it has Lead in it; as I am informed it may have a confiderable quantity without altering its ftriated texture, and for which reafon I am inclined to believe, that English Antimony is the least proper for medicinal use, as it is more liable than Foreign to a faturnine mixture. This Crude Antimony comes to us in the form of the pots or moulds in which it has been melted. Some of the Antimonial Ores of this county, without any fuch preparatory fusion, have been found to produce at leaft as large a quantity of Regulus, and equally fine, as the beft Foreign Crude; and as they generally lie very rich in the earth, this fusion is mostly rendered unnecessary.

Mr. Reed has erected furnaces in Feock parish, on Restronguet river, for extracting its Metal, commonly called Regulus of Antimony; which is performed by mixing the clippings of the

AND THEIR FLUXES.

the Tin-Plate Workers with the Mineral Ore, first well cleanfed from its ftony earthy parts, and fmelting this mixture in pots containing from a half hundred, to one hundred weight : in which operation the reguline part of the Antimony, freed from its Sulphur, by the latter's uniting with the Iron in the beforementioned clippings, by its fuperior gravity finks to the bottom of the pot, leaving the other parts in a light mineral-like fcoria on the top, which readily feparates when cold. The foreign Ores of Antimony are melted in London, for these purposes, in the fame manner; only Mr. Reed's is done in an air furnace, and in London they use the bellows as in other small founderies. The use of the clippings is for the fake of cheapness and convenience, for a fomewhat lefs quantity of fmall Iron alone will effect the precipitation. Regulus of Antimony may also be obtained by fubflituting, for the Iron, Copper, Lead, or Tin; but these must be added in a much greater quantity, and the operation confequently will be attended with much more expence, and greater difficulty, and are, therefore, fubftituted only on very particular occasions. The greatest confumptions of Antimony, befides the medicinal, are made by mixing its Regulus with Tin to make Pewter hard and fonorous; and with Lead, &c. for Printing Types; though it has feveral other ufes.

Cobalt, is a denfe compact and ponderous Mineral; very bright and fhining, and much refembling fome of the Antimonial Ores. It is fometimes found of a deep, dufky, bluifh black; very heavy and hard, and of a granulated ftructure, looking like a piece of pure Iron where fresh broken : at other times it is found more compact and heavy, and of a very even texture, not granulated or composed of any feparate Moleculæ, but refembling a dufky mafs of melted Lead on the furface, and will bear to be cut with the knife. The inner part, where it is always very bright when fresh broken or cut, is also found, in fome places, in a much more beautiful appearance than either of these, being of a fine bright filver gray, and of a beautiful striated texture, the striæ running all great lengths, but very flender and varioufly bent, undulated, and in fome parts broken. It is also fometimes foft, and covered with a blush coloured efflorescence, which is generally rich in Regulus.

We have given our thoughts upon the fubject of Arfenick, and fuggefted that it may be cheaply rendered by our Mundick fublimations, after the manner in which it is procured from O Cobalt;

Cobalt; and the more we look into, and confider the operations whereby Arfenick, Zaffre, and Smalt, are obtained from this Mineral, the more we are convinced, that a fkilful hand may improve upon the hint in relation to the different forts of our repudiated Mundick.

We have had but one Cobalt Mine that ever was diftinguished by that name in this vicinity, which was discovered accidentally by Mr. Beauchamp, in an adit that he drove through some part of his effate at Pengreep in Gwenap. He discovered a Lode of three feet breadth, which contained a branch of real Cobalt; and it happening about the time when the Society of Arts, &c. offered a premium of thirty guineas for the best Cobalt to be discovered in England, he was honoured with the reward for his specimen, pursuant to the advertisement. It did not hold in depth, but foon deferted the pursues; who were likewise very foon after obliged to fuspend their fearch, by a prodigious influx of water to their workings.

At Huel Trugo alfo, a Copper Mine near St. Columb, fome of the pureft Cobalt has been worked. It was in a fmall vein, four to fix inches big, in which there were no other mixtures. It croffed the Copper Lode, which was pretty large, though not rich; and the Cobalt lay in the vein just where it joined the other, but did not hold to any length, fo as to make it worth purfuing. It was very fine, and fuppofed by fome who think they know the value of it, to be worth more than fixty pounds # ton. It was of a pale red, or rather bloffom colour; and, on being exposed to the air for any confiderable time, the furface was covered with a farinaceous fubftance refembling the fublimate of Arfenick, which it probably was; but left the fine colour fhould evaporate, the proprietor, Mr. Champion, ordered it to be put into cafks filled up with water. The common air was, or feemed to be, the menftruum, which diffolved the furface of this Mineral, which it is probable in procefs of time, as it became longer exposed to it, would have totally crumbled into that floury fubftance. Cobalt is also supposed to be in no fmall quantity in Dol-Côth Copper Mine, for the affayers generally find their pots tinged with blue; yet it feems to be fo blended with Copper and Iron that it does not difcover itfelf in a mineral flate, being probably but in the general term of Mundick. Very good Cobalt has also been discovered in Dudnan's Mine in Illogan parish; and in a Mine wrought for Tin and Gal near Pons-Nooth in Perran-Arwothall.

In the laft place, we come to define Metals only, which we fhall prefume to be fuch on the refpective principles of their ductility and gravity. Their malleability may arife from the figure of their parts, perhaps oblong or fquare, which may occafion their cohering fo ftrongly, as not eafily to be feparated ; and it is probable, the pores of their conftituent particles, or of the whole mass, are few and small; which may account for their being fo much heavier than any other bodies. The radical characters of Metals stand thus: the weight of Gold to that of Glass, is as 9 to 1; and the weight of Tin, the lightest of all Metals, is to that of Gold, as 7 to 19: which confiderably furpasses the weight of all Stones, and other the most folid bodies. The specifick weight of the feveral Metals, and of Granate, Water, and Air, stands thus:

| Gold | 19,636 | Copper | 8,843 |
|-------------|---------------|---------|----------|
| Platina | 17,000 | Iron | 7,852 |
| Quickfilver | 14,019 | Tin | 7,321 |
| Lead | 11,345 | Granate | 3,978 |
| Silver | 10,535 | Water | 1,000 |
| | of the Gold e | Air | 10 11 11 |

Formerly there were but fix Metals fo denominated, to which by fome was added Quickfilver, which has every property of Metal except fixidity. To thefe we fhall add another original Metal lately difcovered in the Spanifh Weft-Indies, and by the Spaniards called Platina, from its refemblance in colour to Silver, from which it would not be fo well diffinguifhed, but by its fuperiour gravity, and inferiour ductility; which particularities are extremely remarkable.

Gold, by the ancients, was characterized the fun, which they imagined did influence and produce it. Gold is very rarely feen in a flate of Ore; being of all Metals moft frequently found native. It is a general opinion, that it never was found in a mineral flate, but always pure and metallick : I have, however, feen, in the poffeffion of that curious inveftigator of natural productions, Dr. Hunter, a large fpecimen of mineralized Gold, which the doctor had from Germany : one point of it was pure Metal and Quartz; and the other, I confefs, had all the appearance of a mineralized Gold Ore.

Gold is free from Sulphur and Arfenick; has no certain figure; and is found pure in Flint, white Quartz, or debafed Cryftal.

Cryftal. It is feen in Lapis Lazuli, and fome of our pebbly ftream Tin. It is not uncommon to meet with Grains of folid Gold in our ftream works; and fome large pure lumps have been met with in those works for Tin Ore, of which the late William Lemon, Efq; grandfather of the prefent Sir William Lemon, Bart. had one that weighed fifteen penny-weights and fixteen grains. That there were fuch grains, called Corns of Gold, formerly observed in stream Tin, we have the authority of Mr. Carew, fol. 7; and in the Bayliff of Blackmoor, a M. S. in my poficifion, written by one Mr. Beare in queen Elizabeth's time, there is an account of a gentleman, " who at a wash of " Tin, at Caftle-Park near Loftwithiel, took up out of the " heap of Tin certain fine Corns, Hops, or Grains of Gold, " which they called Rux; and at the fame time, fhewed a " Gold ring on his finger, made of certain Gold, which he had " gathered out of the Tin at a wafh in a ftream work, together " with another Gold ring, each of fixteen fhillings and eight " pence value." He likewife tells us of "two blocks of Tin, " carried by one Mr. Robert Davy to Bourdeaux, which were " by two Florentine merchants valued to be worth all the reft " of the Tin there, by reafon of the Gold contained in them." The late William Glynn, Efq; grandfather of the prefent learned recorder of London, had a large Gold feal ring, made of Gold found in the river under his houfe at Glynnford. Whether the great Mr. Boyle had heard of thefe facts, or that it was a notion of his own, it is most certain, that he imagined a good quantity of Gold might be extracted out of Tin, without prejudicing the Metal; and to that purpofe, fent down Chriftopher Kirby, Efq; (well known for having been unhappily drawn in by Dr. Oates to countenance his plot) to make fome experiments therein, in the latter part of the reign of king Charles the fecond. But in a few months after king James came to the crown, Mr. Kirby being apprehenfive of fome ill usage on account of Oates, fled into Holland, from whence he returned with the prince of Orange; and Mr. Boyle's death happening much about the fame time, this project fell to the ground.

Of all Metals, Gold is eafieft to be amalgamated with Quickfilver; fo that a Gold ring being a little touched with it, will be no longer ufeful to the owner if the Quickfilver is not fpeedily burnt off in a ftrong fire. It is diffolvable in Aqua Regia; but a true Aqua Fortis makes no imprefion on it; for if you put into it a piece of gilt Silver wire, whofe Silver is half a grain,

a grain, and the Gold but one ninety-fixth of a grain, drawn into the length of an ell, the Silver will be eaten out, and a tube of Gold shall remain, which, notwithstanding its extreme thinnefs, will be still opaque. The ductility of Gold is beyond all imagination. By exact weighing and computation it has been found, that there are Gold leaves, which, in fome parts of them, are fcarce the three hundred and fixty thousandth part of an inch thick; yet, with this amazing thinnefs, are still a perfect cover for Silver wire; nor can the beft microfcope difcover the leaft chafm or difcontinuity to admit any known fluid, or even light itself : but this depends altogether (incomprehenfible as it is) on its being free from Sulphur; for mix but one grain of Sulphur with a thousand of Gold, and it is malleable no longer. Neuman fays, "A fingle grain of Tin added to the " foregoing proportion of Gold, will have the fame effect;" which, we fuppofe, must be owing to the Arfenick that is concealed in the Tin. Yet Antimony, which contains much Sulphur, purifies it exceedingly well, and, by abforbing and deftroying all its heterogeneous affociates, promotes its liquefaction.

Although Gold has fo great a fpecifick gravity and folidity, yet its interflices and pores are found to be much larger than those of Silver, but not near fo numerous. Fine Gold is fo very perfect and durable, that it is never injured by lying in the ground for thousands of years; nor will any fire vitrify or deftroy it in a common natural fusion: yet by exposing it to the rays of the fun, in the focus of a peculiar large lens or burning glass, it melts; and being sufficiently continued thus in fusion or calcination, it emits a fume, and becomes a ponderous glass fubfrance or fcoria of a purple colour. [Doubtful]

To render this Metal more hard than it naturally is, they alloy it with Silver or Copper; yet it cannot bear to be mixed with Brafs, which makes it brittle, by means of the Calamy.

Platina is found, not in Ore but in fmall grains; yet not pure, but mixt with a fhining black fand : there are likewife ufually mixt with it, a few fhining particles of a golden colour. When exposed to the fire by itfelf, it is extremely hard to melt; but fufes readily with Gold, Silver, Copper, Lead, or Tin, and incorporates with them. A piece of it was put into ftrong Aqua Fortis, and kept in a fand heat for twelve hours, but P

when taken out, was no way corroded, and it preferved its first weight. It appears then, that no body comes fo near Gold, in fixednefs and folidity. Cronftedt fays, it is heavier than Gold ; and therefore the heavieft of all bodies hitherto difcovered : for though the specifick gravity of Platina, in the hydroftatical experiments made by Dr. Lewis, is found to be, to water, only as 17,000 to 1,000; yet, when melted with other certain Metals, its fpecifick gravity has, by an exact calculation, been found to be confiderably augmented, even fo much as to 22,000. If it could be made as ductile as Gold, it would not eafily be diftinguifhable from it by its other properties. It entirely refifts the vitriolick acid, which diffolves or corrodes every other known metallick body, except Gold ; yet it differs from Gold, in giving no ftain to the folid parts of animals, nor ftriking a purple colour with Tin : it is, therefore, a fimple Metal, of a particular kind, effentially different from all those hitherto known. Platina hardens and ftiffens all Metals; one more than another, but Lead the moft. Tin bears much the leaft, and . Gold and Silver the greatest quantity, without the loss of their malleability. Though it is of an uniform texture, bright and fhining per fe, takes a fine polifh, and does not tarnish or ruft; yet it makes Tin tarnish foon, and Lead very quickly.

The fciences, commerce, and arts, must receive great advantages from the application of a new perfect Metal to useful purposes; which, to the fixidity and indeftructibility of Gold, unites a hardness and folidity almost equal to those of Iron. We regret, that although large quantities of it are found in America, it is here fo exceedingly rare.

The caufe of the great fearcity of Platina is, that the Spanish ministry have prohibited the fale of it, or the extraction of it from the Mines. These prohibitions were certainly from good motives and wife intentions; for this Metal was no fooner known than it was employed for the adulteration of Gold, for which purpose it is very fit, as it fulfains all the ordinary trials of Gold, has the fame specifick gravity, and renders Gold much less pale than Silver. The use of a Metal, with which frauds fo prejudicial might be committed with impunity, was neceffarily interdicted : but fince the best chymists in Europe have examined Platina, they have published certain and easy methods by which the smallest quantity of Platina mixed with Gold may be discovered, and by which these Metals may be feparated in whatever

whatever proportion they may happen to be united. Thefe methods may be feen in the memoirs of the chymifts, who have examined this matter. We shall here only relate one of the most convenient and lefs troublefome. It is founded on a property, which Gold has, and Platina has not, of being capable of precipitation from Aqua Regia by martial Vitriol; and upon a property which Platina has, and Gold has not, of being capable of precipitation from Aqua Regia by Sal Ammoniack. When, therefore, we would difcover whether Gold be allayed with Platina, let it be diffolved in Aqua Regia, and in this folution, which will contain both Metals, let fome Sal Ammoniack diffolved in water be added, and the Platina will be precipitated in form of a brick coloured fediment. If on the other fide, we would know whether Platina contained any Gold ; let this Platina be diffolved in Aqua Regia; and to the folution, add a folution of martial Vitriol in water, upon which the liquor will become turpid, and the Gold will form a precipitate, which may be eafily feparated by decanting and filtrating the liquor. We may then affirm, that the reafons which induced the Spanish ministry to interdict the use of Platina, no longer exift; and we hope, that when they are once convinced of this, the publick will be no longer deprived of a fubftance which may be fo advantageous to fociety. Dictionary of Chymiftry.

Quickfilver, Mercury; which names it feems to claim from its relative velocity to the god Mercury, as well as the planet. This Metal, if it really can deferve that name, is almost fimple as element, when in a fluid purified state. It is fometimes found in that form, and is reckoned preferable to that which is procured from the Ore of it, called Cinnabar. Mercury will amalgamate with all Metals, except Iron; and is, therefore, fometimes adulterated with Lead or Tin, because of their cheapness.

The detection of fuch frauds is of great confequence to the medicinal ufe of Mercury; and, therefore, that which is of a livid or pale colour, any way refembling powder, and runs into globules not exactly fpherical, but oblong like little worms or tears, ought to be rejected. A very minute quantity of Lead largely diluted, we are told by Dr. Baker, is of pernicious and fatal confequences to fome of thofe who take it into their bodies; infomuch as to have given name to a particular diforder in thefe parts, called the Colick of the Dunmonii, which was endemial in Cornwall and Devon in the year 1742, and returns every autumn

autumn more or lefs. I have met with those who have been tortured with this excruciating and uncommon diforder, which, though feldom mortal as a Colick, leaves behind it a fpafmodick Afthma, and an incurable Parefis. All this is occasioned by a few grains of Lead diffolved in the cyder which is made in leaden veffels. If Mercury thus flored with Lead is taken into the human body, what is to be expected but that we may introduce the greater enemy to expel the leffer. To releafe the impure mixture with Quickfilver, you may rub a little of it in a marble mortar with fome vinegar : if the acid becomes a little fweetifh, Lead is certainly mixed with the Mercury; if the vinegar is tinged, fome other Metal is to be fufpected; but it is quite pure, when a little of it, held over the fire in an Iron ladle, totally evaporates. It remains to be remarked, however, that Quickfilver diffolves in all foffil acids. There is fcarce any cohefion at all in the parts of Mercury; for a fingle grain thereof, by the action of a lens, is divifible into millions of globules invisible to the best eye; but by the application of a microscope, they will afford a diffinct prospect of all the neighbouring objects. This incoherence of Quickfilver is the reafon why it is fo extremely volatile as to rife in a fume by the action of a very fmall fire; but being mixed with Brimftone, it embraces it most tenaciously: and may then be reverberated by a great degree of fire, till it becomes fuch a red fubftance, as is fold in the shops by the name of Factitious Cinnabar, or Vermillion.

We have no records to inform us that Quickfilver was ever found in this county; but why this fertile Mineral diffrict fhould be exempt from the production of it, is no way clear: perhaps it might be found, if proper diligence and obfervation were ufed to get at it; though indeed if it was fuppofed to be in any uncommon Stone of a red or gray colour, the common method of affaying would only ferve to fend it up the chimney in an invifible fume, which ought to be faved in clofe veffels.

The chief Mines for Mercury are thefe of Hungary, Spain, Friuli, and Peru. A Mine in Friuli is fo rich, that it always yields one half Quickfilver, fometimes two-thirds. The miferable flaves condemned to work in thofe Mines, are affected with tremors, and proceed to falivate; then their teeth drop out; and they are feized with pains all over, effectially in their bones, which the Mercury penetrates; and thus they die. A common precaution they use is, to hold a piece of Gold in their mouth to imbibe the effluvia and intercept their passage into the body. Dr.

AND THEIR FLUXES. 57

Dr. Pope tells us of one he faw in the Mines of Friuli, who in half a year's time was fo impregnated with the Metal, that on putting a piece of Brafs in his mouth, or even rubbing it in his fingers, it would turn white as Silver. Nor can this be wondered at, fince it has been known to amalgamate the Gold earrings of the falivated wearer ; and I have myfelf feen very minute globules in the rotten proceffes of fome bones, when I diffected under the inftructions of the accurate Dr. Hunter. Non femel in fepulchris argentum vivum capitibus reperi. Anton. Mufa Brafavolus, in tract. de morb. Gallic.

Lead, Plumbum; alfo Plumbum Nigrum, to diffinguifh it from the Plumbum Album or White Lead, which was the name given by Pliny to Tin, although it is radically a diffinct Metal. It is ftiled Saturn, from the Planet of that name. It is feldom found malleable and purely metallick; for what have been taken for fpecimens of native Lead, have produced, very often, three parts in four of fine Silver; from whence many have fuppofed, that there is no fuch thing as native Lead : I have however feen two fpecimens of it, in the poffeffion of Mr. Bennallack in this county.

This Metal feems to confift in part of an impure leprous earth, of a fulphureous nature; and it abounds alfo with fomething very acid and corrofive, though cold, and caufing paralytick complaints in those who are much concerned in the melting of it. It may be diffolved in many forts of weak acid mensfrua, much better than in those of the greatest ftrength; and it will incorporate indifferently well with Quickfilver; but does not admit of ignition, for it melts in a very small degree of heat.

The only Lead Ores which we have feen in Cornwall, are thefe four forts: firft, the lead coloured bluifh gray, of no particular form; fecondly, the Antimoniated ftriated glittering Ore; thirdly, the fteel grained; and laftly, the teffellated or diced Lead: most of which are fo extremely rich both for Silver and Lead, as to be well worth the working, if the Cornish Lead Lodes were of a larger fize, and more lafting than they generally are. The fmall profits arising from this Metal hitherto wrought with us, have damped the ardour of our adventurers in their purfuit of it; and the Lead which has been difcovered in the weft of the county, has for the most part offered itself accidentally, when the Miners have been fearching for Copper, with which it is more generally affociated than with Tin. For my O

own part, I have never feen it blended with Tin; but with Copper frequently; and always very rich for Silver, but in no quantity. Black Jack and Mundick are very close companions with it; but they, and Copper Ore, are all of them diftinct and difcernible from each other, in the Stone or Mineral flate. In fearching for Copper Ore in Nanfkuke Downs, in a very promifing Goffan, we difcovered a leader, fix inches wide, of very rich Lead of the Antimoniated kind upon the north wall of the Lode. The Silver in it was plenty, infomuch as to render the Mineral worth f. 18 or f. 20 \oplus ton without any dreffing. It produced about a ton and half, and then totally difappeared.

It is a miftake of those who think that Lead becomes brittle by extracting the Silver from it, for it is rather more ductile. The deleterious properties of Lead I have already hinted at, in treating of Quickfilver; and I may observe in this place, that any faturnine preparation given inwardly, must be very hazardous, unless administered under the direction of a skilful practitioner.

In degree next to our provincial Metal, Tin, this ifland has been famous in the annals of paft ages for its peculiar production of Lead; and the kingdom in general has been more remarkable for the quanity produced, infomuch that Pliny faith, "In "Britain it runneth ebb in the uppermoft coat of the ground, "and that in fuch abundance, that, by an express act among "the iflanders themfelves, it is not lawful to dig and gather "Ore above fuch a proportion fet down by ftint." And Sir Jofhua Child, in his difcourfe of Trade, tells us, "That our "Lead and Tin, which are natives, and by God's bleffing in-"feperably annexed to this kingdom, carry on much of our trade to Turkey, Italy, Spain, and Portugal; befides great quantities that are fold to Holland, to France, and to the Indies, as is well known to all the merchants that trade to "thofe parts."

We have had many ancient Mines of Lead in Cornwall, particularly in Perran Zabulo; the Garres in St. Allen; and elfewhere. It is faid that the wars in France were carried on by the Silver of those and the Devonshire Mines. The Ore in the Garres, when last wrought about fixty years fince, was fo rich in Silver, as to yield one hundred ounces to one ton of Lead.

.of I driv and behavior allocated than with The.

AND THEIR FLUXES.

Silver, Argentum, C Luna, from its attributed planet. Of all Metals, Gold excepted, this Metal is found moft frequently native; and it is, indeed, found in that flate, more commonly than in Ore; and if you break the flony Glebe or Mineral, you will fometimes find folid grains and lumps of malleable Silver contained in them. Silver is ufually mixed with other Metals, particularly in Cornwall with Copper and Lead, though but in a feattered form and minute quantity, in the former no way adequate to the expence of extracting it.

Real Silver Mines diffinct from any mixture with other Minerals, we have none in England. We read of fuch, but they give us no produce to value ourfelves upon them; and indeed the two nobler Metals are foreign to our country, at the fame time the bafe and more ufeful Metals are beftowed upon us in common with the reft of the world. In our kingdom of Danmonii Silver Mines were difcovered in Edward the firft's time, when 337 men were brought from the peak in Derbyfhire to work them. Edward the third had great profits from them; and queen Elizabeth prefented a cup made of Silver to the earl of Bath, with an infeription upon it, from which infeription we muft conclude, that those Silver Mines, fo called, were abfolutely Lead Mines rich with Silver.

In Sweden they have a Silver Mine 150 fathoms deep, of which they have no records fo ancient as the first discovery of it ; yet we do not apprehend it is a very profitable concern : neither are there any very rich Silver Mines in Denmark, although there is preferved, in the Royal Museum at Copenhagen, a piece of native Silver five hundred and fixty pounds weight, with three other specimens, above three and two hundred weight in each. There are likewife fome confiderable Silver Mines in Hungary; but none in Europe, it is likely, of a produce equal to the Hanoverian Mines, fome of which are worked at the charge of our most gracious fovereign, and others let out to farm to his private and great emolument. I prefume the fingle Mine of Potofi in Peru, has exceeded every other quarter of the globe, in the richness and quantity of this valuable Metal. From this great vein, which is about fix feet wide, do iffue out fome fmall fprigs of little account, and yet here they refine thirty-eight millions five hundred thousand pounds weight of Silver yearly; one pound of their Ore yielding one ounce of fine Silver, at which rate, they muft raife yearly two hundred fifty-fix thousand, two hundred and fifty tons of Ore, before they can answer that account

account in Silver : but by Gerard Molino's account, they muft raife a great deal more. The vein runs directly north and fouth, floping, hadeing, or underlying, in the hill towards the eaft. They have an adit or level, which they were twenty-two years driving; but they do not difcharge their Ore through it as formerly, becaufe it is become very long and crooked; therefore they carry up their Ore on their backs, each flave about fifty pounds weight in wallets, on ladders made of ox-hides, three and three in a row, one of them having a candle tied to his right thumb, to light the reft. This work employs above twenty thousand Miners, and is wrought day and night above a thousand yards deep (see Acosta in his Natural History of the Indies): and feveral merchants that have travelled into those parts relate, that this mountain, by reafon of the numerous fmelting houfes upon it, looks at a diftance as if it were all on fire. (Waller on the Mines of Sir Carbery Price).

Cramer allows but four forts of Silver Ores, fundamentally fuch; others being only impregnations of that Metal with foreign Minerals. The firft is a vitrean Ore of an irregular figure, fulphureous, and of a lead colour: the fecond is a horny Silver Ore, femi transparent, like rofin in colour, of no external figure, but closely examined it confists of very thin plates: the third is a red or fearlet Ore: and the fourth is of a light gray colour: and even this contains more Copper than Silver, even fo as fearcely to deferve the name of Silver Ore. Oftentimes Silver is found, like Wire, woven one within the other, between the rocks; and fometimes it will refemble Lace, by the Spaniards called Metal Machacada, which, from its defeription, I apprehend to be like our native Filagree Copper.

Silver readily amalgamates with Mercury, and is eafily diffolved in genuine Aqua Fortis; but will not yield to Aqua Regalis, nor any other water impregnated with Sal Gem, Marine Salt, or Sal Ammoniack : thefe kinds of Salts, or their diftilled waters, may ferve to precipitate a diffolution of Silver from Aqua Fortis, only for this ill confequence, that Silver thus precipitated becomes very harfh and flubborn for fufion, and is alfo rendered partly volatile, fo that it evaporates confiderably in the fire : this is that precipitation of Silver, which the modern Chymifts call Cornua Lunæ. This Metal per fe, is fo foft, that it is expedient to allay it with Copper or Brafs to fit it for ufe.

Copper,

Copper, Venus, or Meretrix Publica; a common profitute from its reception of all menftrua, other Metals having their peculiar diffolvents. The acid particles of air will readily diffolve Copper, and fhew itfelf by an ærugo or ruft upon the Metal. Oils themfelves diffolve Copper by means of a Salt contained in them; for even the ends of tallow candles which the Miners leave under-ground, if touched by any cupreous water, will prefently be tinged green. This folubility is fo extreme, that a fingle grain diffolved in fpirit of Sal Ammoniack, will give a blue colour to 256,806 times its own bulk of clean water; and a faint, yet difcernible one, to above 530,620 times its bulk. Copper in fufion, will not bear the leaft drop of water; for if the moulds be wet, it flies into numerous particles, like fhot from a gun; and may deftroy the perfons near it, of which I once met with a difmal inftance in one of the workmen at Hayle Copper-houfe.

Native Copper is frequently found in our Mines, near the day or furface, or commonly but a few fathoms deep; though there are fome few inftances of its being found very deep, particularly in the Mine of Cooks Kitchen, from whence feveral tons have been fold to the Cornish Copper Company, for immediate fusion, as it came out of the earth.

On the fide of a rivulet, ten leagues to the fouth of Lake Superior in North America, there is a fingle lump of native Copper, about four tons weight, free from any mixture but a few fmall black Stones of an Iron nature, and fome very fine grains of Cryftal. Lake Superior, north from this lump of native Metal, is very wide. No vein of Copper was difcovered on the fouth fide of the Lake, near this lump; but fome few very fmall ones on the north fide, not worth the purfuit. This I had from two credible Miners of Redruth, who were fent over to make difcoveries in confequence of this fingular appearance.

We have before observed, that Copper is the most eafily diffolved of any Metal, even by common water; but certainly the diffolution must be quicker, if that water is charged with acid or alkaline principles. Wherever Copper is found, there is always green or blue Vitriol, which are foluble and eafily mix with every moifture. The action of these principles, will, purfuant to their relative strength, diffolve and defecate the Copper particles they meet with, from their impure and heterogene admixtures; and keep them fufpended, till they are arrefted

arrefted by the magnetick nidus of Goffan, when it is varioufly deposited, Stalactical, Guttatim, Machacada, or otherwise, as we may judge from the preffure, form, and situation of it when found.

The Stalactical, is generally of a braffy colour; and fo is the bliftered buttony Ore, which is protuberant in a femi-circular form, occafioned by its defcent guttatim, into a foft and yielding bed of clay. But the vitriolick folution that forms malleable Copper, is the ftrongeft that can be obtained; therefore it is the more readily attracted by the ferruginous particles of the Goffan through which it percolates, and in very little time, affumes the place and form of its magnet, in quantity, cæteris paribus, as the folution and the nidus are more or lefs abundant. Being thus fituated and circumftanced, it likewife forms the Filagree, Laced, Machacada Copper of Alonzo Barba; which is the precipitation of Copper on the laminæ of Goffan, interfecting in all directions, and leaving unequal cavities, of various angles between the fepta: the ftructure, therefore, is very cellular, and makes it look like copper lace that has been burnt.

These three forts, however, are very scarce; and more of them are faved for the cabinets of the curious, than are melted in the furnace. Green Copper Ore is likewise very rare in Cornwall; and is seldom so pure, as to be taken for a gem of the Turkois kind. Blue Copper is seldom met with, and in effeem only among the curious.

Gray Copper Ore is one of the richeft forts in this county. It looks like a kind of Lead; cuts with a knife, to a very fmooth face; and will produce the greateft quantity of Metal, of any Copper Ore.

Black Copper Ore, of a bluißh black, is alfo very rich. This is either folid, or fandy, being mixed with a light tender Crystal and fandy Mundick. It is fo light, that it will not bear the usual dreffing by water; but is generally griddled out and put to the pile for fale, as it rifes from the Mine. Being in this condition, it partakes of Mundick, Goffan, Earth, and Crystal, fo largely, that the intrinsick value of the Ore will be carried off with it. It is faid, that formerly feveral thousand pounds worth of this Ore was thus washed into the rivers, and difcharged into the north fea from the old Pool Mine. This kind of Ore in the Lode is oftentimes fo fair, that it may be raifed and

AND THEIR FLUXES. 63

and dreffed fit for fmelting, at the rate of a fhilling out of the pound, in the price it fells for; nay I have known an inftance of its being done for ten pence. In this cafe, the end or ftool of the vein will run of itfelf, like fand, againft the workman with the ufe of his fhovel only. This Ore generally lies fhallow; and feventy years ago, when Copper was not fearched for and little known among us, the Tinners threw it into the rivers as refufe, by the name of Poder, which fignifies duft, Mundick, or wafte. After it became well known, and was wrought for fale, it feldom exceeded £3 10s. # ton for feveral years, while there were but one or two purchafers.

Red Copper Ore is rather fcarce, but it is valuable. There is a kind of red, fteel grained, goffany Ore, that looks very rich, and is worth from \pounds 14 to \pounds 20 \oplus ton, according as it is impregnated with Gal or Iron, which renders it harfh and flubborn for fmelting. But of all Copper Ores, that which goes by the name of Peacock Ore, far furpaffes the reft for beauty and elegance of tint, while it is new and frefh; for after it has been long exposed to the falts of the atmosphere, its beautiful colour fades away. The interior of this is yellow.

Of yellow Copper Ore, I have observed four forts in general. The first is found shallow among black Ore, finall, or not in large rocks; and it can be freely fcraped into a yellow duft of a rich appearance. The fecond is the fine gold coloured flakey Ore, that is rich to the eye and in the crucible; its real value may be from f 12 to f 15 & ton: it is this kind of Ore which fhoots into diffinct and regular tetrahedrons, geometrically defined a triangular pyramid of four equilateral triangles : they are always fmall, diffinct, regular, and of the higheft polifh; are very common, and as commonly overlooked by the fuperficial observer. The third is a perfect brass coloured Ore, which rifes in great quantities, and is reckoned the beft colour of any for its continuance in the Mine : when this comes up in plenty, the Miners pleafe themfelves with the fight of it for that reafon, although the value may be not more than from f_{7} to f_{10} # ton. This coloured Ore feldom rifes before the vein is funk fifty fathoms deep, or at leaft not in great heaps; the richer or more inconftant Ores being superincumbent. But the fourth and deepeft Copper Ore is of a pale yellow, pretty much corrupted with Mundick, and of an inferior price, being from £4 to £6 \$ ton. The superior quantity, however, recompences for its quality and charges of dreffing; for it is not uncommon

uncommon for fome of those Lodes to produce from 300 to 400 tons of Ore monthly. It is very probable, that the ancients meant this kind of Copper Ore, when they speak of their Native Brass. Our Miners express their sense of the folidity and richness of such a Lode, by faying, "She is as folid as a Brass pan:" and Sir John Pettus, in his Fleta Miner. fays, "Yellow Cop-" per, for diffinction, is properly called Brass in the Stone."

The immature poor Ores of Copper, are conflituted of Cryftal, (Spar) Earth, Vitriol, Sulphur, Lead, Black Jack, Mundick, &c. and are vulgarly diftinguifhed by the names of Goffany, Sparry, (Cryftal) Mundicky, Peachy, Flookany Lodes; according as thefe appearances may predominate in the Stone or Mineral Ore, of which in their proper places. Some authors call the Ore of Copper, Cadmia Nativa; and yellow, or mundicky Copper Ore, they call Pyrites Ærofus, and fometimes Chalcitis. The green fpume of Copper, like Verdigreafe, they term Chryfocolla, or Native Borax; and the blue coloured Spume, they call Cæruleum Montanum; and fometimes both by the names of Ærugo Æris, or Copper Ochres. (Pliny, Hill, Da Cofta.)

Copper is to be found in most countries: of late years, however, Cornwall has produced its portion equal to most of them, to the amount of thirty thousand tons of Ore in the year 1770; and for variety of colours none can exceed us.

By Chymiftry we know, that alkaline falts produce a blue colour with Copper, which is changed into green, as foon as any acid is added; and from thence the reafon is obvious, why a green colour may be found among calcareous Copper Ores, viz. when the vitriolick acid is in the neighbourhood of it. (Engeftrom's notes upon Cronftedt). These menstrua being differently qualified by one another, impart the grey, black, and peacock dyes; but when the menstrua are clear and forcible, they borrow from the Copper, and impart the most piercing tints to precious Stones, making the Lapis Lazuli, the Sapphire, Emerald, Amethyst, &c.

Copper Ores are vaftly different from Tin Ores; for the former are always vifible in the Stone, though much inferior in quantity of Metal to the latter, except fome of the grey Copper Ores, which contain as much Metal, as the beft of the Tin. By what we have heard of the Ores of other countries, we believe,

AND THEIR FLUXES.

believe, that those which we have in Cornwall are much poorer in kind, than any where elfe: perhaps, in other countries, the poor veins are neglected. This poverty of our Ores, as well as the waste they are so abundantly mixed with, is the source of infinite profit to the laborious inhabitants; as both fexes of all ages are employed in dreffing and cleansing them so as to be fit for fale.

Iron, Ferrum; Steel, Chalybs; is called Mars, and has fo great a conformity with Copper, as not to be eafily feparated when foldered together; whence arifes that reciprocal friendfhip, which the poets feign between Mars and Venus.

It is fometimes, but very rarely, found native, and is the product of moft countries. Cornwall has likewife her Lodes of Iron, fome of them rich and near the furface, but they are generally fmall; and the charcoal for fmelting of it is fcarce; at leaft it is more profitably ufed for melting of Stream Tin. Thefe reafons, with our vicinity to fundry feaport towns, where all forts of Iron are imported at firft hand, and our natural attachment to Tin and Copper Mining, have occafioned a neglect among us of working our Iron Lodes.

Iron Ore is vulgarly called Ruddle, Reddeng, Oker or Ochre, according to its varieties of colour : the reddeft fort of it is thought to be a kind of Red Chalk. Some is ftalactical, and called Brufh Ore; and fome is fine, foft, and earthy, and called Smit. But those which are mistaken by many for diftinct forts of Fossilis, are the Hæmatites, or Bloodstone; the Magnes, or Loadstone; the Smiris, or Emery; and Magnesia, or Manganese, &c. all which are feparate species of Iron Ore.

It is the hardeft, drieft, and moft difficult to fmelt, of all Metals, and will ignite a long time before it will flow; yet it is the only Ore that ftrikes fire with Flint. Malleable Iron is very difficult to be melted, without the addition of Antimony, or fome other fulphureous fubftance; it will not unite with Quickfilver in any wife; but is eafily corroded and acted upon by every fort of acid menftrua, and by moft if not all forts of Salts. This Metal, in the firft fmelting, is called Caft Iron, which is brittle; but is perfected by annealing it in the fire, and then by hammering of it, though gently at firft, when it becomes malleable. Steel is made of the beft and pureft Iron, by cementing it with the hoofs and horns of beafts, and fuch excrefcences, S

which contain a volatile animal Salt; and being fo cemented, they quench it in water, whereby its pores are fo greatly conftringed, that it immediately grows fo hard as to acquire the properties of Steel.

Of all the fubftances concurring to form the terreftrial globe, Iron feems to have the greateft ubiquity; as it is well known to enter into the composition of Earth, Stone, Plants, and Animals, fo truly, that from the afhes of either you may visibly and fensibly perceive its existence, even fo as to be discovered in various fecretions from human blood, in milk, urine, fat, &c. as may be proved by drawing a Loadstone (whose property it is to attract Iron only) over their calx, as or refiduum, when the Iron particles will be drawn out of them, and adhere to the Magnet.

Iron is the moft ufeful to human life : it is our defence and fecurity; and no arts or manufactories could exift without it. Navigation, trade, and commerce, would be at a ftand; and even the art of difcovering other Mines and Metals, could not be practifed without it : fo that this, which is confidered as the bafeft of Metals, is indifpenfably neceffary for all the various ufes of mankind. Befides the innumerable kinds of inftruments made of it, it furnifhes excellent remedies in many difeafes : by its figure and gravity with the human blood, it becomes a deobftruent and reftorative in cold and relaxed temperaments ; but in full and fanguine habits, it is inflamatory and dangerous, unlefs preceded by venefection and other evacuations.

Tin, Stannum; Jupiter. 30 in the Chaldee fignifies flime, mud, or dirt; and when the Phenicians came into Cornwall, and faw this Metal in its ancient flimy state, they called it, " The Mud :" from thence the name, Tin, (in Cornu-british Stean, in Latin Stannum) has proceeded, and is still continued. Some of the ancients called it Plumbum Album, White Lead, to diffinguish it, perhaps, from common Lead. It was by them called White Lead, from its colour and purity; but they did not know it to be, radically, another Metal. We find no Latin name in authors for the Ore of Tin; probably, becaufe the ancients were unacquainted with it as a Metal characteriftically diffinct from Lead. Neither do the Tinners or Miners call it Tin Ore; for they give it the name of Tin-ftuff, as it rifes out of the earth ; and they diftinguish it by feveral incidents which happen often to it, either from the Ores, or crude Minerals intermixing

AND THEIR FLUXES. 66

intermixing with or corrupting of it; as Pryany, Peachy, Goffany, or Mundicky Tin-ftuff: or elfe according to the degrees of finenefs, or fmallnefs, that it is brought to, by ftamping of it to a powder. Being pulverized fine, wafhed, and cleanfed, it then has the name of Black Tin; and is, therefore, fit to be fmelted into White Tin, or Metal. It does not acquire a real blacknefs by its pulverization, but is of various colours according to the colour of the ftuff with which it is principally mineralized : it moft commonly, however, partakes of a brownifh or dufky liver colour; and obtains the name of Black Tin, in contradiftinction to its metallick colour and properties.

The existence of native Tin remains a doubt among the curious, to this day; but I never heard one reason advanced, why it cannot exist. Although Tin is the lightest of all Metals, its Ore, when rich, is the heaviest of all metallick Ores; infomuch as sometimes to have a greater specifick gravity, than a piece of pure Tin of the same size: this is probably occasioned by the abundant quantity of Mundick with which it is combined.

The Ores of Tin may be generally claffed into Shode, Stream, and Bal or Mine Tin. The Shode is disjunct, and feattered to fome declined diftance from its parent Lode; and is pebbly, or fmoothly angular, of various fizes, from half an ounce to fome pounds weight. Stream Tin Ore is the fame as Shode, but fmaller fized, arenaceous, and in its ftate, is in the form of fmall pyramids of various planes, very broad at the bafe, and tapering to a point at the top. In polifh and colour, thefe grains, fo called, are gloffy jet black, refinous, or red, and are the pleudo garnet, ruby, topaz, &c. The largest fingle grain of Tin that we remember to have feen, is in the poffellion. of Mr. Giddy, Surgeon, in Penzance, which weighs two ounces, four pennyweights, and twenty-two grains. Stream Tin Ore, is the fmaller loofe particles of the Mineral, detached from the bryle or backs of fundry Lodes, which are fituated on hilly grounds, and carried down from thence by the retiring waters of the diluvium, or floods of fubfequent dates, being collected in large bodies or heaps, in the valleys. In the folid rock of the valley, there is no Tin Ore; but immediately upon it, is deposited a layer of Stream Tin of various thickness; perhaps over that, a layer of earth, clay, gravel, &c. and upon that again another ftratum of Tin Ore; and fo on fucceffively, ftratum fuper stratum, according to their gravity, and the different periods

periods of their coming thither, to the depth of eighteen feet at a medium in St. Auftell Moor. In St. Blazey Moor, at the depth of twenty feet, they have what they call Stream (Tin Ore) about five feet in thickness in the bottom, great part of which had been anciently wrought before Iron tools were known, feveral wooden pick-axes of oak, holm, and box, having been lately found therein. Over this they have a complete stratum of black mud, fit for burning; on this a stratum of gravel, very poor in Tin; on this another stratum of mud; and uppermost gravel again.

Bal or Mine Tin Ore, frequently rifes very rich; and inftances are plenty, where it has been difcovered in the richeft and pureft ftate imaginable. Under fuch circumftances, it has been carried to the fmelting-houfe, as it came out of the earth, and the proprietors have received ten parts in twenty of it in Metal, the fimelter having taken to himfelf perhaps one part more for his expence and profit. Polberou in St. Agnes, which belongs to the Donnithorne family, produced great quantities formerly. In the year 1750 it is faid, one rock of Tin from that Mine, weighed 1200 pounds, and produced one half in Metal, clear of all expence to the owner, who gained £100 Ψ diem for fome confiderable time.

I observe that this kind of rich Tin Ore, which confists of the blackeft grains or Cryftals, is usually found at a moderate depth, or within the day fide of forty fathoms. Grouan Lodes; fo called from their participation of the nature of the adjunct and incumbent strata, do most usually produce those very rich Cryftals. But a lofty folid unformed Tin Ore, is commonly the production of all kinds of ftrata; and, according to my observation, is in itself more independent of any contingent influence. I have feen the fame folid lumps of black and dufky liver coloured Tin Ore arife equally alike in form, colour, and appearance, from Lodes in Grouan, Moorftone, Ironftone, Kellas, or Cryftal ftrata. Goffan never exhibits a rich fhew of Tin Ore; for it is in that nidus more diffeminate and minute. It feldom continues in Goffan, above thirty fathoms from grafs. But if we defcend from the loftiness of Tin Ore before described, we may find it, although invifible to the inexperienced Miner, very rich and fmall grained; in which pofiture it is fcarcely known, but by the exceeding gravity of the Stone in which it is enfhrined, and the different colour thereof from the adjacent strata. Sometimes it is in blue, gray, black, or brown coloured Lode-ftones,

AND THEIR FLUXES. 69

Lode-ftones, extremely fmall; fometimes veined in the Stones, and branchy throughout the Lode, whereby it may be feparated and forted as it rifes, to the faving of much expence in dreffing : in other places it may be priany, peachy, flookany, or mundicky, with which it may be either very prevalent or fcanty; but in the latter, and where Copper participates, it must be well burnt before the true value of it can be known.

This Metal feems to be earthy and very fulphureous; almost foft and pliable as Lead, but more white and beautiful. Bend a piece of pure Tin, or bite it hard, and it will give a crafhing noife or ftridor; but its purity is beft known by obferving the whitenefs or delicacy of its grain, when broke off fhort. Tin, like Lead, is more eafily diffolved in a weak acid menftruum, than in a ftrong one. It may be eafily amalgamated with Quickfilver, and melts almost as readily as Lead ; therefore, it will not bear ignition. It is not naturally very fonorous; but becomes fo, when properly commixt with Copper. It will not eafily endure the teft by fire; for as foon as the heat becomes violent it affumes the form of a ftubborn afh or calx, which foon lofes its fluidity, and is changed into a powder called Putty; which powder is alfo made by calcination of Tin, but is reducible into Tin again by melting with a proper flux.

Befides its ufefulnefs in utenfils per fe, it is also neceffary for covering the infide of Copper, Brafs, and Iron veffels, to preferve them wholfome for culinary uses; whence there is a large confumption for tinning Brafs ware and the like : it is ufcful alfo in foldering; but I believe the compound Metal of Pewter, of which it is the principal ingredient, is preferable for that purpose. Befides its domeftick uses, it is a necessary article, when diffolved in Aqua Fortis, for the new fcarlet or Bow die. And if I am rightly informed, our most beautiful and lasting coloured fine cloths owe their fuperlative excellency to the retentivenels given by our finest grain Tin; infomuch, that the English superfine broad cloths, dyed in grain by the help of this ingredient, are become famous in all markets of the known world.

It is more than probable, that the purple die of the Tyrians gained the very great reputation it had among the ancients, in great part, if not wholly, from their use of our Tin in the compofition of their die stuff, as the Tin trade was folely in their own T management

management and direction. I think the known facts of its being their monopoly, the exceeding ufefulnefs of it as one of the non-colouring retentive ingredients, and the fame in all parts of the world of the unfading colour of that purple which is fuppofed to be given by the juice or faliva of a certain fhell fifh called Purpura, do very much preponderate towards my conjecture.

We may be certain, that almost the fole traffick to this island four and twenty centuries ago, was for this Metal; and we have before observed, that in those very early ages, our Tin was fold to the Phenicians, who (like the present Hollanders, the grand carriers of Europe) transported the commodity in their bottoms to all foreign parts. " Tyrus, O thou that art fituate at the " entry of the fea, which art a merchant of the people for " many isles." (Ezekiel).

Jefus the fon of Sirach, the author of Ecclefiafticus, lived 247 years before Chrift. In fpeaking of Solomon's glory, chap. xlvii. verf. 18, he fays, " By the name of the Lord God, " which is called the Lord God of Ifrael, thou didft gather "Gold as Tin, and didft multiply Silver as Lead." Which fhews that Tin in those days, viz. 247 years before Chrift, was exceedingly plenty in the Holy Land. And it is remarkable, that Tin and Lead in this place, are both mentioned, and diftinguished; fo that the latter cannot be taken or meant for the former, as they have been miftaken and confounded together for one Metal by others, though characteriftically different. By the fhips Solomon fent out, he had a return in one voyage only, of no lefs than 420 talents of Gold; therefore it is expreffed, I Kings x. 27. " Money was in Jerufalem as Stones " for plenty." How vaftly plentifull muft Tin have been then in Jerufalem, to be fpoken of in the above figurative way?

We cannot, however, fay politively, that no other country produced this Metal in those days; but if it was then known in other nations, it was very little fought after, and was effimated as a ftaple by no country except Cornwall. Pliny fays, it was found in Gallicia and Lusitania, but not at a depth or in quantity to merit much attention. A Tinner, in the time of Richard earl of Cornwall and king of the Romans, upon some difgust at home, went over to Saxony, and taught the natives to feek for Tin, and render it merchantable : they have to this this day fome workings for Tin, though of no further account, than for their own confumption. Alonzo Barba, fays, that they had rich veins of Tin at Oruro and Potofi; but their vicinity to fuch immenfe Mines of Silver, is the reafon of their being never worked to any purpofe. A great deal of Tin has been imported into Europe thefe latter years from the Moluccas, fome bars of which the writer has feen equal to the beft Cornifh Grain Tin.

Of the Strata of the Barth, and the Fiffures in which Meeds are found, their Direction, Inclination, or Underlie

B F O R E was diffeover the receffer of our Metals and Manufedge and acquaintance with the circumjacant Strate, which enalofe the objects of our enquiry: purfuant, therefore, to the plan of a late ingenious author, upon our entrance on the fobject before us, we will examine the fuell firft, and then confider the kernel.

The Strata of different countries are various; and from exquiry 1, comot find that they are influenced by the atmosphere of climaterian any degree; and they are not only various, but alternate an their extent, breadth, and depth, in all parts of the world. In the Mining countries, they are found of different dentities and gravity, Stratum fuper Stratum throughout; franbard, fime foft, then hard and foft again. Thus we may find uppermoft, a Stratum of Granite, or Moorfcare-rock; then a folice thranite, called Grouge; now Kelles; and for any the contact of the grand any is. Half a mile diffant, the layers of Rock or Stone will be altogether changed in their politions are complexions; whereby its altogether changed in their politions before the induction of meeting wills this or that Stratum before the induction of meeting wills this or that stratum before the induction of meeting wills this or that stratum.

I finall not attempt to defenile all the Struta that are to be not with; but that confine invict to Coniwall, and even the save of it which is difficled for Metal, within compare of m $X_{11} O = O = B$ firstion.

The general law of attraction evidently appears in the diffribution of our Strata; and their specifick gravities form notes determine them for much as might be expected : whenever may

AND THEIR FLUXES.

this day fome workings for Tin, though of an further account, than for their own conjumption. Alonso Earba, days, that

fonce hars of which the writer has from equal to the beft Countly. Grain Tin. I. . I. . I. A H J

Of the Strata of the Earth, and the Fiffures in which Metals are found, their Direction, Inclination, or Underlie.

B E F O R E we difcover the receffes of our Metals and Minerals, it will be convenient for the reader to have fome knowledge and acquaintance with the circumjacent Strata, which enclose the objects of our enquiry: purfuant, therefore, to the plan of a late ingenious author, upon our entrance on the fubject before us, we will examine the shell first, and then confider the kernel.

The Strata of different countries are various; and from enquiry I cannot find that they are influenced by the atmosphere or climate in any degree: and they are not only various, but alternate in their extent, breadth, and depth, in all parts of the world. In the Mining countries, they are found of different densities and gravity, Stratum fuper Stratum throughout; fome hard, fome foft, then hard and foft again. Thus we may find uppermost, a Stratum of Granite, or Moorstone-rock; then a foster Granite, called Grouan; now Kellas; and fo on, to the concave of the grand abyfs. Half a mile distant, the layers of Rock or Stone will be altogether changed in their positions or complexions; whereby no abfolute rule can be formed, to decide upon the certainty of meeting with this or that Stratum, before the industrious Miner has laid them open to view.

I fhall not attempt to defcribe all the Strata that are to be met with; but fhall confine myfelf to Cornwall, and even that part of it which is difpofed for Metal, within compass of my own perfonal infpection.

The general law of attraction evidently appears in the diftribution of our Strata; and their fpecifick gravities feem not to determine them fo much as might be expected : whence we may

may argue, that when folids and fluids formed, (and from a ftate of chaos became divided into diffinct bodies) the parts of the former being deferted by the latter, must needs grow closer together. But the maffes of Earth, Stone, and Clay, were not at this time merely paffive ; they formed larger and more compact bodies, every where, according to the mutual attraction of their fimilar parts within proper diffance. It must be further observed, that as all similar parts struggled to come into contact with each other, fo at the fame time they deferted, repelled, and expressed all diffimilar and contending particles; confequently, maffes of different natured particles, feceded and fled from each other, every party (if I may be allowed the expreffion) tending to unite and combine with its like. Dr. Worthington, in his Scripture Theory of the Earth, fays, " All matter gravitates towards all matter; fo all homogeneous " parts of matter gravitate still more powerfully towards each " other, whereby they are more closely united and compacted " together, according to their specifick textures. Each there-" fore will affort themfelves, and affemble with their kinds " respectively." These causes then, viz. the desertion of moifture, the union of fimilar, and the mutual repulse of diffimilar particles, must all have contributed to form the masses of our terraqueous globe into fuch separate portions as we now find them in. This accounts for the diverse distribution of our Strata, which by this theory will not be founded upon chance or cafualty, as was the cafe by Mr. Hawkfbee's return to the Philofophical Society in the year 1712, when he bored to the depth of thirty Strata of a coal pit.

However, in the natural class and order of our Strata, I shall make my observations in proportion to their hardness and solidity, beginning with the tenderest first.

Soft Grouan, though a Stratum, can fcarcely be called a Stone; for it is rather a fandy or priany Stratum of Moorftone gravel, not cemented together, but lax, arenaceous, and mixed with difperfed Stones of Granite. It generally lies at the extremities of the Moorftone Stratum, or hard Grouan. In fome places it is fo fair or foft, as to run out againft the workmen, and requires a great deal of timber to fecure it; but notwithftanding this, it enclofes numbers of Tin Lodes of confiderable value in the parifhes of Wendron, Camborn, Crowan, Redruth, Gwenap, Illugan, &c.

on the Culm wing in Wales. It fornet mes runs in a direct

Slate

OF STRATA, AND FISSURES,

Slate is common to many parts of our county; but, in quality of Slate, is not difpofed to fecerne Mineral juices, although fome thin efflorefcencies of Mundick have been feen on the edges of the famous Delabole Slate-ftones. The Slate, or Shelfy-ftone, is always uppermoft next the loamy foil; but, in depth, it enters into the nature and confiftence of real Killas.

Of Killas I have observed fix forts common to us, the white, the red, the yellow, the brown, the cinereous or bluifh, and the deep blue. The first is very white and tender, and from its exceeding tenderness is called Fair Ground; it requires much timber and boards for binding, and fecuring it from filling the Mine, and endangering the workmen's lives. The red is not fo fair, but is well disposed for Copper, or Tin Lodes; the latter preferably. The yellow is but indifferently disposed for either. The brown, which has various fhades of lighter and deeper colours, is generally a hard Stone, and contains Lodes of Tin more commonly than Copper. But of all the Killas, the cinereous or pale blue is most defirable, as the enclosing Stratum of a Copper Lode. We find it the most common and agreeable cheft that encloses our cabinets of jewels. Conftant experience will incline us to give this Stratum the preference to all others for Copper Mines, on account of its generally accompanying a rich Mine; and becaufe it is tender and agreeable to work upon in the finking of fhafts and the driving of drifts or adits out of the Lode. It is this kind of Killas which we call Feafible Ground, i.e. to be eafily broken, and yet firm enough to fland without the fupport of binding with timber and boards. However this will oftentimes, by infenfible degrees, wear out as we call it, and become a deep blue, hard, unkindly, and coffly Killas, neither favourable to the Mine nor the labourer. It will require great addrefs, and much gunpowder fometimes, to break and make way through it. A Killas in its beft flate, is foft, tender, fleaky, and fatty; will cut to any form underground, and requires no timber; but if it is hard and untractable, and works in very fmall fhreds of Stone, it is unfavourable to work or enclose Metal.

Elvan, at a shallow level, is a gritty kind of Stone, most like a coarse Freestone, but in depth is exceeding hard. The two most common colours of this Stone are a bluish grey and a yellow Freestone. It commonly yields great quantities of water; and we take it to be of the fame kind with that Stone which lies on the Culm veins in Wales. It fometimes runs in a direction

AND THEIR DIRECTION, &c. 75

tion north, and fouth, contrary to the metallick veins, which generally keep their courfe through it, but the Lodes are frequently fqueezed up by its accompanying them fome length in their courfe, or are fplit into many fmall branches. Sometimes the Fiffures or Lodes are thrown flort on one fide, out of their direct courfe as it were, by the extreme hardnefs of this Stratum, and afterwards they recover their courfe again. At other times the metallick veins are elevated or deprefied by it, though they always recover their former direction, and unite again ; for this Stratum wears out at a great depth, and is fucceeded by Killas.

Moorftone or Granite. The name of Granite, which thefe Strata have univerfally obtained, is a modern name given them by the Italian writers, on account of their being concreted into grains, or in a granulous ftructure, and not compact and uniform as the Marbles, &c. are; thence Granita i. e. è granis compofita. The parts of Granite are not homogeneous, but are different concretions of Quartz and Micæ. The varieties are compofed of black and white Talc, a dead earth not unlike the white Boles or Pipe Clay, and true Gryftal.

We have five forts common to us, viz. the white, the dove coloured, the yellow, the red or Oriental Granite, and the black or true Cornifh N° 1 of Hill. Either of thefe as a Stratum, is called a Hard Grouan Country, (in the Swedifh tongue Graberg, and Graften) and the two laft are frequently fo hard and invincible as to tire the patience and pocket of the adventurers, and the labour of the workmen. Grouan Strata are difpofed for Tin, which in fuch fituations is generally of a rich quality, or cannot long be fought after or wrought in its almoft impregnable walls. They are feldom likely for Copper Ore; and were long thought to be wholly adverfe to that Mineral, till the great Mine of Trefavean proved that rule exceptionable.

The Ire-ftone, or Iron-ftone, is by much the hardeft of all Strata, and borrows this name from its extreme hardnefs, and not becaufe it contains Iron. It is of a dark bluifh colour, like Lead that has been long exposed to the weather; and usually fo hard, that it must be wrought with Steel borers, and then blown by gunpowder. It often keeps a courfe east and west like a Lode, but is commonly very wide; and therefore it is very tedious and chargeable, where an adit must be driven acrois through it. It is this Stratum that is uppermost through great part

OF STRATA, AND FISSURES,

part of the middle of Camborn and Illugan parifhes, where many principal Copper Mines are enclosed in it. Tin Lodes are very feldom found in Ire-ftone, but very rich Copper Lodes in many places are natural to this Stratum or country. We do not observe that it ever gets into the Lodes themselves, although there are fome dark hard peachy Stones very like it in fome Lodes. The author of a familiar difcourfe concerning the Mine adventure, fays, " It is a conftant observation amongst all " Miners, that the harder the rock, the richer the Mine; na-" ture generally makes the cafe ftronger or weaker, according " to the richnefs of the treafure therein contained : for where-" ever the fides of a vein are cracked and broken, the mineral " water that feeds the vein, runs off, and the vein proves dead " or very poor : but when the fides of a vein are folid and firm " without cracks, the mineral feeder impregnates and enriches " the Mine, and the fame proves quick and rich in Ore." This cannot be a general rule, for our theory and observation prove its falfity. It cannot depend upon the confinement of mineral water in one particular place, that a Lode shall be rich in Metal, fo much as upon the ftrength and peculiar attraction of the nidus through which it circulates; for we conceive the attraction to be inftantaneous : therefore, water charged with mineral falts or particles continually paffing through a vein, will more abundantly impregnate that vein, than if its principles are decomposed, and the water is left pure and unmixed. This is the reafoning of most experienced Miners; for when a rich Lode of Copper, &c. is cut with abundance of water following the difcovery, they always declare, " It is a very promifing " circumftance."

The foregoing Strata are only common to Tin and Copper Lodes in this county, and if we have not fpecified more which may be thought of by the difcerning Miner, we will neverthelefs take upon us to fay, any others that may be mentioned will only prove to be varieties of fome of thefe. We cannot learn, that there are either Chalk, Marble, or Limeftone, in any part of our mining Strata; confequently real Spar is foreign to our country.

Now when the general affimilation of kindred particles happened, and folid bodies were feparated from fluid; between the diffimilar, certain cracks, chinks, and Fiffures, in various directions and contortions, were effected at their extreme angles; but as the matter of each Stratum became more compact and denfe

denfe by the defertion of moifture, each Stratum within itfelf had its Fiffures likewife, which for the moft part being influenced by peculiar diftinct laws, were either perpendicular, horizontal, or oblique; but at the angles of different Strata, were fhattered, ragged, and in all directions. "Linnæus wonders at "the nature of that force, which fplit the rocks into thofe "cracks; but probably the caufe is very familiar; they were "formed moift, and cracked in drying." (Hill). This may account for the roughnefs or fmoothnefs of the walls of fome Lodes. But whether this theory is difputable or not, we are neverthelefs certain, that cracks, or Fiffures, are abundant in all parts of fubterranean matter; and likewife that thofe very Fiffures are the wombs or receptacles of all Metals, and moft Minerals.

The comparative fmallness of the largest Fiffures to the bulk of the whole earth, is really wonderful. In the fineft pottery we can make, by a microfcopick view, we may difcover numerous cracks and Fiffures fo fmall, as to be impenetrable to any fluid, and impervious to the natural optick : therefore if a globe of earth, whole circumference is 24,000 miles, is only fplit into the very fmall comparative clefts we behold, how wife and good muft that Creator be who hath fo contrived by his laws of attraction, repulsion, and gravity, to fix and fettle the limits of his creation within their juft and proper bounds ! No ; the great Architect, who contrived the whole, determined the feveral parts of his fcheme, fo to operate, as that one ufeful effect fhould become the beneficial caufe of another. God provided for the uses of things in his first ideal disposition of them; and their respective beneficial uses flowed naturally from each other, thus aptly disposed. Hence it happens, that matter could not contract itfelf into folid large maffes, without leaving Fiffures between them; and yet the very Fiffures are as neceffary and useful as the Strata through which they pass. They are the drains that carry off the redundant moifture from the earth, which, but for them, would be too full of fens and bogs for animals to live or plants to thrive on. In these Fiffures, the feveral ingredients which form Lodes, by the continual paffing of waters and the menstrua of Metals, are educed out of the adjacent Strata, collected and conveniently lodged in a narrow channel much to the advantage of those who fearch for and purfue them ; for if Metals and Minerals were more difperfed, and fcattered thinly in the body of the Strata, the trouble of finding and getting at Metals (those necessary instruments of art and

78 OF STRATA, AND FISSURES,

and commerce and the ornaments of life) would be endlefs, and the expence of procuring exceed the value of the acquifition.

" Thefe Fiffures," fays Agricola de Ortu, &c. " were the " channels through which the waters retired at the time of the " creation into the ocean, when the dry land made its first ap-" pearance :" and Woodward in his Nat. Hift. thinks they are breaches made in the Strata by the retiring waters of the deluge, prior to which æra (according to his hypothefis) there could be neither Fiffure nor Lode. The opinion of the former is eafily refuted; for the walls of the Fiffures in fome places are too hard to be overcome, and to yield to the power of any current of water; and in other places too fair and tender to endure the force of fuch a torrent : befides, their east and west direction, have not that tendency, in our parts, to difcharge into the ocean, as they might feem to fhow, if their courfes made for St. George's channel in the north, and the British channel in the fouth. With regard to the latter opinion, our Shodes will notorioufly evince the miftake; as the Fiffure must be antecedent to the matter of its contents, whofe Shodes, it is generally believed, were feparated from the fuperior part of the Lode by the retiring diluvium.

The infide of those Fiffures are commonly glidered or coated over with a hard, cryftalline, earthy fubftance or rind, which very often in breaking of hard Ore comes off with it, and is vulgarly called the Caples or Walls of the Lode : but I take it the proper walls of the Lode are the fides of the Fiffure itfelf. and not this coat, which is the natural plaifter upon those walls. furnished perhaps by the contents of the Fiffures, or from oozings of the environing Strata. We can prefently fee the breadth of a Lode or of a branch, by the incrufted fides of the Stones of Ore, if brought whole to grafs, although we were never under-ground to take the measure of it; therefore it is common to fay, " I perceive the breadth of this or that Lode, " to be fo many inches wide; becaufe here are the fmooth " walls or caples affixed to and broke off with the Stones of " Ore." But this can be only in fmall Lodes, and hard Strata, where the Lode breaks stoney. If a Lode is inclinable to yield any fort of Ore, it is the more promifing provided the caples or walls of the Lode are regular and fmooth, or at leaft if one of them is fo; but if they are uneven and rugged, it is the lefs encouraging. There are, however, but few Lodes or Fiffures that make regular walls, until they are funk on a few fathoms. DITE Thus,

Thus, the medullary or inner part of a Fiffure, in which the Ore lies, is all the way environed and bounded by two walls or coats of Stone, which are generally parallel to each other, and include the breadth of the vein or Lode; fo that when the Miners dig down or along in a large Lode, then the roof, i. e. the upper, the hanging wall, or incumbent wall of the Lode or Fiffure, is (in a certain proportion according to its inclination or underlie) over their heads; and the lower, or other wall or rind, is under their feet : and further, whatever angle of inclination fome Fiffures make at first in the firm folid Strata, they feldom vary from the fame in depth : there are, however, fome exceptions to this rule. Some Fiffures are very uncertain and different in fize; for they may be very fmall near the furface, or very wide in depth, and vice verfa; but as to the regular breadth or largeness of Lodes in their length or direction, they generally make a great variation; for although a Fiffure may be many fathoms wide in one particular place, yet, a little further east or west, it may not perhaps be an inch wide.

This variation may happen from feveral caufes, but more efpecially in very compact Strata, when the Lode or Fiffure is fqueezed, as it were, through means of hard rocks, which feem to comprefs and ftraiten the Fiffure. However, a true Lode, Courfe, or Fiffure, is never entirely cut out or deftroyed by hard rocks or Strata; for the Fiffure always continues through the hardnefs, yielding a rib or ftring of metallick Ore, or elfe of a veiny fubftance; which often ferves for a leader for the Miners to follow, until it fometimes brings them again to a large and rich part of the impregnated Fiffure : all which variety of fize in the length, breadth, and depth of Fiffures, fhews that they are the immechanical operations of nature, to fix and fettle different congeries of mixed bodies into their peculiar fhapes and pofitions.

As to the length and depth of Fiffures, perhaps they feldom admit of any period or limitation; for none can tell how long or how deep they reach: but in regard of their breadth, thicknefs, width, or largenefs, they are limited and various. Though the depth of Fiffures is unlimited beyond the power of man to follow after, yet it appears in general, that their fruitfulnefs for Metal is diftinct and limited. The richeft flate for Copper is between forty and eighty fathoms deep, and for Tin between twenty and fixty; and though a great quantity may be raifed of either at fourfcore

OF STRATA, AND FISSURES,

80

er, and

fourfcore or one hundred fathoms, yet the quality is often decayed and dry for Metal.

The Fiffures then of Cornwall, which are productive of Metals and Minerals in their progrefs or direction, are extended eaft and weft; or, more properly fpeaking, one end or part of the Fiffure points and runs weft and by fouth, or elfe weft and by north, or thereabout; and the other end looks or tends eaft and by fouth, or eaft and by north : and thus they often pafs through a confiderable tract of country, with little or no variation in their directions, except they are obftructed by fome intervening caufe; of which hereafter, when we come to fpeak of the interruption of Lodes, &c. Henceforward we fhall not always take notice of their deviation from the cardinal points of the compafs; but, for the moft part, fhall confider them as tending eaft and weft, as the only Fiffures which are filled with Tin and Copper Ores in Cornwall.

Befides this eaft and weft direction of Fiffures, there is yet another of a contrary manner and tendency, which the Miners properly name, the underlying of the Lode, or the Hade. This is the deflection or deviation of the Fiffure from its perpendicular line, as it is followed in depth like the flope of the roof of a houfe, or the defcent of the fide of a fteep hill. Inftead of its tending directly downwards to the center of the earth, it inclines either to the north or the fouth, or nearly fo. Suppose, for inftance, one fide of the roof of a church to be a Lode bared of its incumbent Strata : the length of it east and west, will shew what I mean, by the direction of the Lode or Fiffure; and the flope or fide will explain its inclination or tendency downward ; that is, the north fide of the roof underlies north, and the fouth fide underlies fouth : fo that if a Miner should dig down perpendicularly where he first began, or cut the Lode, then it would foon be gone away from him, either to the north or to the fouth : therefore, when it happens thus, they are often obliged to fink new fhafts or pits on the underlie or inclination of the Lode, to cut it in depth, for the eafe and conveniency of winding or drawing up the water and Ore in a perpendicular line. This underlying varies much in different Lodes, and fometimes also in the fame Lode; for it will often flope or underlie a fmall portion different ways, as hard Strata on either fide may feem to force it. Some Fiffures do not alter much from a perpendicular; and fome do underlie a fathom in a fathom; that is, for every fathom which they go down in depth, they are

are also gone a fathom further to the fouth or to the north, which ever way the inclination or underlie may be. Other Fiffures, again, underlie fo faft, or obliquely, that they differ not much from an horizontal polition, and they are thence called Flat Lodes, or Lode Plots. There is another fort of Flat Lode or Lode Plot, which underlies irregularly with refpect to other Lodes or Fiffures; for this underlies or widens horizontally for a little way, and then goes down perpendicularly not unlike ftairs, with only a fmall ftring or leader to follow after; and thus they alternately vary, and yield Ore in feveral flat or horizontal Fiffures. Yet this kind of Fiffure is very rarely met with, and is wrongly called by the Tinners, a Floor or a Squat, which properly fpeaking is a hole or chafm impregnated with Metal, that makes no continued line of direction, or regular walls; nor yet goes down any confiderable depth; for when a Floor of Ore of this fort is dug away, there appears no footftep or fign of a vein or Fiffure, either under foot, or pointing or leading any where elfe. Alonzo Barba, in the Spanish tongue, calls it a Sombrero, which fignifies a Hat or a Heaped Mine, where Metal is found in a heap together. In Cornwall, they call it a Bunny of Ore or Tin; and fometimes " The Pride of " the Country ;" which laft epithet we apprehend more properly belongs to the Bryle or loofe fhattery back of a Lode, when it is very rich for Tin or Copper, immediately to the day or furface. Inftances of Bunnys of Ore are very rare with us. We have heard of fuch among the Tin Mines in St. Juft, near the Land's End; and that there are feveral fuch chafms, impregnated with Copper or Lead, in Wales and the north of England, where they are called Pipes of Ore. In the latter we have been informed of a Pipe of Copper Ore, called Eaton Mine, which is two hundred fathoms deep, the Sough or Adit being one hundred fathoms below the furface. When those Pipes are exhaufted, if they find water come in upon them, they work to meet it, without regarding what point of the compass it flows from; and this oftentimes leads them to another Pipe or Bunny of Ore. Likewife, if a few Stones of Tin are found difperfed in our foft Grouan Stratum, by properly remarking the tendency of these Stones, and where the heaviest part of them points, it may be nearly gueffed how far off another little Pipe or Bunny of Ore may be; or, at leaft, they will bring you to what is more natural, a true Lode, as we every day experience in our difcoveries of Tin Lodes by Shodeing, as will be hereafter defcribed.

After

82 OF STRATA, AND FISSURES,

After all; the Fifures which are common to us, are the perpendicular, and the inclined, let their direction be either north and fouth, or eaft and weft. Be they impregnated with Metal, or quite barren and void of Ore, they are ufually fuch as we have above defcribed; and when any Floor, Pipe, or Bunny of Ore is met with, we look upon it as a very uncommon difpofition of Metals in Cornwall.

Perpendicular and horizontal Fiffures, probably remain little altered from their first position, when they were originally formed at the induration of Strata immediately after the waters deferted the land. Refpecting the former, we find them more commonly fituate in level ground, and at a diffance from hills, or the fea fhore, where the Strata might make lefs refiftance to fecondary accidents. But with regard to the latter, we find that the upper and under maffes of Strata, are different in their folidity, and other properties; whence their formation, purfuant to their diffinct and natural efforts to join each with its like, and to separate from those which are unlike. Hence it is very apparent to us, that inclined Fiffures owe their deflection or underlie, to fome fecondary caufe, violence, or fubfidence of the earth : for though perpendicular Fiffures are feldom feen, yet the inclined at a very confiderable depth become more downright, the central Strata being not fo liable to be wrefted from their primary polition, as those more near to the furface, on the fides of hills, and the cliffs of the fea fhore, of vallies, and of rivers. It is more than probable, that fundry and diverfe agitations and fubfidencies have been effected fince the creation, nay even in our own time and knowledge; which could not but influence, in various degrees, all the adjoining Strata, and their Fiffures or Lodes.

Fiffures are not only inclined but fractured; which fracture muft have been the effect of violence. The inclination alfo muft have been the effect of force, though, in many inftances, that force only bent, and did not proceed to that degree of violence, as to break it flort off, but only to occafion what we call the underlie of the Lode. Now if we can difcover the probable caufe of the inclination or underlie of Fiffures, the fame caufe, allowing it but a greater impetus, will account for that fracture which we call a flide or a heave.

Betwixt the underlie of Fiffures, and the dippings of the adjoining Strata, there is oftentimes fo manifest an agreement and

and correspondence, that whatever occasioned the latter could not but produce the former. Let us first note the dippings of the Strata; for if they have also been wrefted, their Fiffures, or the Lodes contained in them, could not have preferved their station. The original polition of Strata must have been horizontal or parallel to the furface of the earth ; but we often find those Strata very fensibly declined from that first position; nay fometimes quite reverfed and changed into perpendicular. When we fee a wall lean, we immediately conclude that the foundation has given way, according to the angles which the wall makes with the horizon; and when we find the like declination in Strata, I should think we may conclude, by parity of reafon, that there has been a like failure of what supported them, in proportion to that declination; or that whatever made the Strata to fall fo much awry, must also cause every thing included in those Strata to fall proportionably. Wherever the greatest fubfidence is to the north, the top of the Lode or Fiffure will point to the north, and in confequence underlie to the fouth; and vice verfa; the flide or heave of the Lode manifefts the greater fubfidence of the Strata, but the fame Lode is frequently fractured and heaved in feveral places : all of which, by due obfervation, will fhew us, they were occafioned by fo many feveral fucceffive flocks or fubfidencies; and that the Strata were not unfooted, fhaken, or brought to fall once only, or twice, but feveral times. (For uncommon fubfidencies of the earth, fee Philos. Transact. 337. 349. and 405.)

The caufe of the underlie, interruption, or fracture of our Lodes or Fiffures, being given, it remains to account in fome meafure for the caufe of those subfidencies, which is the efficient Aristotelian "id unde," from which the others originate.

When the Almighty Architect, in his infinite wifdom, forefaw the neceffity and ufefulnefs of mountains and vallies, he fuffered the more lax and weaker Strata to fink into the abyfs, either totally as in the depths of the ocean, or partially as in coombs, dales, and vallies; and the more compact and ftony Strata were left to form the mountains and hilly parts of the land. It muft neceffarily follow that when those fubfidencies happened, the adjunct Strata muft have been proportionably affected, and likewife their Fiffures; hence fo manifeft a relation in the Strata and their Lodes in many places, to these first and principal depressions.

The

OF STRATA, AND FISSURES,

The encroachments of the fea from time to time, by its fluctuating pervading ebb and flow, hath fearched out, and carried off many of the laxer fubftances between the Strata; nay it hath even, by its own force and violence, deftroyed large portions of folid rocks and cliffs, which is well known by every perfon acquainted with the fea fhore : thefe, together with the larger fubmarine gulphs or fwallets, cannot but influence the maritime Strata, and produce fecondary fubfidencies of the earth ; to which we may afcribe thofe contrary and irregular underlies of Fiffures with us, who are fo narrowly fituated between the two channels, and whofe Lodes are remarkably difforted thereby in the parifh of St. Agnes, and elfewhere on the fea coafts.

One more effective caufe of the diflocation of Lodes, is that of the general deluge; which deluge, in the parish before mentioned, is evidenced not only in the multiform fractures and interruptions of the Lodes, but in the diffinct and folitary mountain, called St. Agnes Beacon, in the proper British dialect, Carne Bury-anacht, or Bury-anack, the Still Spar-ftone Grave ; where, fuitable to the name, on the natural remote eminencies thereof are raifed three Quartz-ftone Tumuli. The natural circumftances of this mountain are worthy the confideration of a philosopher: for though it is a very high mountain, abutting on the Irifh fea or St. George's channel, and rifing pyramidally from the fame at leaft five hundred and forty feet above the fea, yet on the top thereof, under those Tumuli, is difcovered by the Tinners five feet deep good arable, land or earth; under that, for fix feet deep more, is a fine fort of white and yellow clay, of which tobacco pipes have been made; and beneath this clay is a Stratum, or layer of fea fand, and fmooth beach pebbles. Two or three hundred fathoms from the fea, and about eighty fathoms above it, under this fand, is to be feen for five feet deep nothing but fuch beach Stones, as are ufually washed on the fea shore, and in many of them grains of Tin: under those Stones, the foil or matter of the earth for fix feet deep; and under that appears again the firm rock, through which Tin Lodes have been wrought at fifty, fixty, or feventy fathoms deep.

It would be needlefs and impertinent to enter here upon a difquifition into the univerfality of the deluge, and the natural means the Almighty ufed to produce fo unparalleled an event: the greatest naturalists and philosophers have given different and

AND THEIR DIRECTION, &c.

and contradictory folutions of it. I beg leave, however, to obferve, that we are fupplied with innumerable evidences of this grand phenomenon; and notwithftanding we have no exuviæ of land or fea animals buried in our Strata, yet this mountain, of which we have just fpoken and given the particular circumftances of its fite and contents, is at once a production and an irrefragable proof of Noah's flood.

It is agreed by moft naturalifts, that fome parts of the prefent dry land were, before the flood, part of the ocean's bed; among which, I fuppofe, the top of this mountain was placed, till the Almighty caufe moved upon the furface of the waters, and directed the bottom of the fea to inflate and elevate the mountains of the deep, and thereby diffufe its waters, and level the furface of this earth. But when the vengeance of Omnipotence was finifhed, he commanded the fea and the waters to retire into their former refervoir; whereby the land appeared again, though not uniformly the fame as it was before; neither was it neceffary it fhould be fo, fo long as it was fufficient for all the purpofes of life. At the fame time, the Father of Mercies left thofe remains of his power and juffice, to convince us by nature, as well as revelation, that he is able to do all things.

If we may have credit for this hypothefis, we are to believe alfo, that fome parts of the elevated deep returned to their firft flations, and that others remained and became the prefent dry land, which was before the bottom of the fea; whereby we prefume to account for the appearances under the furface of St. Agnes beacon, and those diffortions of the Strata, &c. in our parts, fome inclining one way, fome another, and fome quite reverfed. Neither will this elevation of the deep, and concomitant fubfidence of the land, appear unnatural to our idea of the matter, when we confider that the loftiest mountain upon the face of the earth, is not quite four miles in perpendicular height, which in fact amounts not to one fix thousandth part of its circumference; and bears not fo great a proportion to the bulk of the earth itself, as the little rifings on the coat of an orange bear to the bigness of that fruit.

There can be no doubt, that many alterations have happened to various parts of the earth, before, at, and after the flood, from inundations, earthquakes, and the diffolvent powers of fubterranean fire, and water; which variety of caufes and circumftances muft infallibly have produced many irregularities Z

86 OF STRATA AND FISSURES.

in the difpofition and fituation of circumjacent Strata and Lodes.

Having, as fuccinctly and clearly as I am able, delivered my own and other people's opinion upon thefe matters, I fhall, in the next place, proceed to examine the contents of those Fiffures and their properties; wherein a local and peculiar natural hiftory will be fo evident, that I fhall hold myfelf excufable to fyftematick naturalifts, if I appear to them irregular and immethodical in the manner which I shall take to purfue my fubject. As I have also shewn the cause, nature, and variations of the Fiffure, I shall in future make little use of that term; but in compliance with the cuftom of my country, Ihall indifcriminately call a Fiffure, or its contents, the Lode : for inftance, when I come particularly to define and defcribe the interruption and diforders of Lodes, I fhall fay that this or that Lode is heaved to the right, or to the left, up or down, by a crofs Lode, a Contra, a Goffan, a Slide, a Flookan, or the like, purfuant to the idiom of our Miners; without taking notice of the Strata, upon which fuch alterations of Fiffures and their veiny fubftances depend.

We have ventured to advance the foregoing hypothesis, as the most likely to account for those appearances which occur in the bowels of the earth; and we are not fingular in it, but are fupported by the concurrent opinion of fome very approved writers upon part of the fame fubject. And though we are fensible that fome objections may be ftarted against it; yet we can fearcely think, that those who may be most forward to deny it, are fupplied with one that will more rationally point out the causes of these appearances we speak of. As, however, we do not infiss upon the infallibility of our fentiments, we shall submit them to the naturaliss and philosopher with the greatest deference; and shall be extremely glad to find, in our own day, the errors of our theory rectified by some abler pen.

bus same, lo, vip with high sind C H A P.

orange bear to the bignels of that fruit.

We fhall divide Lodes which carry J

day or furface; but this more frequent in the latter, though of

. OF DIFFERENT LODES, AND THE

Of the different kinds of Lodes in refpect of the Earth and Stones they contain.

THE contents of our Fiffures are very complicated, and obtain their feveral diffinct appellations from the nature and appearance of the most predominant Earth, Clay, Stone, or Mineral, contained in them; without any respect to the metallick impregnations of Tin, Copper, or Lead, unless the Ores of those Metals are very rich, and more abundant, than all the other contents of their Fiffures. The fame Lode, at higher or inferior levels, shall be alternately named a Gosfan, Mundick, or Flookany Lode, pursuant to their predominancy at twenty, forty, or fixty fathoms depth; or any other intermediate level they may offer to the observation of the Miners. Upon this account, most Lodes take their names from the kind of Stone or Mineral they most abound with, which often participates very largely of the nature of the Strata enclosing them.

The generality of our Lodes are very different to the eye and in their impregnation, near the furface, from what we find them when deeply funk upon; and though it has been known, that the backs of fome few veins have proved very rich, yet they do not always hold Metal, and frequently they do not carry Tin or Copper Ore enough to pay the charge of drefling or cleanfing them: neverthelefs, in the finking upon fuch veins, we hope they will depart from their primary colour and appearance, and form large bodies of Tin or Copper Ore.

The flight metallick impregnations of our Lodes, which, efpecially in Copper, are generally obferved to fifteen, and even thirty fathoms deep, muft certainly arife from the fearcity of faline mineralick principles, which the water fo near the furface cannot be largely faturated with; and having lefs depth of Strata to receive the metallick folutions from, they of neceffity cannot be furnifhed with ftrong menftrua, to act upon the Lodes, or depofite themfelves. Although Mines are feldom difcovered rich upon the backs, we prefume for the reafons before given; yet experience will inform us, that they are fometimes well ftored with Copper and Tin Ores of the richeft quality near the day

88 OF DIFFERENT LODES, AND THE

day or furface; but this more frequent in the latter, though of no long continuance.

We fhall divide Lodes which carry Tin, Copper, and Lead, into twelve different kinds, in regard to their foreign Materials; and the removes visible in them, we fhall class into their proper fubdivisions. The Lodes are ranged in the following order :

| I. A. | Goffan Lode. | VII. A. | Cryftal Lode. |
|--------|--------------|---------|------------------|
| II. A | Peach Lode. | VIII. A | Killas Lode. |
| III. A | Scovan Lode. | IX. A | Mundick Lode. |
| IV. A | Caple Lode. | X. A | Black-Jack Lode. |
| V. A | Pryan Lode. | XI. A | Flookan Lode. |
| VI. A | Quartz Lode. | XII. A | Grouan Lode. |

I. Of all these Lodes, the Gossan is most common; and is ever disposed to yield Tin and Copper, if it runs east and west; but those of a contrary direction, in respect of those Metals, are strengthering and worthless. Gossan may not improperly be divided into five forts: viz. I. a Tender Red Gossan; 2. a Tender Brown Gossan; 3. a Dry Pale Yellow Gossan; 4. a Poor Tin Gossan; and 5. a Gal or Gally Gossan: all of which are ochreish substances, of a rust ferruginous complexion, being mostly Earth and Crystal coloured by Iron, with frequently no inconfiderable portion of that Metal.

1. The Tender Red Goffan is very much inclined to produce Copper Ore, efpecially if the Goffan be fpungy, cellular, and of a very red colour, like to a well burnt brick. When it is thus, and fpotted, or tinctured with green Copper Ore, like pieces of Verdigreafe, it does not often deceive the proprietors. So, likewife, Stones of blue or black Copper Ore, or of yellow Ore having a black or purple outfide, are very hopeful to follow when mixed in this Goffan. Yet the Ore in this nidus is bunchy and uncertain, till proved to fome tolerable depth. But if Stones of Lead Ore be found in this Goffan, it promifes well to produce a good quantity of Lead. This kind of Goffan was upon the back of Pednandrea Lode, and fome parts of Huel Sparnon, and is now very plentifully to be rifen at Michell's Goffan Mine, in Redruth.

2. A tender Brown Goffan, much of the colour of Iron, very brittle, and full of holes. The fmaller particles of it are of a brownifh yellow, very crumbling, and fall to duft by long exposure

EARTH AND STONES THEY CONTAIN.

exposure to the air. It is this Gossan which backs the Huel Virgins in Gwenap.

3. A Pale Yellow Dry Goffan, of a hard cryftalline intermixture. This fort of Goffan fometimes yields Copper Ore, yet feldom turns to any great account. However, I believe it to be more promifing for Lead than Tin or Copper, as I have observed it to produce that Metal in Nanskuke Downs and elfewhere. This must be most like the Gossan of Hernn Groundt Copper Mine in Hungary, the mother of which Ore is yellow, fays Dr. Brown, Philos. Tranf. 59.

4. A Poor Tin Goffan, implies that which is fo in refpect of its yielding Tin; for otherwife, it may be kindly enough for Copper. This Goffan fometimes will yield a very tolerable profit, on account of its cheap and fpeedy working for Tin. If it is red and brittle, it is a good indication of Copper Ore in depth, as the Tin leffens and wears out; and if it is tinctured with Verdigreafe, it is very hopeful indeed. Formerly, a notion prevailed, that every Goffan which did not produce Tin upon the backs, was not worth the attention of the concerned for Copper; but it was a vulgar error derived from father to fon, in times when Copper was very little known. Huel Virgin, and other great Copper Mines, have proved, that Goffans not productive of Tin, will yield abundance of Copper.

5. A Gal, (Kal) or Gally Goffan, is of a hard compact nature; its colour blacker than the other Goffans, and more like rufty black Iron. This makes Tin; but it very feldom anfwers for Copper, unlefs it changes to tender and brittle. This Goffan contains fo much Iron, that it fometimes ought to be ranked as an Ore of that Metal: I have been informed by my friend Mr. Bennallack, that he has affayed fome Stones of this Gal, which have produced three-fifths of their weight, good Iron; but this is feldom found in confiderable quantities, and its different Lodes are impregnated therewith, from this large to an exceeding fmall proportion.

Though all these Gossans have an intermixture of each fort, yet that which is most abundant, gives the Lode its denomination. A tincture like Verdigreafe is not to be rejected in any of them, for it is very promifing for Copper.

II. A a lool a miled a dim II. A

OF DIFFERENT LODES, AND THE

90

II. A Peach or Peachy Lode, takes its name from a kind of Stone which principally abounds in the Lode, and is generally of a fpungy texture, and of a greenifh or dark green olive colour. It is better for Tin than Copper; but is not a defirable Lode for either, efpecially the latter, which is always of a poor quality and value when found in a Peachy Lode.

III. A Scovan Lode, is formed of a hard compact crystalline Stone, either of a brown or black hue, according to the colour of the Tin with which it is mixed. The Ore is often rich, ponderous, and folid in this Stone; and when it is worth one half for Metal, they call it Scove. The Lode is usually very fmall, from the breadth of four inches to fourteen ; the latter is thought to be a tolerable fize; and, notwithftanding its folidity and demand for gunpowder to blaft it, will yield much profit to the adventurers under other favourable circumstances. Sometimes this Scovan Tin lies in a lefs folid Lode, as to the Lode itfelf, which is cavernous, and full of holes, thence called a Sucked Stone by the Tinners, as if all the heterogeneous matter had been fucked or rather washed out of the Stone, and nothing was left behind but pure folid Tin Ore. This fucked Scovan Lode is larger when it occurs, even to fome feet in breadth; and fo is the folid Lode likewife at times.

A Caple Lode. The Scovan Lode, when in decay for IV. Tin, will commonly degenerate into a Caple; which, in fact, is mostly of the nature of a Scovan Lode's walls, or that enclofing Stratum, which it is in contact with; thence called the Caples, or walls of the Lode. But there is really fuch a thing as an original Caple Lode, properly fo called; which abounds with a very fliff hard Stone, fomething like a Limeftone, except the colour; wherein the Tin is fometimes veined, and other times very fmall and diffeminate. A primary Caple Lode is promifing for Tin, though but feldom fo for Copper; unlefs there is a branch of Copper Ore or Goffan, that runs downwards in the Lode: if this Caple chances to hit into a body of Copper Ore, it commonly makes a durable Mine though the Ore is none of the richeft. " nouth all these Goltan

V. A Pryan Lode, is fo named, not in respect of any peculiar quality of the Earth or Stone, any further than barely that it lies in the vein, in an arenaceous pebbly state, with small Stones of Ore intermixed, and not in large rocks or Stones; in which sense, a Gossan, Flookan, Mundick, or any other Lode, may

EARTH AND STONES THEY CONTAIN. 91

may be called a Pryan Lode. This fort of Lode is very tender, and apt to yield Tin of the pureft metallick quality. The Lode is often fo very lax and fandy, that it will run againft the workmen like a fand bank; and the man who handles his fhovel beft, is preferable to a Pick-man. If the walls of the Lode are tender likewife, it requires much timber to bind and keep open the workings. When Copper Ore is Pryany, it comes to grafs very cheap and fpeedily, and produces a quick profit.

VI. A Quartz Lode, or Rampant Spar Lode, vulgarly fo called, is placed by fome among the Goffans, though I do not fee for what reafon; this being a hard unmetallick petrifaction, thence called a Spar Lode by those unacquainted with real Spar. There is no Lode totally exempt from this Stone; and many branchy veins of it are to be seen throughout all our strata, unmixed with any other matter. In the gross here spoken of, it is a hard, opaque, yellow, or white crystalline exudation, from the adjoining Crystal rock.

VII. A Cryftal Lode. Quartz is undoubtedly the moft debafed kind of Cryftal; yet with regard to Cryftal Lodes, I can from experimental knowledge make four other diffinctions, whereby their good or evil tendency for Tin or Copper, will more evidently appear.

1. The first is a greyish white, dull, hard, opaque, and rocky Crystal, which produces no Metal in itself, or in those Lodes which degenerate into its kind; for even if there are fome Stones of Ore found in other Lodes, yet where this comes in, it is a certain prognostick of sterility and decay. It is most natural to Tin Lodes at a great depth.

2. A fmutty black, or black grey Cryftal, is a very unlikely appearance for Copper Ore. It occurs but feldom; and when it does, it betokens a very fudden decay, though the Lode was fruitful before.

3. A brown candied, or amber coloured Cryftal. This is fmall, tender, and very like brown fugar candy. I take it to be hopeful for Copper; and it moftly abounds with a black Pryany Copper Ore, which laft confiftence it imparts from its arenaceous property. This wears out in finking, and the Lode generally changes to a yellow Ore, and folid Stone.

A

4.

4. A white candied, or pellucid Cryftal, commonly termed a White Sugar Candy (Spar) Cryftal. This, if it is mixed with Goffan and Stones of Copper Ore, is very likely to abound with great quantities of Ore, but the Cryftal muft be very tender, lax, and fandy. Alfo if it is clear, or tinged with green or purple, it is very promifing for Copper; and difappoints the patience and purfuit of the adventurers, as feldom as any Lode.

All these Crystal intermixtures, are very often found in different parts of the same Lode; and the nature and qualities of the Lode vary accordingly. The two latter are mostly in Copper Lodes, and seem to be more particularly the Crystal Septa of Gosfan Stones in a broken shattered state, by the discharge of its Mineral Earth or Ochre.

A Killas Lode. All Lodes, except this, derive their VIII. names from the coat they wear upon their backs; at leaft their first names are given in confequence of their first discovery : but in this before us, the cafe is otherwife; whence fome may object to the name of this Lode adopted by the writer; but they may as well demur to the received name of a Grouan Lode, or any other which participates of the environing ftratum. Goffan and Scovan Lodes, which are rich upon the backs, in depth come (though very rarely) into the nature and qualities of the enclosing stratum of Killas. The red Killas bears Tin; but it is dry, barren, and ferruginous: the brown is common with Tin, and is hard and Capley : blue Killas, in depth, is fometimes blended with Copper Ore by the cementing medium of white Cryftal. If the Killas is tender, fat, and fleaky, it is fpeedily wrought, and agrees well with its united Ore; but if it becomes exceeding hard and flubborn, the Ore is impoverifhed and chargeable to break. I fpeak of this Lode as a Rara Avis, and merely adventitious.

IX. A Mundick Lode. Some Lodes are moftly composed of rank Mundick near the furface, and too often continue fo in depth; but there are inftances, of their being richly blended with Tin and Copper in further finking. "The Pyrites (Mun-"dick) proves a fure guide to Lead and Copper Ores, which "with us are not eafily feparable; feeing they generally lie fo "mixed together, or fo near each other, in one and the fame "view, that it appears almost impossible for the one to be "without the other: and, indeed, it is no easy matter to "find a vein in the earth, in what direction, and to what "depth

EARTH AND STONES THEY CONTAIN.

" depth fo ever it runs, unaccompanied with Pyrites (Mun-" dick)." (Henckell).

In cafe the Mundick affociates with a rotten, black, ferruginous earth, which contains Stones of Copper Ore, it bids fair for an agreeable alteration. By finking in a bed of Mundick, or driving through it on the courfe of a Lode, it may probably alter and come into Copper Ore. On the contrary, if a Mundick Lode continue hard and inflexible, it portends no good. Tin or Copper Lodes, that change their metallick impregnations for Mundick, and hardnefs, are better deferted han followed.

X. A Black-jack or Mock-lead Lode. This is very fhallow and rich both in its nature and appearance. It is composed of flakey, tabulated, polifhed, fhining, fatty, black earthy Stones; and, like many other Minerals, is most rich, in proportion as it is lefs hard. This is one of the Zinc Ores, and it has been ufed in fome quantites inftead of Calaminaris; but it is fo corrupted by a certain admixture of Iron, that it holds an inconfiderable effimation among the workers in Brafs. This Wild-lead is commonly found with Stones of Copper and Lead intermixed with it; but it feldom or never has any Tin. If it affumes a hard nature in depth, and breaks off in great jointed rocks, it is a bad fign for Copper Ore; and that which is got in this fort of Lode, is never very rich in quality. We have been affured by fome who are converfant with affaying Copper Ore, that where the Ore has been much corrupted with this Blackjack, their affays had the appearance of and undoubtedly were a very coarfe Brafs.

XI. The Flookan Lode takes its name from that tenacious glutinous Earth or Clay, that fometimes runs without fide fome veins, immediately between either wall of the Lode and the Lode itfelf, and more frequently I believe adherent to the hanging or fuperior wall. At other times it is intimately mixed in and throughout the Lode itfelf; and if the vein exceeds eighteen inches in breadth, it is very troublefome to keep from running againft the workmen, and takes much timber to fecure the backs, ends, or other parts of the Mine, which they chufe to leave unwrought. It is generally of a bluifh or whitifh colour, or elfe fhaded between both of a clouded cerulean caft. If Stones or Pebbles of Ore be found in a vein of Flookan, it is B b

94 OF DIFFERENT LODES, AND THE

very likely to make either Tin or Copper Ore in depth; and the latter in most abundance, if there is a Gossan branch or leader.

This Flookan or clay-matter in its barren unmetallick ftate, is feldom absent from a cross course or cross Gossan, either adjoining to one wall of the course, or like a pith in the center thereof; and is the preventive whereby the water from the east or west of it cannot circulate from the true Lode through the cross Gossan. Flookany Gossan Lodes running east and west parallel to Scovan or Tin Lodes, if they meet in opposition to each other upon the hade or underlie, will sever at the angle of incidence, and will heave such Tin Lodes higher up; by which means sometimes a deep work has become as it were renovated, so as to make a new back and new work. But of this in its proper place.

XII. The Grouan Lode abounds with a kind of rocky Stone of that name, either cafually very foft and tender, or very hard and invincible to pick and gad, unlefs firft blafted by gunpowder: where Lodes do abound with this Stone, it is always in a ftratum of its own kind, ufually called a Grouan or Moorftonecountry. It is an aggregation of coarfe, angular, arenaceous Pebbles, or fragments of Quartz and Cockle, cemented together by a cryftalline juice, and variegated with fmall fcales of black or filver fhining Talck. When Tin Ore happens in thefe Lodes, it is always good in quality; but they feldom mifs of deceiving thofe who feek for Copper or Lead: and when a Goffan Lode happens in a Grouan ftratum or country, it is not fo inducing to adventure in, as when it happens in a Killas country; but that it is totally unpromifing for Copper Ore, the Mine of Trefavean will contradict.

We again remark, that what we have faid above on the different forts of Lodes, is moftly on a fuppolition of their being difcovered fhallow; and alfo, that they frequently change and vary, both in depth and alfo on the courfe of the Lode; fo that in order to make a fatisfactory trial of a vein, the Miners muft "fpend ground," in other words, they muft fink down, and alfo drive on the courfe of the Lode, before they can form a right judgment, whether it may prove fuccefsful or not: and though a prudent caution forbids every thinking perfon to engage improvidently and deeply in a Mine which has difcouraging fymptoms; yet, on the other hand, it is often feen, that on trying

trying of Lodes, they alter in their nature and properties very much : however, while a Mine carries a bad appearance, it merits but little regard and attention. All the dry hard Goffans, the Peach, the Pryan, the Caple, the Scovan, the Mundick, and the Grouan Lodes, are liable to yield Tin; and the tender Goffan, the tender Cryftal, Killas, Mundick, Mock-lead, and Flookan Lodes, are disposed for Lead or Copper Ore ; especially if they produce Stones of their own proper quality and nature, or are tinctured with Vitriol. Experience flews, that the hardness of a vein or Lode near the furface, always denotes no good difposition for Copper or Lead; nor is it always a good fign, to meet with Copper Ore at a shallow depth : but as to Tin the cafe is opposite; for it is often found rich in a hard Lode, and at a fmall depth, the richeft Tin Lodes we have being in a very hard Stone; yet a tender Lode often produces Tin as well as Copper; and, upon the whole, I would prefer a tender Lode for both." and calquooo ne of two firings or leaders of Ore on both of

Stones of Ores or Metals, have their finufes or joints, the fame as common quarry Stones; and those finufes often facilitate the breaking and working of the Ore, because the labourers are thereby at greater liberty to drive their gads or iron wedges into fuch joints or divisions, in order to break the folid rocks of Ore. When a Lode breaks away in large jointed rocks, be it of what kind soever, it implies no good for Copper or Lead; however, if it chances to alter and prove better for either, it generally makes a lafting Mine : sometimes it fo falls out, that as a tender Lode comes into Ore in depth, it proves fo hard, that they are often obliged to bore holes in it, and blow it with gunpowder; and yet the Mine shall be very rich, lafting, and profitable.

We muft not omit fome particular forts of Stones, which are often met with in Lodes, though the veins are not called by their names; becaufe the Stones do not continue, except for a fhort length, and fmall depth. There are alfo fome other Stones which are very troublefome to the labourers, and very chargeable to the adventurers.

Among these the Elvan Stone is very common; which is a fandy gritty Stone, mostly very hard, and of a pale yellow, or whitish grey colour. When it is found in a Lode, it forebodes no good fuccess in that part where it lies; for, as far as it continues, it is faid to starve the Lode with respect to Copper or

96 OF DIFFERENT LODES, AND THE

or Lead, although fometimes it does not prove very hurtful to Tin. Another fort of Stone is often met with in Lodes, which they call a Lîver Stone, or Lîvery Stone, from its ufual liver colour. This is generally very hard, and apt to impoverifh the Lode; but when the Miners work a little further or deeper, they commonly come to an alteration of ground, and then the bad effect of thefe Stones alters likewife.

It frequently happens in very large and alfo rich Lodes, that when they dig a great depth in them, there appears a kind of Stone about the middle of the vein, of the fame nature of the ground or stratum nigh the Lode, being not at all of a veiny quality, though it is in the body of the Lode. This is mostly of the Killas kind, it being the common stratum at a great depth. It will first be discovered, perhaps, in the middle of a vein; and will fpread as you fink upon it, like the back of a horfe pack faddle, till it occupies the whole breadth of the Fiffure, except one or two ftrings or leaders of Ore on both or either fide of it. The Cornish Miners call it a Horse; and when they meet with it fay, " The Lode has taken horfe." The continuance of this unwelcome ftranger, may be for the finking or driving of feveral fathoms of ground; and it may be thought expedient fometimes to fink and drive under it, through it, or at one end of it, and leave the greateft part flanding, which may fave expence, and be useful to keep open the workings, if its footing or fupport at the bottom is not unfkilfully wrought away by the incautious Miners. Thus, by finking and driving, according as place and circumftance will admit, they recover the Lode again : however, it is always fufpected whether the Lode will continue fo rich and plentiful as before; and it has fo happened, that the Lode has never recovered its former good quality.

At, or foon after the time, when the fplit, crack, or Fiffure, in fuch place happened, a part or fide of the Fiffure being more lax and incompact, feparated, fell off, and lodged upon the lower wall of the Fiffure : which feems to me, the only accountable caufe for the formation of those large Horfes we fometimes fee in Lodes; and in fupport of my opinion, I remark, that the contents or fubftance of a Horfe, is lefs hard than the Stratum from which it was feparated, it being of a fhattery loofe texture, like a flatty Killas. It generally occurs where the Fiffure is largeft; and the continuity of the veiny part of the Lode each fide, further corroborates the idea. Therefore

EARTH AND STONES THEY CONTAIN.

Therefore it is no wonder, when injudicious Miners work away the footflool of a Horfe, that they fhould pay for their temerity, by the forfeit of their lives; yet fuch has been the cafe, and the adventurers have been often put to unneceffary expence in stemples and lock-pieces to fecure the Mine from falling in.

It is observable in driving, or stopping upon the course of a Lode, that when it changes from its usual underlie to nearly perpendicular, and then the lower wall ftarts off from its common underlie, to that which is contrary, and the Lode or Fiffure widens pretty much; in fuch cafe the Miners expect to meet with what they call a Horfe : but unlefs they come down in finking upon the back or top of it, they feldom call it by that name; and when met with in ftopeing, or driving as aforefaid, they commonly fay, " It is a ftope of dead ground."

C H A P. III.

How Mines are diforded, interrupted, fractured, elevated, and depressed, by the Intervention of Cross-Gossans, Flookans, Slides, Contras, &c.

T ODES are not interrupted, fractured, heaved, or otherwife difordered, by the intervention of Flookans, Crofs-Goffans, Slides, or the like : it has ever been the miftake in this cafe, to fubflitute the effect for the caufe. I have already fhewn, that the fracture and heave of a Lode, is produced by a fubfidence of the ftrata, from their primary politions; fo that what we call a heave, is a falfe term, and altogether contrary to the idea I conceive of the matter; for, inftead thereof, it is a finking of the ftrata, and ipfo facto occasions a depression, fubfidence, or finking of a Lode, inftead of an elevation or heave. Neverthelefs, in compliance with the phrafeology of our Miners, I am obliged to use that dialect which is commonly known and received among us. It will be difficult, nay almost impoffible, to perfuade thirty thousand illiterate perfons, that their notions are wrong, and their expressions inaccurate. I must, therefore, proceed in the usual style of the Tinners, and write as they converfe upon those fubjects.

The methics Lode is intercepted at right angles, ital oWed to the sight hand a voyOittle ways perhaps not more

OF THE INTERRUPTIONS OF MINES

98

We have already obferved, that our veins generally run eaft and weft; but this muft be underflood of the metallick veins; for there are fome, which run quite acrofs them, that is, north and fouth, or obliquely fo, with fome finall deviations from those cardinal points: these are called Crofs-Lodes, Crofs-Courfes, Crofs-Flookans, Crofs-Gosfans, and Contras or Caunters. They are generally quite barren for Tin or Copper; but we have fome few inftances of Crofs-Gosfans being wrought for Lead, though not to any great profit. Some antimonial veins run alfo north and fouth.

The Crofs-Goffan runs flraight on, without any interruption from other Lodes; for it feems to be irrefiftible in its flretch through the earth, breaking through and interfecting all metallick veins it meets with, feparating and throwing afide the correfpondent ends of those veins from each other, perhaps twelve inches or twenty fathoms. The underlie of those Crofs-Goffans are either east or west, little or much, like other veins. These Crofs-Lodes are not without their use; for in bringing home adits, they afford an easter passage, than perhaps the folid flrata would have permitted, especially if a flratum of Ire-stone lies in the way: furthermore, by carrying one of the walls of the Crofs-Course in the level or adit, you are almost certain of cutting all metallick veins in your way to the Mine.

When the Miners are working upon a metallick Lode, and are driving from eaft to weft, or from weft to eaft, they often meet with a Crofs-Goffan, which, as before observed, unheads and breaks off the continuity of the Lode they work upon, by running acrofs through it and caufing a fchifm or rent; fo that if they work ever fo far in the fame line or direction through the Crofs-Courfe, they never will meet with the loft vein, becaufe its corresponding part is removed from its true fite and position by the intervention of the Crofs-Courfe which throws it off further north or fouth. The Crofs-Goffan interfects the Lode fometimes at right angles, and fometimes obliquely, and diforders it more or lefs in proportion to the bignefs of the Crofs-Goffan, and also of the underlie both of that and of the true courfe; and it is often fo very intricate, that the most expert Miners are at a lofs to find and difcover the fevered part of the true vein al orth to alvil

If the metallick Lode is intercepted at right angles, it is moved to the right hand a very little way, perhaps not more than than one fathom, as in figure 2. plate 1. Thus, if they are working or driving from eaft to weft, or contrary from weft to eaft, and perceive the Lode is gone and the Crofs-Courfe fully apparent, then they cut through the Crofs-Courfe, and fo turn houfe as they call it, or, in other words, they drive north or fouth, making a right angle almost with their former drift or working on the metallick Lode; and thus they work till they find the loft or adverse part again, or till they think they are gone too far, and that the Lode is thrown the other way; then they face about and drive the other way, which feldom difappoints their expectation of cutting the true Lode again. By certain experience this is the only method of difcovering the metallick Lode, provided it is only removed at the fame depth in which you lofe it. This will beft appear by confidering figure 1. plate 1. Let the Lode E and W reprefent a vein interfected and thrown out of its true plane of direction by the Crofs-Goffan N S, fuppofing the Miners are working from E to W; then, when they come from E to B, they will lofe their Lode, and meet with the Crofs-Courfe; in cutting of which quite through, and then driving to C, they will meet with their metallick Lode afresh to the right hand. The converfe of this proposition is easily demonstrated; for if we suppose they are driving from W to E, then, when they come from W to C, they will lofe the Lode, and meet with the Crofs-Goffan; but in cutting through it, and fo driving to B, they will find the metallick Lode again, to the right hand as before.

The pointing also of a rib or string of the true Lode, if carefully obferved, will inform them to which fide or hand the other part is removed; as will also what they call a Scrowl of the true Lode in the Crofs-Goffan : therefore none but wary cautious Miners fhould be fuffered to work in an end or ftool of Ore, when it is thought to be near a Crofs-Courfe, who by observing every string or branch of the metallick Lode, at the place of incidence, may judge which way it is thrown, and feek for the loft part of the Lode accordingly. This interruption by a Crofs-Goffan at right angles, is most common, and attended with leaft difficulty; but when the interruption happens at oblique angles, the Lode is not eafily recovered. The general rule, however, ftands thus; when the Crofs-Courfe runs obliquely N E and SW (north eaft and fouth weft) it moves the metallick Lode to the right hand, as in figure 3. plate 1. on the other fide of the Crofs-Goffan; but if it runs very obliquely SE and NW.

NW, it fometimes removes to the left hand on the opposite fide of the Crofs-Goffan, as in figure 4. plate 1.

An explanation of the first figure in plate 1, is fufficient to convey an idea of the horizontal diforder or interruption of Tin and Copper Lodes, by the intervention of Cross-Gosfans. The diforder imputed to real cross unmetallick Lodes, is folely horizontal, either rectangular, or oblique, and the true Lode is never elevated or depressed thereby as in Course-Flookans or Slides and parallel Lodes of a contrary inclination.

Crofs-Goffans not only move Lodes out of their places, and true point of direction, but they diforder them fometimes fo as to break and divide them into leffer ribs or branches; fo that Miners often follow the wrong branch to their great detriment and difappointment: thefe alfo, or rather the hardnefs of the adjoining ground, fometimes occafion a deflexion or turning in the Lode, which we call an Elbow, whereby it deviates more or lefs from its true direction.

In the center, or on either of the walls of these Cross-Goslans, there is always a clayey fubftance, called the Flookan of the Courfe, not unlike the pith of vegetables; which, though it be no more than a finger's breadth, effectually dams up the water from circulating from one part of the metallick Lode, to the other that is fevered by the Crofs-Courfe; infomuch, that the two parts of the fame vein may be worked to any different depth, without being at all annoyed by the water thus feparated by the fmalleft Flookan : or however quick the water may be on one fide, the other may be fafely worked without fear of interruption from the water of the other fide; which is a great advantage in Mining, and therefore, under certain circumftances in fome Mines, they are very careful not to penetrate through this natural dam, left they lofe their Mine by an inundation of water. We may venture to add our opinion, that we owe many of our fountains and fprings on the furface of the earth, to thefe crofs veins; for the circulation of the water brought by innumerable fprings into the larger veins being ftopt by these crofs Lodes, it bubbles up when favoured with a fuitable fituation in the furface.

Near to a Crofs-Courfe, the true Lode, or the diverged branches thereof, are generally rich for Metal; becaufe the water, whether impregnated little or much with Mineral or metallick

BY CROSS-GOSSANS, &c.

metallick particles, meeting with an obftruction at that place, if the nidus is at all disposed for the decomposition of the sufpended Mineral, it will confequently be deposited immediately there, by means of its obstruction, reft, and continuance in that particular place. In some instances, however, one part of the Lode may be rich home to the Cross-Course, and its corresponding segment poor and barren : the one part will be tender and feeding for Ore, and its adverse will be hard and unpromising.

It would be difficult to conceive, how the broken parts of a vein, which in all probability were once united, fhould be of fuch different qualities at the point of interfection, except for the reafon before given why they fhould be rich at fuch places; for it is eafy to imagine, that water may be ftrongly or weakly impregnated with mineral particles on either fide of the obftruction through which it has no intercourfe, and therefore muft be differently faturated, according as the neighbouring ftrata by their fterility or copioufnefs of mineral principles may improlificate that element. I beg leave to obferve, that thefe facts, and my theory in confequence of them, are to me coincident proofs in fupport of my opinion of the origin of Metals and Minerals.

Becaufe the Crofs-Goffans, or Crofs-Flookans, run through all veins of oppofite directions, without the leaft interruption from them, but, on the contrary, do apparently disjoint, and diflocate all of them; it feems reafonable to conclude, that the eaft and weft veins were antecedent to crofs veins; and that fome great event, long after the creation, occafioned thofe transfverse clefts and openings. But how, or when, this should come to pass, we cannot prefume to form any adequate idea; unless the reader will admit the following scriptural and philofophical account of the deluge, as a probable folution.

The inftrumental caufes of the deluge, were "the broken "fountains of the great deep, and the rain which poured from "the windows of heaven." Now Mr. Whifton fhews from feveral remarkable coincidencies, that a comet defcending in the plane of the ecliptick towards its perihelion, paffed juft before the earth on the firft day of the deluge; the confequences whereof would be, firft, that this comet, when it came below the moon, would raife a prodigious, vaft, and ftrong tide, both in the fmall feas, (which, according to his hypothefis, were in the antediluvian earth, for he allows of no great ocean there, as D d

IOI

OF THE INTERRUPTIONS OF MINES

in ours) and alfo in the abyfs which was under the upper cruft of the earth ; and that this tide would rife and increase, all the time of the approach of the comet towards the earth." By the force of which tide, as also by the attraction of the comet, he judges, that the abyls must put on an eliptick figure, whole furface being confiderably larger than the former fpherical one, the outward cruft of the earth, incumbent on the abyfs, muft accommodate itfelf to that figure, which it could not do while it held folid and conjoined together. He concludes, therefore, that it must of necessity be extended, and at last be broke, cleft, and fiffured, by the violence of the faid tides and attraction ; out of which clefts or fiffures, the included waters iffuing were a great means of the deluge; this answering to what Mofes speaks, of " the fountains of the great deep being broke " up." To remove this valt orb of waters again, he fuppofes a mighty wind to have arole (" God made a wind to pais over the earth, and the waters affwaged. The fountains also of the deep, and the windows of heaven were flopped, and the "waters returned from off the earth continually") which dried up fome, and forced the reft into the abyls again, through the clefts or fiffures by which it came up; only a large quantity remained in the alveus of the great ocean, &c. He has fince proved, that there was actually a comet near the earth at that time, viz. the fame great comet which appeared again in 1668. Mr. Whifton, therefore, no longer looked upon what he had advanced as an hypothes; but has republished it in a particular tract, entitled " The Caufe of the Deluge demonstrated." ealt and well veins were antecedent to crois veins;

To whatever active caufe we may attribute the completion of fo great a phenomenon, we are neverthelels certain from the word of God, and natural observations, diffinct from philosophical enquiries, that the waters of the great deep were broken up, the hills in the ocean were elevated, the mountains of the land were funk, and the earth was varioufly rent and torn afunder. When those schiffins were made, it is probable, the earth was wrung with contortions to the right and to the left, and reeled to and fro like a drunken man, whereby the continuity of veins in the earth were divided and feparated to fome diffance afunder, and eventually caufed those chaims and fillures called Crofs-Courfes; which partly by the return of the waters into the great abyfs from whence they came up, were filled with the toole contiguous Earth and Stone within the vortex of the minister of God's vengeance; and partly by the petrifying agglutinating properties that are inherent in waters circulating through

BYM CROSS-GOSSANS, Rc.O 103

through the bowels of the earth. Indeed it is probable, that the greatest part of the contents of those contra fiffures, which are only obvious and proximate to our shallow refearches, are produced by the petrifactive quality of water; for they confist of a large proportion of debafed Crystal, a branch or pith of clay, and a yellow or red ochreous earth, which gives it the name of a Gostan. The first is a petrifaction; the fecond is the finer parts of the ftrata fqueezed out by the compression and reconsolidation of the earth, if I may be allowed the expression; and the last, is that spume or ochre, which continually oozes through the pores of mineralized strata, as we see on the fides of every drift and adit under-ground.

every branch he meets with is faid, by the Miners, to be coming

When two metallick Lodes near each other, do not run parallel in their courle or line of direction, but make an oblique angle, they muft neceffarily meet together; and if they are both rich and inclinable to produce Ore, they commonly yield a body of it at the angle of incidence, or, as the Miners fay, where the Lodes elbow each other: but if the one Lode is poor, and the other rich, then they are both either enriched or imipoverifhed by their conjunction; and it is uncertain which will happen. After fome time they will firike off again, and each continue its former direction, diffinet though near to the other; but there are fome very few exceptions to this, both continuing fometimes united.

When the Miners are working along on the courfe of a Lode, ever fo good, and they find it feparate and diverge into branches or firings, it is a great fign of its poverty, in that place where it is fo difordered; but, on the contraity, if they are driving on branches of Ore, and they find them embodying or coming together, as they work on the courfe of the Lode, it is promifing.

There are alfo branches from another quarter, which inflead of being within, are without-fide the walls of the Lode, in the contiguous firata or country. These branches often come into the Lode either transversely or obliquely, to its line of direction. Now, if these branches or firings are alive, or impregnated with Ore, and also if they underlie faster than the Lode, then they are faid to overtake or come into the Lode, and to feed where they come into it; but if the branches do not underlie faster than the Lode, then they are faid to go off from it, and thereby flarve and impoverish it: yet it is difficult to conceive a right notion

OF THE INTERRUPTIONS OF MINES

104

notion of thefe kind of branches, without occular demonstrafiration; neither are thefe nor any other indications of the fruitfulnefs or sterility of a Mine, entirely to be depended on; for many Mines which have no good fymptoms at first, do neverthelefs prove rich; others again, which feem exceeding hopeful, alter for the worfe; fo that there is no certainty how a Mine will answer till it is tried in depth: however, as it is not prudent to neglect an adventure of a promising aspect; fo also it is very imprudent to expend much money on a Lode, which wants encouraging marks of making a profitable Mine.

If a man is working downwards in depth in a Mine, then every branch he meets with is faid, by the Miners, to be coming into the Lode; on the contrary, if he works upwards towards the furface, then every branch he meets with is faid to be going off from the Lode : now, this is like taking the fame thing in two different lights; for at this rate the fame individual branch may be faid to go into or proceed from the Lode, according to the polition the Miner works in. I think it will be most intelligible to the reader, to fay, that those branches, which come in on the hanging wall of the Lode, are going off from it; and those which come in through the underlying or lower wall, are properly those branches coming into the Lode, enlarging or enriching it with fuch Ores as the branches contain; and it is very notorious, that Lodes are oftentimes enriched by branches coming into them, of the fize of an inch in thicknefs, or under.

Lodes are frequently fo fqueezed and comprefied in hard compact ftrata, that they are not an inch wide; yet if they be alive, that is, if they have a folid ftring or leader of Ore, they often prove well in further purfuit; for by following the rib or leader, they may chance to come into a more tender ground, or lefs compact ftrata. So if branches or leaders of Ore widen in driving on them, or if they widen in depth, either of thefe is encouraging; but if the branches lie flat or horizontal, and not inclining downwards, they bear no good afpect. A Mine, however, is not immediately to be given over for a fmall difcouragement, becaufe, on fpending ground, or working on the Lode, it may alter again, and reward the patience of the adventurers.

Small Lodes of Tin but three inches wide, are worth the working, when they are rich, clean, folid, and in good feafible ground. Alfo Copper Ore Lodes of fix inches breadth, when they

BY CROSS-GOSSANS, &c.

they are folid, and are clean from wafte, in fair ground will pay very well for the working. Some of our greateft Mines have had exceeding large veins; and fometimes feveral very fmall veins near together, but rich in kind, clean, and in good working ground or ftrata, confequently very profitable.

Befides this natural inofculation of veins, and their ramifications, we have those which frequently pass through all others except Cross-Gosfans, and are called by the name of Contras. Such Lodes direct east and west, more nearly than any others; and, therefore, in their course run through many other Lodes, interfecting them at very oblique angles. If a Contra-Gosfan impregnated with Copper, meets with its like, they generally make a Gulph of Ore at the place of interfection; but if it takes its course through a Scovan Lode, it mostly damages, impoverishes, and diforders the Scovan.

All veins croffing each other, may be termed Contras in refpect of each other, as their courfes are in oppofition; but from the beft information I can procure, all those Gossans which are direct east and weft, run through every other Lode like Crofs-Goffans, but do not diforder them in the fame manner : therefore, I chufe to fix the name of Contra, vulgarly called Caunter, to these direct east and west Lodes, of whose direction and fertility the great Huel Virgin is one notable inftance. It is very obfervable, that almost all Goffans take their courfe through Tin or Scovan Lodes, and from that circumftance have the names of Mafter Lodes : hence we have abundant reafon to conclude, that all the fiffures of Scovan or Tin Lodes were coeval with the creation ; and that the fiffures of Goffan Lodes, of every fort and kind, have been formed fince the creation; and it is apparently fo from the circumftances before mentioned, for, the Lode which separates and goes through another, must have been formed subsequent to that which it divides and paffes between. Jos and north

In the next place, I fhall take notice of Lodes that meet in their underlie; as two Lodes are fometimes known, in running a parallel courfe eaft and weft, to take a direction downwards or underlie towards each other, the one north, the other fouth, and fo make confiderable alterations for the better, or the worfe : for if two neighbouring Lodes do underlie against each other, they must then meet in depth; and if both are prone to Ore, E e there

106 OF THE INTERRUPTIONS OF MINES

there are great hopes of a quantity thereof when they meet; but if one be rich, and the other poor, it is uncertain how they will prove at their junction: yet this cafe feems rather more promifing, than when two Lodes meet fhallow, for this reafon, becaufe the Ore generally happens at fome depth; but if they are differently impregnated, that is, if the one is a Tin Lode, and the other a Copper Courfe, a diforder always enfues, for the Goffan in that cafe occafions an Elevation, Leap, or Heave of the Tin Lode; but if two Goffans meet thus upon the underlie, they will mutually incorporate and pafs through each other, or perhaps firike off from each other, and both take a contrary underlie for fome depth, and may be varioufly rich or poor for Copper, as their nidufes may be varioufly mineralized.

Now if two Lodes are very near together, and underlie both one way, but the hinder Lode more or fafter than the other, which feems to go from it; when the cafe is thus, the hinder Lode will overtake the other in depth, and affociate with it. But if two Lodes near each other, underlie alike, and if the hinder one doth not underlie fafter than the other, they will never meet, unlefs they form an angle in their courfe eaff in weft. By the hinder Lode, I mean that which, by its underlie, follows another underlying Lode; as when two eaft and weft Lodes do underlie north; of confequence the moft fouthern of the two is the hinder one, becaufe it follows the northern on the underlie.

10

The most confiderable diforder which Lodes are liable to in Cornwall or elfewhere, is what is termed a Start, a Leap, or a Heave by a Slide or Courfe-Flookan. It fo happens, that in finking upon a Tin or Copper Lode, they are fuddenly at a lofs for the continuation of the Lode downwards. In one day's time, in the working a rich Lode of Tin, they are thus difappointed, and have no further fign of a Lode to work upon ; but at the extremity of their working down the Lode in depth, they may perceive a vein of Flookan or clayey-matter, underlying in opposition to the Lode they were finking upon. This Flookan may be half an inch, or a foot, in thickness; it may be even more or lefs : but as it is, whenever the Miners are foiled of the Lode they were working, or have loft it in this manner, they conclude and fay they are " cut out by a Slide." Now I apprehend the heave is, cæteris paribus, in proportion to the fize of the Flookan or Slide, which may vary according to the angle of fubfidence ;

BY CROSS-GOSSANS, &c.

107

fubfidence; that is, if the fubfidence is great or fmall, fo may the Flookan be more wide or narrow, and the Elevation or Deprefion of the fractured Lode be more or lefs up or down; therefore fome Lodes may be heaved up fome fathoms, and others only fo many feet. Be it little or much, there is an infallible rule whereby they may recover the Lode again, as the reader will readily apprehend by the following fection in the plate.

Tin Lodes are not only heaved by Flookans, called Slides; but they are fo in the very fame manner by oppofite underlying Goffan Lodes, which are fometimes impregnated and fometimes not: but those heaves are generally more diftant, and higher up, in proportion to the fize of the Goffan, according to the position laid down before. This fracture of the Lode by a Goffan Slide, is what they call, in other parts of England, "A trap up, or a trap down by a ridge;" which, in Somerfetshire, is defined, "A parting of Clay, Stone, or Rubble;" as if the veins were disjointed and broken by fome violent shock, fo as to let in Rubble, &c. between them.

have driven fixty

As we cannot make the reader readily apprehend this fracture of Lodes, without a representation of it; we have given a transverse section of Goon Laz and the Pink Mines in St. Agnes, taken from an actual furvey. Here it appears, that the Tin Lode underlies north, and the Goffan Slide fouth. At the junction of the two Lodes at G, the Tin Lode is cut out by the Slide, and heaved up to H, twenty-two fathoms in perpendicular height, nineteen fathoms horizontally north, and thirty diagonally, by the underlie of the Goffan; fo that if a fhaft had been funk between C and D, no Tin Lode could have been cut or difcovered : but, by the fhaft B, the fame Lode is cut again in the Pink Mine at I, a fmall depth under the adit level, and not very far below the fouth wall of the Goffan. The adit in this place, feems to give the Miners fome direction, how and where to put down their fhaft B : but when the fame Lode was fractured, and heaved again from K to E, their next care was to drive a drift L from K to M, where they cut the Lode again, and role upon the back of it up to the north wall of the fecond and fmaller Goffan 2 E; and likewife funk upon their Tin Lode down to N, where it was again fractured by a third and fmaller Goffan 3 O, and heaved about nine feet ; cut once more at P, and is now working by virtue of a water engine in the fhaft Q Q, which

OF THE INTERRUPTIONS OF MINES

108

which draws the water out of the bottoms of the Mine to the adit, from whence it is difcharged into the fea half a mile off.

The common method for recovery of a Lode, when thus diforded by a Slide or Goffan, is exemplified in the drift L driven from K to M; fo that almost always, when it is heaved, they drive immediately from the angle of incidence, from the bottom wall of the Slide, be it either north or fouth, until they find the frustum of their former Lode again: that is, (as in the cafe before us) if the metallick Lode underlies north, the Slide must underlie fouth, and of confequence the drift for recovery of the lost part must be north; and fo vice versa.

In fome cafes they find the Lode again by finking a fhaft from grafs, which answers a double intention ; for a shaft must be had, whenever the Lode is cut by any other method, in order to work the fame effectually : in the Pink, however, if a fhaft had been funk between C and D, or E and F, they never could have cut the Tin Lode again, but in fact would have miffed every remove of it. Again, if they had driven immediately from the place of interfection G, they must have driven fixty fathoms north, before they could cut the Lode again; which in all likelihood would have been fo tedious and expensive, that they would have deferted their purfuit before they had driven half the ground, and entirely miffed the intermediate heave K H. Neverthelefs, a difcerning Miner, in either cafe, might find the intermediate heave; for if a fhaft had been funk between C and D, the first great Gossan I must have been funk through perhaps at T, and the fame continued down through the next Goffan at V. Thus, by having funk through two Goffans, the experienced Miner concludes the first heave to be fituated between them, and rifes in the back to cut it, if air and other circumstances are favourable; or, which is better, will fink a shaft B. The fame proposition holds good in driving; for if a drift is driven from G to V, both the Goffans muft be cut; whence it is eafy to conclude, that there must be a heave between them. It is very clear, that none but the most observant experienced Miners are proper for this work : incautious injudicious perfons may eafily fink or drive through a Slide, and be totally ignorant of the matter; for they are fometimes not an inch wide, and are fcarcely difcernible; fo that it is a matter of the utmoft nicety, and most accurate enquiry, to recover a Lode when it is cut out by a Slide, &c. Toteve e to putting of perishave w

From

BY CROSS-GOSSANS, &c.

From what has been advanced, thefe corollaries may be drawn : First, that all those heaves are fractured parts of one and the fame Lode, which were formerly united ; efpecially as they confift of the fame kind of Tin, make the fame angle with the horizon, and are all of one breadth. Secondly, that this fractured Lode was formed in the fiffure before it became inclined or fractured in this manner; for G was joined to H, K to E, and N to P. Thirdly, that there must have been three fucceflive different fubfidencies, to occafion those three fractures. Fourthly, that the greatest fubfidence is from C to G; and the Goffan of confequence must be largest, on account of the greater rent or feparation there. Fifthly, that the other fubfidencies from E to K, and from P to N, with their Goffans, are, cæteris paribus, proportionally lefs. Sixthly, that those Goffans are the effect, and not the caufe of those subsidencies, which are fo reverfely called Heaves; being fo many rents or fiffures filled up in length of time with Clay, Rubble, Ochre, &c. from the contiguous strata.

Moreover, it is particularly remarkable, that the furface and ftrata carry many corroborating proofs of fundry fubfidencies at this place; for, at the very fpot, there is a fudden fteep defcent, which forms a narrow deep coomb, or valley. Half a mile further north, I have remarked the fea cliffs, where inftead of the ftrata dipping towards the fea, they are inclined to the fouth, towards the land, and make an angle of nearly forty-five degrees with the horizon. Further off, at a greater diftance in the fea, are two huge rocks, which look like fmall iflands, and are always above water equally high with the main land : whence I have reafon to conclude, that thefe rocks were once a part of the continent; that the contiguous ftrata have been unfooted and funk downwards, not only once, or twice, but many times.

There is another fracture and remove of Lodes, dependent on the fame caufe with the foregoing, which is more truly and commonly called the being "cut out by a Slide." This Slide does not underlie in opposition to the metallick Lode, as that at Goon-Lâz; but, on the contrary, it comes in behind the Lode, which it interrupts by underlying faster. This Slide is composed of a fine unctuous gray or white clay; is feldom fix inches big; and the remove is rarely fix feet F f

OF THE INTERRUPTIONS OF MINES.

diftance. Let A A reprefent the true or metallick Lode, and BBB the Slide, and the fracture and remove will be feen at one glance; whence the reader may judge for himfelf, how expeditioufly and certainly the metallick Lode may be recovered.

A B B B

with the horizon. Further of, at a greater diffiance in the fea,

now it is that that the consignous Brata have been unfooted

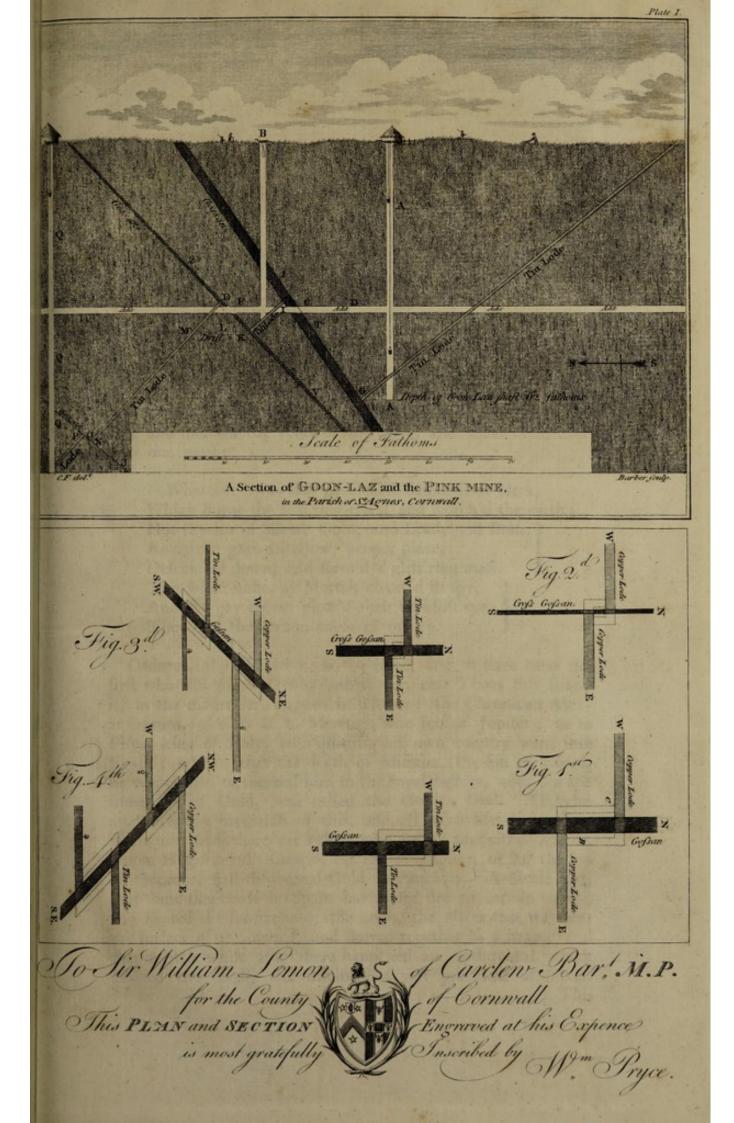
There is another fracture and remove of Lodes, copendent on the fine caule with the foregoing, which is more truly and commonly called the being " cut out by, a Slide. Tals Slide does not underlie in opposition to the metallick Lode, as that at Goon-Laz; but, on the contrary, it comes in

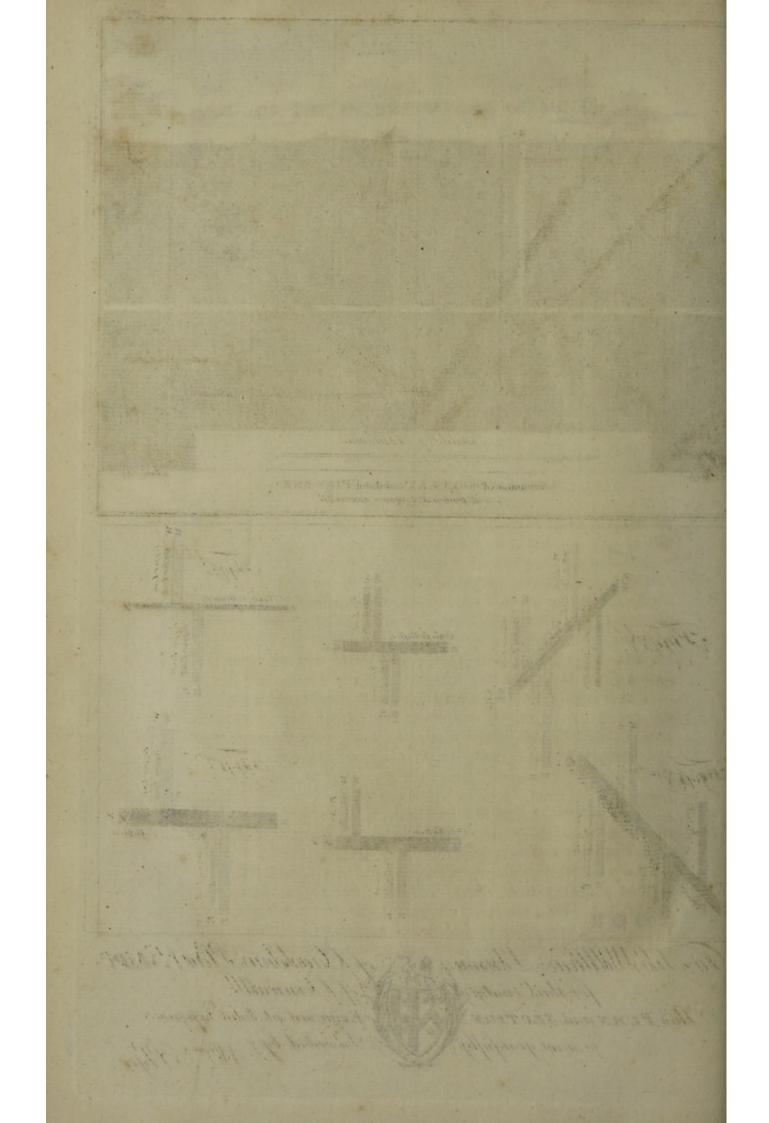
X O O B Bis composed of a fine uncinous gray or white clay; in foldom fire inches big ; and the remove is rarely fix fact

Lode, which is interrupts by underlying fafter.

TOPOTALT. Cal AD AR CH CILLING STUF

IIO





BOOK III.

CHAP. I.

Of the various Methods of difcovering Mines.

UCRETIUS, who afcribes the first difference of Metals to the burning down of woods, fays, that the heat of the flames melted the Metals, which were difperfed here and there in the veins of the earth, and made them flow into one mass:

Whatever 'twas that gave thefe flames their birth, Which burnt the tow'ring trees, and fcorch'd the earth; Hot ftreams of Silver, Gold, and Lead, and Brafs, As nature gave a hollow, proper place, Defcended down, and form'd a glitt'ring mafs. This when unhappy Mortals chanc'd to fpy, And the gay colour pleas'd their childifh eye; They dug the certain caufe of mifery.

Cadmus, the Phenician, is, by fome, faid to have been the first who discovered Gold; others fay, that Thoas first found it, in the mountain Pangæus in Thrace: the Chronicon Alexandrinum, afcribes it to Mercury, the fon of Jupiter; or to Pifus, king of Italy, who quitting his own country went into Egypt ; where, after the death of Mifraim, the fon of Cham, he was elected to fucceed him in the royal dignity, and, for the invention of Gold, was called the Golden God. Æfchylus attributes the invention of this, and all other Metals, to Prometheus : and there are others who write, that either Æaclis, whom Hyginus calls Cæacus the fon of Jupiter, or Sol the fon of Oceanus, first discovered Gold in Panchaia. Aristotle fays, that fome shepherds in Spain having fet fire to certain woods, and heated the fubftance of the earth, the Silver that was near the furface of it, melted, and flowed together in a heap; and that a little while after there happened an earthquake, which cleaved the earth, and difclosed a vaft profusion of Silver. This

112 OF THE VARIOUS METHODS

This is confirmed by Strabo, lib. iii. and Athenæus, lib. vi. who fay, that the Mines in Andalufia were difcovered by this accident. Cinyra the fon of Agryopa, firft found out the Brafs (Copper) Mines in Cyprus; and the difcovery of Iron Mines Hefiod afcribes to thofe in Crete who were called Dactyli Idæi: and Midacritus was the firft man that brought Lead (Tin) out of the ifland Caffiteris. (Lucretius, Pliny, Polydore Virgil).

We shall close this ancient account of the first discovery of Metals, with the following lines from Dr. Garth's Dispensary.

Now those profunder regions they explore, Where Metals ripen in vaft cakes of Ore. Here, fullen to the fight, at large is fpread, The dull unweildy mass of lumpish Lead; There, glimmering in their dawning beds, are seen The more associated as of some fightly Tin; The Copper starkling next in ruddy streaks, And in the gloom betrays its glowing cheeks.

Mines have been often difcovered by accident, as in the fea cliffs, among broken craggy rocks, or by the washing of the tides or floods; likewife by irruptions and torrents of water iffuing out of hills and mountains; and fometimes by the wearing of high roads. Another way of finding veins, which we have heard from those whose veracity we are unwilling to queftion, is by igneous appearances, or fiery corufcations. The Tinners generally compare these effluvia to blazing stars, or other whimfical likeneffes, as their fears or hopes fuggeft; and fearch, with uncommon cagerness, the ground which these jack o'lanthorns have appeared over and pointed out. We have heard but little of these phenomena for many years; whether it be, that the prefent age is lefs credulous than the foregoing; or that the ground being more perforated by innumerable new pits funk every year, fome of which by the Stannary laws are prohibited from being filled up, has given thefe vapours a more gradual vent; it is not neceffary to enquire, as the fact itself is not generally believed. The art of Mining, however, does not wait for these favourable accidents, but directly goes upon the fearch and difcovery of fuch Mineral Veins, Ores, Stones, &c. as may be worth the working for Metal. The principal inveftigation and difcovery of Mines, depends upon a particular fagacity, or acquired habit of judging from particular figns, that metallick matters are contained in certain

OF DISCOVERING MINES.

113

certain parts of the earth, not far below its furface. But, as ignorance and credulity are the portions of the illiterate, we have people conftantly in fearch for Tin, where our dreaming geniuses direct them to follow after the images of wild fancy; confequently, we have a Huel-dream in every Mining parifh, which raifes and difappoints by turns the fanguine hopes of the credulous adventurers.

Mines are also discovered by the harsh disagreeable taste of the waters which iffue from them, efpecially those of Copper : but this feems to be, only when the Ore is above the level at which the water breaks out; for, otherwife, it is unlikely that the water fhould participate of much impression or quality from the Ore that is underneath it, or untouched by it. A better expedient to find whether the water is impregnated with Copper, is to immerge a piece of bright Iron in it, for two or three days ; in which time, the Iron will look of a Copper colour, provided the water is of a cupreous quality, or at leaft contains a certain share of vitriolick acid : further, if fome Aqua Fortis be affufed to a little of this water, in a clear phial, it will prefently exhibit a bluish green colour, either fainter or fuller according as it is impregnated with the acid of vitriol. A candle or piece of tallow put into the fame water for a few days, may be taken out tinged of a green colour.

Hoofon fays, that "the first inventor of the Virgula Divina-" toria, was hanged in Germany as a cheat and impoftor :" on the other hand, Dr. Diederick Weffel Linden fays, in anfwer to him, that " Dr. Stahl, when he was prefident of a chemical " fociety in his country, published a reward of twenty-five " ducats for any body that could prove who was the inventor " of the Virgula Divinatoria." It is impossible to afcertain the date or perfonality of this difcovery, which appears to me of very little confequence to pofterity : but perhaps we may not be far off from the truth, if we incline to the opinion of Georgius Agricola, in his excellent latin treatife De Re Metallica, that " the application of the inchanted or divining rod to metallick " matters, took its rife from magicians, and the impure foun-" tains of inchantment." Now the ancients not only endeavoured to procure the neceffaries of life by a divining or inchanted rod, but also to change the forms of things by the fame inftrument : for the magicians of Egypt, as we learn from the Hebrew writings, changed their rods into ferpents; and, in Homer, Minerva turned Ulyffes when old into the likenefs of

Gg

OF THE VARIOUS METHODS

of a young man, and again to his former appearance: Circe alfo changed the companions of Ulyffes into beafts, and again reftored them to the human fhape; and Mercury, with his rod called Caduceus, gave fleep to the wakeful, and awakened thofe that were afleep. And hence, in all probability, arofe the application of the forked rod to the difcovery of hidden treafure.

Neverthelefs we find no mention made of this Virgula before the eleventh century, fince which it has been in frequent ufe. It was much talked of in France towards the end of the feventeenth century; and the corpufcular philosophy was called in to account for it. The corpufcles, it was faid, that rife from the Minerals, entering the rod, determine it to bow down, in order to render it parallel to the vertical lines which the effluvia defcribe in their rife. In effect the Mineral particles feem to be emitted from the earth : now the Virgula being of a light porous wood, gives an easy passage to those particles, which are very fine and fubtle; the effluvia then driven forwards by those that follow them, and preffed at the fame time by the atmofphere incumbent on them, are forced to enter the little interffices between the fibres of the wood, and by that effort they oblige it to incline, or dip down perpendicularly, to become parallel with the little columns which those vapours form in their rife.

The primary and most fimple affections of matter, according to the great Mr. Boyle, are (1) Local Motion, (2) Size, (3) Shape, and (4) Reft. But because there are some others, that naturally flow from thefe, and are, though not altogether univerfal, yet very general and pregnant, we shall subjoin those which are the most fertile principles of the qualities of bodies, and other phenomena of nature. Those leffer fragments of matter, which we call corpufcles or particles, have certain local respects to other bodies, and to those fituations which we denominate from the horizon; fo that each of these minute fragments may have a particular (5) pofture or polition, as erect, inclining, horizontal, &c. and as they respect us that behold them, there may belong to them a certain (6) order or confecution, whereby we fay, one is before or behind another ; and many of these fragments being affociated into one mass or body, have a certain manner of exifting together, which we call (7) texture or modification. Almost all bodies, and those fluid ones that are made up of groffer parts, will have (8) pores in them : and very many bodies having particles, which, by their fmallnefs,

OF DISCOVERING MINES. 114

fmallnefs, or their loofe adherence to the bigger or more flable parts of bodies they belong to, are more eafily agitated, and feparated from the reft by heat and other agents; therefore there will be great flore of bodies, that will emit those fubtle emanations, which are commonly called (9) effluvia.

Each of these nine producers of phenomena, admit of a variety fcarcely credible. For not to defcend fo low as infenfible corpufcles, (or those which are imperceptible to natural or artificial opticks, many thousands of them being requisite to conftitute the fize of a muftard feed) what an innumerable company of different bigneffes may we conceive between the bulk of a mite, (a crowd of which is neceffary to weigh one grain) and a mountain, or the body of the fun ! Figure, though one of the most fimple modes of matter, is capable of great varieties, partly in regard of the furface or furfaces of the figured corpufcles, (which may confift of fquares, triangles, pentagons, &c.) and partly in regard of the fhape of the body itfelf, which may be either flat like a cheefe, fpherical like a bullet, eliptical like an egg, cubical like a die, cylindrical like a pump, hexagonal pointed like a pyramid, or conical like a fugar loaf. And yet all these figures are few compared to those irregular shapes, which are to be met with among rubbish, &c. So likewife motion, which feems fo fimple a principle, efpecially in fimple bodies, may even in them be very much diversified ; and as to the determination of motion, the body may move directly upwards, or downwards, declining, or horizontally, eaft, weft, north, or fouth, &c. according to the fituation of the impellent body. There will likewife arife new diverfifications, from the greater or leffer number of the moving corpufcles ; from their following one another close, or more at a distance, &c. from the thicknefs, thinnefs, pores, and the conditions of the medium through which they move ; and from the equal or unequal celerity of their motion, and force of their impulse : and the effects of all these are variable by the different fituation and structure of the fenfories, or other bodies, on which these corpuscles act.

Now there are, first, many bodies, that in diverse cases act not, unless they be acted on; and some of them act, either folely or chiefly as they are acted on by common and unheeded agents. Secondly, there are certain fubtle bodies that are ready to infinuate themselves into the pores of any body disposed to admit their action, or by some other way effect it. Thirdly, there are bodies, which, by a mechanical change of texture, may

116 OF THE VARIOUS METHODS

may acquire or lofe a fitnefs to be wrought upon by fuch unnoticed agents, and alfo to diverfify their operations on it, upon the force of its varying texture. All thefe propositions are proved from the most common, though unheeded affairs and occurrencies of human life; as eafily, as the polarity and magnetifm of an old Iron bar taken from a church window, where it has ftood upright for many centuries, is proved to derive its virtue from the magnetick effluvia of the earth.

As many deny, or at leaft doubt, the attributed properties of the divining rod, I shall not take upon me, fingly to oppose the general opinion, although I am well convinced of its abfolute and improveable virtues. It does not become me to decide upon fo controvertible a point; particularly, as from my natural conftitution of mind and body, I am almost incapable of cooperating with its influence; and, therefore, cannot, of my own knowledge and experience, produce fatisfactory proofs of its value and excellence. I fhall, however, give those accurate observations on the virtues of the Virgula Divinatoria, which I have been favoured with by my worthy friend Mr. William Cookworthy, of Plymouth, a man, not lefs effected for his refined fenfe and unimpeachable veracity, than for his chemical abilities. It is to him the publick is indebted for the late improvements in the porcelain manufactory now eftablished at Briftol, which, under his direction, is likely to be rendered not lefs elegant and durable than the beft Afiatick China.

His first knowledge of the rod, he fays, was from a captain Ribeira, who deferted the Spanish fervice in queen Ann's reign, and became the capt. commandant in the garrifon of Plymouth; in which town he fatisfied feveral intelligent perfons of the virtues of the rod by many experiments on pieces of Metal hid in the earth, and by the actual difcovery of a Copper Mine near Oakhampton, which was wrought for fome years. The captain made no difficulty to let people see him use the rod, but he was abfolutely tenacious of the fecret how to diffinguish the different Metals by it, without which, the knowledge of its attraction is of little use: but by a close attention to his practice, the writer has discovered this, and made many other discoveries of its properties, which he is willing fhould be published, being fully perfuaded of the great utility of this inftrument in Mineral undertakings; and the reader may be affured, that he is fully convinced of the truth of what he communicates from abundant and very clear experience.

may

Captain

Captain Ribeira held, that rods cut from the nut or other fruitbearing trees, were the only proper ones for this use; and that the virtue was confined to certain perfons, and those comparatively few. Agricola fays, " If the attractive power of veins does not " turn the rod, when in the hands of fome particular metallifts " or others, it is owing to fome fingular occult quality in the " holder, which impedes and reftrains the attractive power; " for fince that power moves and turns the rod, in the fame " manner as the Lodeftone invites and attracts Iron, it is " debilitated and deftroyed by the occult quality in the holder, " just as garlick weakens and excludes the attractive quality of " the magnet, for a magnet rubbed over with juice of garlick " does not draw Iron." But this proves to be a miftake of captain Ribeira; for the virtue, as he calls it, refides in all perfons, and in all rods, under the circumftances hereafter defcribed.

The rod is attracted by all the Metals, by Coals, Bones, Limestone, and Springs of Water, with different degrees of ftrength in the following order : 1 Gold, 2 Copper, 3 Iron,, 4 Silver, 5 Tin, 6 Lead, 7 Coals, 8 Limeftone and Springs of Water. One method to determine the different attractions of the rod, is this: Stand, holding the rod, with one foot advanced; put a guinea under that foot, and a halfpenny under the other, and the rod will be drawn down ; fhift the pieces of money, and the rod will then be drawn towards the face or backwards to the Gold, which proves the Gold to have the ftronger attraction. By trying all the fubjects of the rod in the fame manner, their respective attractions in point of ftrength will be found to correspond with the order in which I have already placed them.

The rods formerly used, were shoots of one year's growth that grew forked, as figures 1 and 2, plate 2; but it is found, that two feparate fhoots tied together with fome vegetable fubftance, as packthread, will answer rather better than those which are grown forked, as their fhoots being feldom of equal length or bignefs they do not handle fo well as the others, which may be chosen of exactly the fame fize. The shape of the rod thus prepared, will be between 21 and 3 feet long, like fig. 3, plate 2. They must be tied together at their great or root ends, the fmaller being to be held in the hands. Hazle rods cut in the winter, fuch as are used for fishing rods, and kept till they are dry, do beft; though where thefe are not at hand, appletree

tree fuckers, rods from peach-trees, currants, or the oak, though green, will answer tolerably well.

It is very difficult to defcribe the manner of holding and ufing the rod: it ought to be held in the hands, in the position fig. 4, plate 2, the fmaller ends lying flat or parallel to the horizon, and the upper part in an elevation not perpendicular to it, but 70 degrees, as fig. 4, plate 2.

Alonzo Barba directs the rod to be fixed acrofs the head of a walking flick in form of a T, and the end which is neareft the root will dip or incline to the Mineral Ore.

The rod being properly held by those with whom it will answer, when the toe of the right foot is within the femi-diameter of the piece of Metal or other fubject of the rod, it will be repelled towards the face, and continue to be fo, while the foot is kept from touching or being directly over the fubject; in which cafe, it will be fenfibly and ftrongly attracted, and be drawn quite down. The rod fhould be firmly and fleadily grafped; for if, when it hath begun to be attracted there be the leaft imaginable jirk, or opposition to its attraction, it will not move any more, till the hands are opened and a fresh grasp taken. The stronger the grafp the livelier the rod moves, provided the grafp be fleady, and of an equal ftrength. This observation is very neceffary, as the operation of the rod in many hands is defeated purely by a jerk or counter action ; and it is from thence concluded, there is no real efficacy in the rod, or that the perfon who holds it wants the virtue ; whereas by a proper attention to this circumftance in using it, five perfons in fix have the virtue as it is called; that is, the nut or fruit bearing rod will answer in their hands. When the rod is drawn down, the hands muft be opened, the rod raifed by the middle fingers, a fresh grasp taken, and the rod held again in the direction deferibed.

A little practice by a perfon in earneft about it, will foon give him the neceffary adroitnefs in the ufe of this inftrument : but it muft be particularly obferved, that as our animal fpirits are neceffary to this procefs, fo a man ought to hold the rod, with the fame indifference and inattention to, or reafoning about it or its effects, as he holds a fifhing rod or a walking flick; for if the mind be occupied by doubts, reafoning, or any other operation that engages the animal fpirits, it will divert their powers from being exerted in this procefs, in which their inftrumentality

OF DISCOVERING MINES. 1

inftrumentality is abfolutely neceffary; from hence it is, that the rod conftantly answers in the hands of peasants, women, and children, who hold it fimply without puzzling their minds with doubts or reasonings. Whatever may be thought of this observation, it is a very just one, and of great confequence in the practice of the rod.

If a rod, or the leaft piece of one, of the nut bearing or fruit kind, be put under the arm, it will totally deftroy the operation of the Virgula Divinatoria in regard to all the fubjects of it, except water, in those hands in which the rod naturally operates. If the leaft animal thread, as filk, or worfted, or hair, be tied round or fixt on the top of the rod, it will in like manner hinder its operation; but the fame rod placed under the arm, or the fame animal fubftances tied round or fixt on the top of the rod, will make it work in those hands, in which, without these additions, it is not attracted.

The willow, and other rods, that will not anfwer in the hands, in which the fruit or nut bearing rods are attracted, will anfwer in those hands in which the others will not; fo that all perfons using fuitable rods in a proper manner, have the virtue as it is called of the rod. A piece of the fame willow placed under the arm, or the filk, worsted, or hair, bound round, or fixt to the top of it, will make it answer with those to whom the nut or fruit bearing rods are naturally fuitable, and in whose hands without those additions it would not answer.

All rods, in all hands, answer to springs of water.

A piece of Gold held in the hand, and touching the rod, will not only hinder its being attracted by this Metal; but, on the contrary, the rod will be repelled towards the face. It is the fame in regard to Copper as well as Gold, if the latter is held in the hand.

If Iron is fo held, the rod will be repelled by that means. If any of the white Metals, viz. Silver, Lead, or Tin, be held in the hand, the rod will not be attracted, but repelled by all those Metals. It is the same with Limestone, Bone, and Coal. And, vice versa, if a person with whom the rod doth not naturally operate, holds a piece of Gold in his hand, the rod will then be attracted by Gold and Copper. The same holds good with all subjects of the rod.

On

OF THE VARIOUS METHODS

120

On these properties of the rod, depends the practice of distinguishing one Metal or subject from another. There is, however, another way of distinguishing, drawn from the same principles, but much more certain and ready than the former; and that is by preparing rods, that will only operate on Gold and Copper, Iron, the white Metals, Coals, Bones, and Limestone.

Thus, if a rod is wanted for diftinguishing Copper or Gold, procure filings of Iron, Lead, and Tin, fome leaf Silver, Chalk in powder, Coal in powder, and rasped bones: let a hole be bored with a small gimlet in the top of the rod; then mix the least imaginable quantity of the above ingredients, and put it in the gimlet hole with a peg of the same wood with the rod, when it will only be attracted by what is left out, viz. Gold and Copper.

In preparing a rod for diffinguifhing the white Metals, leave out the Lead, Tin, and leaf Silver, and add Copper filings to the other ingredients; and fo of every fubject by which you would have the rod attracted, the refpective filings, or powder, must be left out of the mixture, which is to be put into the hole, at the top of the rod. As for Coal and Bones, they may be omitted in the diffinguishing rods that are used in Cornwall, for obvious reasons : but it is neceffary to put in the Chalk or Lime; for though there is no Limeftone in the Mining part of the county, yet there are abundance of strata that draw the rod as Limeftone; for the diffinction of a dead or a live courfe, holds as well in regard to Limeftone, as to the Metals. This, however paradoxical it may appear, is a truth eafily to be proved; and it is one axiom in the fcience of the rod, that it makes no diffinction between the living and dead parts of a courfe. Like the Lodestone, it only shews the courfe, leaving the fuccefs of the undertaking, to the fortune, skill, and management of the Miner; as the Lodestone doth that of the voyage, to the fortune, ability, and prudence of the mariner and merchant.

It is advifable for young beginners to make no experiments but about actual Lodes, where the backs of them are known by the Miners; or elfe nigh the fea, where a Lode being difcovered, they may trace it to the cliffs, and will be fure to find it.

The fame holds

The all hubjeds of the rod

The rod being guarded against all subjects except that which you want to difcover, as Tin and Copper for example; walk fleadily and flowly on with it; and a perfon that hath been accuftomed to carry it, will meet with a fingle repulsion and attraction, every three, four, or five yards, which must not be heeded, it being only from the water that is between every bed of Killas, Grouan, or other strata. When the holder approaches a Lode fo near as its femidiameter, the rod feels loofe in the hands, and is very fenfibly repelled toward the face; if it is thrown back fo far as to touch the hat, it must be brought forward to its usual elevation, when it will continue to be repelled till the foremost foot is over the edge of the Lode : when this is the cafe, if the rod is held well, there will first be a fmall repulsion towards the face; but this is momentary; and the rod will be immediately drawn irrefiftibly down, and will continue to be fo in the whole paffage over the Lode; but as foon as the foremost foot is beyond its limits, the attraction from the hindmost foot, which is still on the Lode, or elfe the repulsion on the other fide, or both, throw the rod back toward the face. The diftance from the point where the attraction begun, and where it ended, is the breadth of the Lode; or rather, of a horizontal fection of the bryle or back juft under the earth. We must then turn, and trace it on obliquely, or in the way of zig zag, as far as may be thought neceffary.

In the courfe of this tracing a Lode, all the circumftances of it, fo far as they relate to its back, will be difcovered; as its breadth at different places, its being fqueezed together by hard ftrata, its being cut off and thrown afide from its regular courfe by a Crofs-Goffan, &c.

In order to determine this, it will be neceffary, that fome one prefent fhould either cut up a turf, or place a flone at the places where the rod began, and on the other fide where it ceafed to be attracted.

To Grals ; more y

The draughts, in plate 2, of Veins parted and proved according to the above directions, may make this fufficiently clear. The dots reprefent the turf or ftone; and the zig zag, the line in which the operator moves in purfuing the Vein. Fig. 5, is a Lode going on eaft and weft regularly, with the repulfion expressed by the lines north and south on each fide. Fig. 6, is a Lode squeezed by a hard ftrata in some places almost to a ftring. Fig. 7, is a Lode cut off by a Cross-Gostan, wherein the I i method

122 OF THE VARIOUS METHODS

method for difcovering of the feparated part is obvious to any intelligent Miner, upon the fame line at grafs with the rod, as underground with the Pick and Gad.

In tracing a Lode for a confiderable length, there is no neceffity for the zig zag traverfing, but it may be done according to the delineation fig. 8, wherein the operator endeavours to keep the middle of the Lode, and turns when the rod, by its repulfion, intimates that he is got beyond it.

If the rod is well held, its motion is furprifingly quick and lively: nothing is neceffary, but to keep the mind indifferent, to grafp the rod pretty ftrongly, and fteadily; opening the hands, and raifing the rod with the middle fingers, every time it is drawn down. If the rod is raifed and replaced without opening the hands, it will not work.

The difcovery of the Metal a Lode is naturally difpofed to contain, is very eafy: try it with a diffinguishing rod; if it attracts it, it contains the Metal that is left out of the mixture at the top of that rod; if it draws more than one rod, the Lode is compounded of those Metals.

Copper Lodes generally draw the rod diffinguishing Iron, because of the ferruginous Gossan contained in them; but Tin Lodes frequently draw none but their proper rod, unless Gal, which is a kind of Iron Ore, is intermixed.

It has been faid above, that the rod makes no diffinction between the living or dead parts of a Lode: though this is invariably true, yet this inftrument is of great ufe, as it helps us to trace any known Lode from the fpot where it is wrought, through other people's lands who might be willing to try it.

If the Lode is alive to its top, or as it is ufually phrafed by the Tinners, To Grafs; more work may be done in the way of difcovery with the rod in a quarter of an hour, than by the ufual methods in months, as a perfon has nothing to do, but to open the Lode immediately at grafs, and difcover its fize and underlie, which may be done at a trifling expence.

The difcovery of Crofs-Goffans by the rod, is a property which may be usefully employed in Mining, particularly in driving driving adits, as the driving an adit through a Crofs-Goffan is much eafier than through the country.

In feeking for water by the rod, no notice is to be taken of those fingle attractions of the rod which are occasioned by the commissures or crevices (called Cafes of Water by the Tinners) between the courses or distinct runs of Killas; but a vein must be found, which answers to the rod as a Metal, and if this is funk unto a proper depth, a good quantity of water will be discovered.

It may not be amifs to clofe this little effay on the Virgula Divinatoria, with fome few striking instances of courses, that have been cut by means of it in Cornwall.

A quantity of grain Tin having been found in the pond at Heligan, the feat of the reverend Mr. Henry Hawkins Tremayne; and it being a queftion, whether this Tin might not come from fome neighbouring Lode, it was difcovered by the rod and funk upon; but it proved a barren Vein for Metal in any quantity. A fhaft was funk at St. Germains, near the houfe of Francis Fox, to difcover water; it drew the rod as Iron, and contained Mundick : another shaft was funk between Penzance and Newlyn, according to the direction of the rod; the faft lay deep beneath the furface, but a Lode containing much Mundick was discovered. In a close just by St. Austle, to fatisfy the curiofity of fome gentlemen, Mr. Cookworthy difcovered by the rod the back of a Lode that had been wrought, but not turning to advantage the undertaking had been dropped, and the ground levelled. This Lode was traced just as the Miners informed the gentlemen it ran; and the Lode appearing by the rod at a certain place to be fqueezed to nothing, the Miners declared this alfo to be true; for at this very fpot where the Lode was thus fqueezed, they loft it. Being required to difcover a Lode that had been tried in the cliff under St. Auftle Down, he found it in the country by the rod, and traced it to the cliff. It was a large Goffan-Lode; and as the attraction was found to ftop, and after paffing on a foot or two to begin again, he declared this was a cleft Lode, and had what the Miners call a Horfe in it, which the Miners prefent who had wrought in it declared to be true.

Hence it is very obvious, how useful the rod may be for difcovery of Lodes, in the hands of an adept in that fcience; but

OF THE VARIOUS METHODS

but it is remarkable, that although it inclines to all Metals in the hands of unfkilful perfons, and to fome more quick and lively than to others, yet it has been found to dip equally to a poor Lode, and to a rich one. I know that a grain of Metal attracts the Virgula, as ftrongly as a pound; nor is this any difadvantage in its ufe in Mining; for if it difcovered only rich Mines, or the richer parts of a Mine, the great prizes in the Mining lottery would be foon drawn, and future adventurers would be difcouraged from trying their fortune. But, indeed, we are fo plentifully ftored with Tin and Copper Lodes, that fome accident every week difcovers to us a frefh Vein; rich Mines having been feveral times difcovered by children playing, and digging pits in imitation of fhafts, whereby profits have arifen to their parents and others; and thefe puerile difcoveries have in fundry places borne the name of Huel-Boys to this day.

Another way of difcovering Lodes is by finking little pits through the loofe ground, down to the faft or folid country, from fix to twelve feet deep, and driving from one to another acrofs the direction of the Vein; fo that they muft neceffarily meet with every Vein lying within the extent of thefe pits; for moft of them come up as high as the fuperficies of the firm rock, and fometimes a fmall matter above it. This way of feeking, the Tinners call Cofteening, from Cothas Stean; that is, fallen or dropt Tin.

Another and very ancient method of difcovering Tin Lodes, is by what we call Shodeing; that is, tracing them home by loofe Stones, fragments, or Shodes (from the Teutonick Shutten to pour forth) which have been feparated, and carried off, perhaps, to a confiderable diffance from the Vein, and are found by chance in running waters, on the fuperficies of the ground, or a little under.

When the Tinners meet with a loofe fingle ftone of Tin Ore, either in a valley, or in plowing, or hedging, though at a hundred fathoms diftance from the Vein it came from; thofe who are accuftomed to this work, will not fail to find it out. They confider, that a metallick Stone muft originally have appertained to fome Vein, from which it was fevered and caft at a diftance by fome violent means. The deluge, they fuppofe, moved moft of the loofe earthy coat of the globe; and, in many places, wafhed it off from the upper, towards the lower grounds, with fuch a force, that moft of the backs of Lodes or Veins which protruded

124

OF DISCOVERING MINES. 125

protruded themselves above the fast, were hurried downwards with the common mass: whence the skill in this part of their business, lies much in directing their measures according to the fituation of the surface.

Upon the top of moft Tin Lodes, in the fhelf or ftratum under the loofe mould and rubbifh of the earth, is that mineralized fubftance, which is called the Broil or Bryle of the Lode. Though it is a part of the Lode, yet it is different in fituation and appearance from all other parts of it; forafmuch as it is not confined between two walls, the ftratum fo near the furface being of a more lax tender texture, than in the folid rock a fathom or two under it. The Bryle, therefore, is very loofe, and in fome places fcarcely metallick, for want of depth, and of thofe lateral chinks and cracks, which feed and nourifh the Lode, at deeper levels, with Mineral principles educed from the ftrata of the earth.

Copper and Lead Shodes are very feldom met with ; yet fuch

Such is the Bryle of a Lode ; confequently, when the waters of the deluge retired into their refervoir, great part of the Bryles of Lodes were carried off by the force of the waters to various diftances, according to the gravity of Shode Stones, and the declination of the plane upon which they were difperfed. Tinners who defcribe this diffribution of Shode, to make it more eafily underftood, compare it to a bucket of water difcharged upon the declivity of a hill; near the bucket, it will take up but a fmall fpace; but as it defcends, will fpread wider, in the manner of a truncated cone.

Hence it is manifest to reason and experience, that the more diftant Shodes are from the Bryle of the Lode, the more diverged they are, and fewer in number; and, by parity of reafoning, they are more in quantity near to the Bryle, and are collectively in lefs fpace. Neverthelefs, in fome certain fituations, they are in greater quantities in valleys, than on the tops or fides of hills; but fuch are fmaller, and more eafily carried down by water, and formed into ftrata, which furnish our ftream works. In level ground, they are found fcarcely removed from the Bryle; but on a declivity, they are always found difperfed on the fides of the hill, at a greater or lefs diftance, in proportion to the length or declivity thereof, and their own specifick weight : confequently, the heaviest Stones are nearest to the Lode, and the lighter are protruded to a greater diffance (even to five miles diftance, as it is faid in Philos. Transactions no. 69) which Kk

126 OF. THE VARIOUS METHODS

which are alfo nearer to the foil, by means of their levity and fize; while the more grofs and weighty lie deeper interred as they are nearer the Lode. It is almost needlefs to observe, that as the texture, gravity, and black or brown colours of Tin Shodes, are different from all others; fo they are thereby known and diftinguissed, as well as by the smoothness of them a great distance from the Lode, and the acuteness of their angles when near to it; which entirely depends upon the trituration they have undergone, rolling over rough furfaces, by the force of water, and the attrition of other bodies passing over them.

Henckell and Rofler fay, "That Mundick Shode is very "common; and that Wolfram, Granate, and Iron Corns, nay "Quickfilver, are found in Shode and Stream." "All of which," Henckell further fays, "were washed and tore away from their "Veins, by the violence of the Noachian deluge."

Copper and Lead Shodes are very feldom met with; yet fuch there are. Their Bryles being chiefly composed of tender unmetallick Goffan, is not fo well disposed for bearing that force and attrition, as the more stoney matter of Tin Lodes are; and the former generally is not mineralized into Copper Ore at the Bryle.

It is a miftake in those who deny the existence of any other Shode but Tin; so far from it, every hard stratum of the earth which is uppermost, will shew us numbers of their Shodes dispersed from them at a distance, and reclined upon strata of quite different natures, as hills and vallies are fituated to help forward or retain those rocky fragments. I think our distinct loose Moorstone, or Granite rocks, upon the fides, and at the bottoms of our mountains, are the Shodes of their strata underneath; and many large Shodes of Irestone are to be seen, though in less plenty, dispersed upon Killas strata at a distance from their parent rock : all of which are incontessible witness of those violent conquasifiations and convulsions of our country, at the time of the flood.

It is much to be lamented, that the fcience of Shoding is greatly loft in the prefent age. Among all our Miners, we have not fifty, who fcientifically or experimentally underftand any thing of the matter; and those that are intelligent therein, are become old and feeble; whereby it is much to be feared,

OF DISCOVERING MINES, 127

that this useful, and I think improveable science, is in danger of being practically lost.

Almost every Lode has a peculiar coloured earth or grewt (grit) about it; which is also fometimes found with the Shode, and that in greater quantity, the nearer the Shode lies to the Lode; beyond which that peculiar grewt is feldom found with the Shode. A valley may happen to lie at the feet of three feveral hills, and then they may find feveral deads grewt or earth moved by the waters of the deluge, but not contiguous to the Lode, with as many different Shodes in the middle of each. This is also termed the Run of the country; and here the knowledge of the caft of the country, or each hill in respect of its grewt, will be very neceffary, for the furer tracing them one after the other as they lie in order.

Likewife, when the Miners find a good Stone of Ore or Shode in the fide or bottom of a hill, they first of all observe the fituation of the neighbouring ground, and confider whence the deluge could most probably roll that Stone down from the hill : and at the fame time they form a fuppolition, on what point of the compass the Lode takes its course : for if the Shode be Tin, or Copper Ore, or promifing for either, they conclude that the Lode runs nearly east and west; but if it is a Shode of Lead Ore, they have equal reafon to conclude that the vein goes north and fouth. After finding the first Stone or Shode, they fink little pits as low as the fast rubble, which is the rubble or clay never moved fince the flood, to find more fuch Stones; and if they meet with them, they go further up the hill in the fame line, or a little obliquely perhaps, and fink more pits ftill, while they find Shode Stones in them; but they feldom fink those pits deeper than the rubble upon the shelf, except they are near the Lode. If the Shode is found in the vegetable foil, the Lode is not at hand; but if it lies deep, maffy, and angular, it is a certain fign that the Lode is not far off; more efpecially if the Shodes are of a pyramidal or conical form, and the bafe or heaviest part of them lies pointing one way, it is both a fign that the Lode is not far off, and that it is to be found opposite to the base or heaviest part of the Stones.

The account which the learned Alvaro Alonzo Barba gives of difcovering Silver Mines, by what I take to be Shoding; is very much like mine, and is as follows, p. 79. "The Veins of "Metal are fometimes found by great Stones above ground; " and

OF THE VARIOUS METHODS

" and if the Veins be covered, they hunt them out after this "manner, viz. taking in their hands a fort of mattock (a pick) "which hath a fteel point at one end to dig with, and a blunt head at the other to break ftones with, they go to the hollows of the mountains, where the downfall of rain defcends, or to fome other part of the fkirts of the mountains, and there obferve what Stones they meet withal, and break in pieces those that feem to have any Metal in them; whereof they find many times both middling fort of Stones, and fmall ones also of Metal. Then they confider the fituation of that place, and whence these Stones can tumble, which of neceffity must be from higher ground, and follow the tract of these Stones up the hill, as long as they can find any of "them," &c.

But to return-As they advance thus nearer the Lode with their pits, they find their Shode more plentiful and deeper in the ground; but if they chance to go further from the Lode, or pass the yonder fide of it, there is a greater fcarcity of the Shode, or perhaps none at all : in which cafe, they return to their laft pit which produced Shode most plentifully, and work the intermediate ground, with more care and circumfpection, by drifts from one pit to the next, until they cut the Lode. Sometimes they find two different Shodes in the fame pit at different depths; then they are fure, that there is another Lode further on; and in training up to the fecond, they may meet with the Shode of a third. However, when they are just come to the Vein they fet out for, they find an uncommon quantity of Shode Stones answering to the description before given, and then they fay, that they have the Bryle of the Lode; upon which they dig down into the folid hard rock, which was never moved or loofened, until they open the Lode, and find its

Some Lodes, however, are fo difpofed, that they yield no Shode at all, nor are they to be difcovered in a good depth; which may happen to be the cafe for feveral reafons. The fituation of fome places might have preferved their Veins from having their furfaces torn up and difperfed by the flood; or elfe, being fo much torn and diffurbed, their loofe Bryle might have been totally carried off to a vaft diffance, towards which its poverty for Metal and confequential levity might contribute; in the place of which, a fediment or earthy part might have fettled, and buried the Lodes fo deep, that they are not difcoverable

the Lode is not at hand; but if it lies deep, maily, and angu-

128

OF DISCOVERING MINES. 129

discoverable by shoding. Again, the backs of some Veins are depreffed, and fo deep under the firm folid rock which lies over them, that they do not make a rife or back immediately up to the loofe ftone or earth ; that is to fay, fome Lodes make no back at all, and therefore produce no Shode, fo that it is impoffible to difcover them, except by fome favourable accident, of which I have known feveral inftances.

These different dispositions of the strata I have taken notice of, fometimes deceive the Miners in fhoding for Veins; for when they suppose that there is but one bed or layer of stones or earth over the firm ground, and there happens to be a double ftratum of rock and rubble between, which is far from being uncommon, perhaps they dig no deeper than the first fhelf; in other words, they dig no deeper than till they think they are come down almost to the fast or firm ground, where they expect to find either the Shode or the Bryle of the Lode; but as they are covered by the other shelf or stratum, which the Miners are not apprized of, they have their labour for their pains, in feeking in fuch uncertain ground, which perhaps contains a double or treble fhelf.

The Miners are of opinion, that the waters by their great emotion, did not only remove, and confuse the furface of the earth, but alfo broke the loofer parts of Veins from off their fuperficies or backs; and thereby difordered and removed the face of the earth as deep as the faft and firm rock or ftratum, as I have faid before : and indeed our apprehenfion of the matter very much favours this fuppofition : whence, undoubtedly, those Shodes or fragments of Veins are the veftiges or remains of the deluge. Hence it is, that part of the Shode has been rolled down the declivities of hills from the Mines; moreover, that Shode which is found a great way diftant from the Mines, is much more worn and fmoother than that which is nearer to it, as it happens to ftones on the fea fhore, or on the fides of rapid rivers, which are fretted and worn fmooth by the agitation of the waters, and the friction of other bodies. If any perfon will but confider the fea cliffs, he may obferve, in feveral places, that the upper coat or covering of the earth, has been greatly moved and agitated; and that the loofe ftones did preponderate and fubfide on the firm rocks, purfuant to their specifick gravities; next those, the rubble refided, and over all the pure light earth refted. Yet this order is not absolutely perfect and without exception; for loofe ftones are often found in the light earth,

L 1

o OF THE VARIOUS METHODS

earth, and on its fuperficies; which by the impetuofity of the waters, and fituation of particular places, were molefted in fubfiding. For we are not to fuppofe our globe to refemble a trough, or the like excavated figure, wherein the varioufly mixed earths are to be regularly difpofed, as in the operation of buddling or wafhing of Ores; but to be of a fpherical arched figure, where the waters, as on a hanging bottom, powerfully rend, and pull it afunder: and this force of the waters we may fuppofe to be greateft at the beginning and end of the deluge.

So likewife, in fome places, the loofe earth and ftone, which cover the firm rocks, lie in ftrata; for immediately on the rock, there may be, for inftance, a layer of fand or clay, and over that a bed of large ftones, and fo alternately ftratum fuper ftratum, for fome depth. Now thefe variations might very well happen on the decreafe of the deluge : for when the flood was high and more at reft, the flimy light earth was deposited downwards; but when the waters came lower, and bent their courfe to the beach, then it came to pass that there was a ftrong current from off the land to the fea, which rolled down the loofe ftones upon the mud or fediment that fell and fettled beforehand; fo this current might have been interrupted again by the fituation of the place and interpolition of high ground, till the water had let fall another fediment, and afterwards found or perhaps broke another paffage for itfelf through the land. This might have happened feveral times in the deluge, till at laft the remaining water partly evaporated and partly funk into the ground, leaving the deepeft earth or fediment where it continued longeft; as it happens frequently in floods or overflowings of water, where we may observe the fituation of high and low grounds do not a little contribute to the fame kind of effects that are here fpoken of.

Another way of difcovering Lodes, is by working drifts acrofs the country as we call it, that is from north and fouth, and vice verfa. I tried the experiment in an adventure under my management, where I drove all open at grafs about two feet in the fhelf, very much like a level to convey water upon a mill wheel; by fo doing I was fure of cutting all Lodes in my way, and did accordingly difcover five courfes, one of which has produced above one hundred and eighty tons of Copper Ore, but the others were never wrought upon. This method of difcovering Lodes, is equally cheap and certain; for a hundred fathoms

130

fathoms in a fhallow furface may be driven at fifty fhillings expence.

In feafible (tender ftanding) ground, a very effectual, proving, and confequential way is, by driving an adit from the loweft ground, either north or fouth ; whereby there is a certainty to cut all Lodes at twenty, thirty, or forty fathoms deep, if the level admits thereof. Such depths are proving the Lodes difcovered by them, and the adit will ferve to drain all parts of the ftrata above it ; and likewife be a difcharge for all water drawn from the Mine into it; fo that it is effectual for difcovery, proving for trial, and confequential to the future working of a Mine. But in Granite, Elvan, and Ireftone ftrata, this cannot be complied with, neither is it adviseable but under certain circumftances, where the ground is to be wrought for eighteen fhillings & fathom, unlefs a Crofs-Goffan lies ready at hand, when the method in use is to drive partly on one fide of the Goffan, breaking down the adjunct wall of it, whereby they drive the adit cheaply, expeditioufly, and effectually for difcovery.) In driving adits or levels across, north or fouth, to unwater Mines already found, there are many fresh Veins discovered, which frequently prove better than those they were driving to. Witnefs the Pool adit in Illugan, where the late John Pendarvis Baffet, Efq; cleared above one hundred and thirty thousand pounds. I m made clean from all wafte, and ready for in.

and ni villamma avoid IC H A P. a II. - volgras of electros

Of Streaming, and Smelting of Stream Tin in the Blowing-Houfe, &c.

or land owner; for liberty, from

W E cannot help repeating in this place, that the deluge is an event which has produced the moft remarkable alterations in the earth, and to which many effects obfervable at this day are to be afcribed. The hiftory of the deluge gives great light towards the knowledge of nature, and the prefent flate of the earth feems to verify that event : by the violence of the deluge the Mineral kingdom was thrown into confusion, parts before conjoined were feparated, Ores and Veins were diflodged, and new beds and politions given them. The feveral ftrata in which Minerals are at prefent found, afford convincing inflances, as well of the truth of this event, as of the confusion wrought by it, effective

132 OF STREAMING, AND

efpecially in parts where Clay, Sand, Rubble, Stone, and the like, lie in beds and layers on each other. But I fuppofe there are no particular inftances under the fun, that can afford us fo clear an idea of the flood and its effects, as the Stream works in St. Auftle, Roach, St. Dennis, St. Stephen's, Luxillian, and Lanlivery.

It happens that what I have already faid in my account of fhode and fhoding, together with my fection on the article Tin in chapter the 3d, book the 1ft, leaves little more for me to fay on the fubject of Stream Tin. I muft, therefore, wave the defcription of it here, and refer the reader back to those places. Of courfe nothing elfe remains than to defcribe the manner of Streaming, upon which I fhall be concise because it is a part of my subject that is very simple and less important than deep Mining to the community in general; but as it occurs, in the course of my writing, more naturally in conjunction with or immediately after the method of stream, I beg leave to introduce it in this place.

When a Streaming Tinner obferves a place favourable in fituation, he takes a leafe, commonly called a Set, of the land owner or lord of the fee, for fuch a fpot of ground, and agrees to pay him a certain part clear of all expence in Black Tin; that is, Tin made clean from all wafte, and ready for fmelting. The confideration is generally one fixth, feventh, eighth, or ninth, as can be fettled between them; or, inftead thereof, he contracts to employ fo many men and boys annually in his Stream work, and to pay the land owner, for liberty, from twenty to thirty fhillings a year for each man, and fo in proportion for every boy; that is, for twelve fhillings monthly wages, he articles to pay the lord half as much as for a man.

He then finks a hatch (fhaft) three, five, or feven fathoms deep, to the rocky fhelf or clay; on both of which in the fame valley, the Tin is frequently ftratified, without any difference in its being more abundant in one than the other. It is found in different places, in different depths; and fometimes ftratified between what is called a firft, fecond, or third fhelf, which is reconcileable upon the principles laid down in my chapter upon fhoding, &c. The ftratum of Stream Tin may be from one to ten feet thicknefs or more; in breadth, from one fathom to almost the width of the valley; and in fize, from a wallnut to the fineft fand, the latter making the principal part of the Stream,

SMELTING OF STREAM TIN.

133

Stream, which is intermixed with ftones, gravel, and clay, as it was torn from the adjacent hills.

When he finks down to the Tin ftratum, he takes a fhovel full of it, and washes off all the waste; and from the Tin which is left behind upon the fhovel, he judges whether that ground is worth the working or not. If it is proving work, he then goes down to the loweft or deepeft part of the valley, and digs an open trench, like the tail or low flovan of an adit, which he calls a Level, taking the utmost care to lose no levels in bringing it home to the Stream. This level ferves to drain and carry off all water and wafte from the workings, in proportion as he hath a weak or powerful current of water to run through it. Some places are very poor and not worth the expence for working; others again are very rich and thence called Beuheyle or Living Stream, as is most commonly the cafe if it is of a Grouan nature, which being more lax and fandy, is more eafily feparated from its native place or Lode, and therefore more abundant and rich in quality according to the known excellence of Grouan Tin.

In the latter cafe, the Streamer carries off what he calls the Overburden, viz. the loofe earth, rubble, or ftone, which covers the Stream, fo far and fo large, as he can manage with conveniency to his employment. If in the progrefs of his working he is hindered, he teems (or lades) it out, with a fcoop, or difcharges it by a hand pump : but if those fimple methods are infufficient, he erects a rag and chain pump fo called; or if a rivulet of water is to be rented cheaply at grafs, he erects a water wheel with ballance bobs, and thereby keeps his workings clear from fuperfluous water, by difcharging it into his level : mean while his men are digging up the Stream Tin, and washing it at the fame time, by cafting every shovel full of it, as it rifes, into a Tye, which is an inclined plane of boards for the water to run off, about four feet wide, four high, and nine feet long, in which, with fhovels, they turn it over and over again under a cafcade of water that wafhes through it, and feparates the wafte from the Tin, till it becomes one half Tin.

Though there is little dexterity in this manœuvre, yet care is requifite to throw off the Stent or rubble from the tye to itfelf, whilft another picks out the Stones of Tin from the Garde or fmaller pryany part of it. During this operation, the beft of M m the

OF STREAMING, AND

the Tin, by its fuperior gravity, collects in the head of the tye directly under the cafcade; and by degrees becomes more full of wafte, as it defcends from that place to the end or tail of the tye, where it is not worth the faving. If there is a copious ftream of water near at hand, they caft this refufe into it, by which it is carried fo far as to make its exit into the fea, for which practice they certainly deferve our fevereft cenfure; at leaft, if the choaking of harbours and rivers, and the deftruction of thoufands of acres of improvable meadow land, are not more than an equivalent for the cafual and temporary profits arifing from Stream Tin.

I need not mention, that in the ufual method of Streaming for Tin, the foil is either thrown into the bed of the rivers, or buried under the gravel and ftones that form the interior ftrata; by which fuch land is rendered irreclaimable. That the Bounder, or working Tinner, fhould thus wantonly deftroy what he had no intereft in preferving, feems by no means extraordinary; but can we fay the fame for the lord of the foil ?

Surely, it did not require any great degree of penetration, to have comprehended Streaming and Draining under one idea, and thus have made the improvement of the furface go hand in hand with the extraction of the Tin. The additional trouble of removing back the foil in heaps, and levelling the Stream ground to receive it, is fo little that I know, by feveral inflances, the Tinner will have but little reluctance in acceeding to; which the reader will readily apprehend when I affure him, the overburden upon the Stream is digged and rolled off at fome diftance, for only eightpence a cubick fathom; but at all events it is the intereft of the proprietor to have it done, either by the Streamer or fome other perfon. This method has been purfued in fome parts of the county of Cornwall, and has been attended with the fuccefs to laudable an undertaking merits; as thereby those fprings which lie too deep for the ordinary modes of draining, have been most effectually cured. I hope I shall not be accufed of exaggeration when I affert, that the rental of this county, by following this obvious method of procedure, might have been increased in a proportion almost equal to the present value of the Stream Tin; and this too without leffening its produce, or injuring in the fmalleft degree the ducal revenue.

That this practice was not adopted by our anceftors, was owing to the fmall comparative value of land in those days, confidering

134

SMELTING OF STREAM TIN. 135

confidering either the flate of population or the uncertain and precarious tenures under their feudal lords. But when Britons have long fince wrefted, from their petty monarchs, the property of the foil, together with the invaluable privilege of transmitting their improvements from father to fon, that a cuftom fo injurious to the community, as well as to the individual, fhould ftill continue;

" Et dici potuiffe, et non potuiffe refelli."

After the Tin is thus partly dreffed in the raifing of it, they carry it to grafs; and when a competent quantity is collected, they proceed to drefs it for blowing. There are feveral ways of dreffing this kind of Tin; but the general method is, to make what they call a Gounce, which is nothing more than a fmall tie before defcribed, and what we call in the Mining parts a Strêke, in which the fmaller tin is washed over again as was done before in the tye, but with a lefs current of water, and a larger degree of care and caution, left the Tin be carried off with it. The richer part of the Tin, as before mentioned, lies nearest the head of the gounce, which is carefully taken up, divided, or kept feparate, according to its goodnefs, and put into large vats or kieves; while the wafte that lies in the hinder part of the gounce, is dreffed over again, till all the Tin is taken out, and the remaining wafte becomes abfolute refuse. The Tin is then fifted through wood or wire fieves, whereby the greater particles are divided from the fmaller; by this method, likewife, the wafte from its levity lies uppermoft in the fieve, which is carefully fkimmed off, and laid afide to work over again. The fmalleft Tin which paffes through the wire fieve, is put into another finely weaved horfe-hair fieve, called a Dilluer, by which and the skill of the workman, it is made merchantable. Some of the nodules or lumps of Tin are blowed or fmelted as they come out of the tie; but those which are mixed with wafte, are put with the refuse of the garde and poor Tin, which were in the tails of the tye and gounce, and being fent to the ftamping mill, are triturated and pulverifed, fo that all wafte may be cleared from the Tin by fundry ablutions, the fame as are performed in the dreffing of Mine-Tin, it must don't in must

Befides these Stream works, we have another fort of them occasioned by the refuse and leavings from the stamping mills, &c. which are carried by the rivers down to the lower grounds ; and

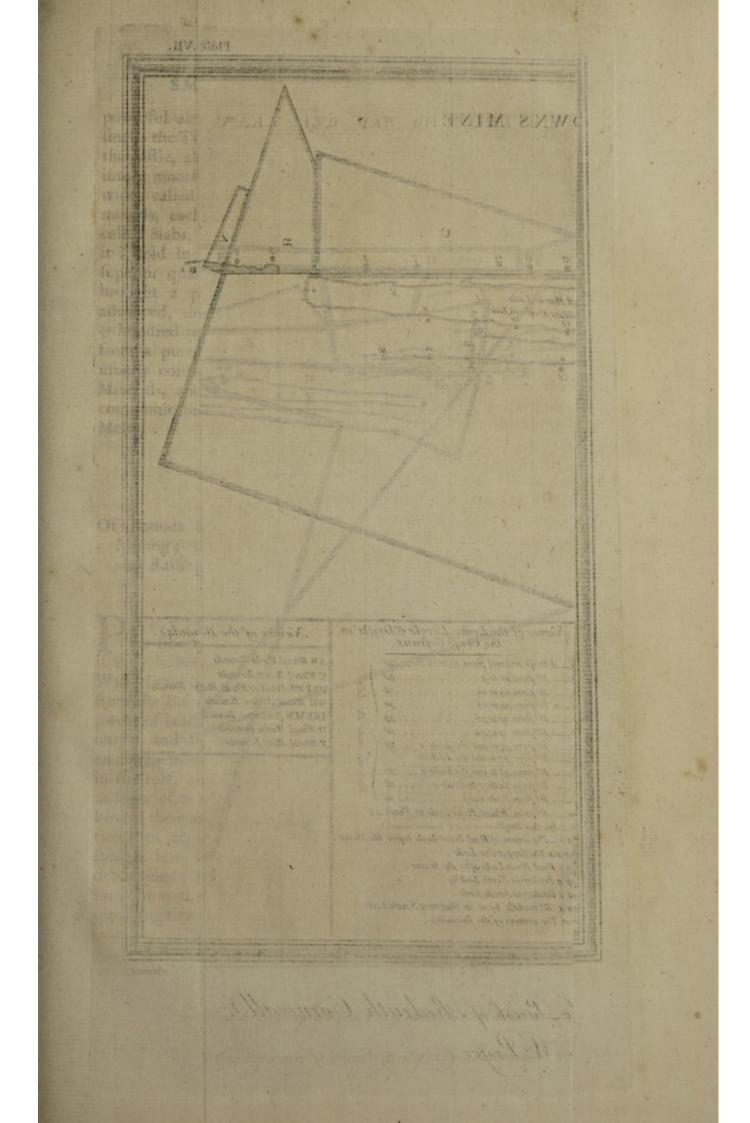
OF STREAMING, AND

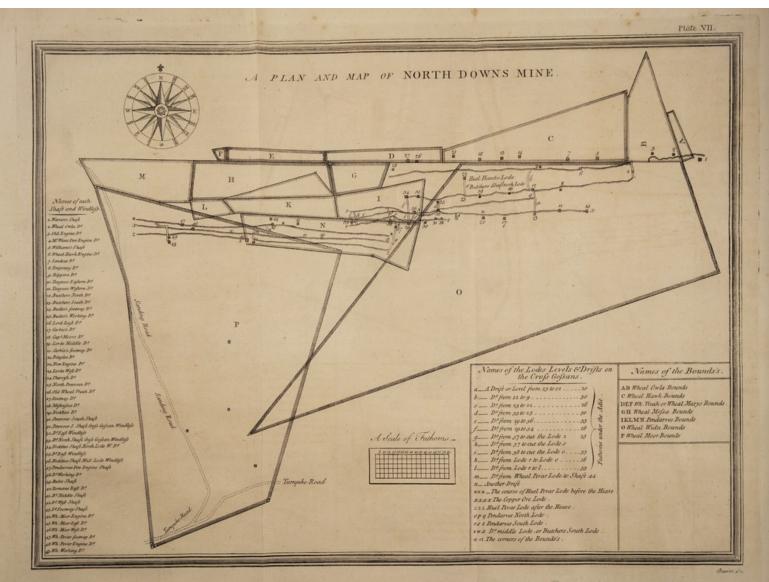
and after fome years lying and collecting there, yield fome money to the laborious dreffers, whom they diffinguish by the name Lappiors, I suppose from the Cornish word Lappior, which fignifying a Dancer, is applied to them, from the boys and girls employed in this work, and moving up and down in the buddles, to feparate the Tin from the refuse, with naked feet like to the ancient Dancers. I have been told, that about feventy years back, the low lands and fands under Perran Arwothall, which are covered almost every tide with the fea, have, on its going off, employed fome hundreds of poor men, women, and children, incapable of earning their bread by any other means. To return :

Stream Tin being prepared and made ready for blowing with a charcoal fire, is carried to the blaft furnace, which is called a Blowing-Houfe ; where, formerly, the Tinner might have his Tin blown, paying the owner of the houfe twenty shillings for every tide or twelve hours, for which the blower was obliged to deliver to the Tinner, at the enfuing coinage, one hundred grofs weight of white Tin for every three feet, or one hundred and eighty pounds of Stream Tin fo blown; which is equal to fourteen pounds of Metal for twenty of Mineral, clear of all expence. Now, that the blowing-houfes are farmed, the Tin is ufually blown and fold by fample, as the Mine-Tin is at the reverberatory furnaces.

The furnace itself for blowing the Tin, is called the Caftle, on account of its ftrength, being of maffive ftones cramped together with Iron to endure the united force of fire and air. This fire is made with charcoal excited by two large bellows, which are worked by a water wheel, the fame as at the Iron forges. They are about eight feet long, and two and a half wide at the broadeft part. The fire place, or caftle, is about fix feet perpendicular, two feet wide in the top part each way, and about fourteen inches in the bottom, all made of moorftone and clay, well cemented and cramped together. The pipe or nofe of each bellows is fixed ten inches high from the bottom of the caftle, in a large piece of wrought Iron, called the Hearth-Eye. The Tin and charcoal are laid in the caftle, ftratum fuper ftratum, in fuch quantities as are thought proper; fo that from eight to twelve hundred weight of Tin, by the confumption of eighteen to twenty-four fixty gallon packs of charcoal, may be fmelted in a tide or twelve hours time. Those bellows are not only ufeful for igniting the charcoal, but they throw in a fleady and powerful

136





To the Revel Francis Cole, this Plan of NORTH DOWNS MINE in the Parish of Redruth Cornwall). Engravid at his expense is most gratefully Inscribed by W. Dryce.

SMELTING OF STREAM TIN. 137

powerful air into the caftle; which, at the fame time that it fmelts the Tin, forces it out alfo through a hole at the bottom of the caftle, about four inches high, and one inch and a half wide, into a moorftone trough fix feet and a half high, and one foot wide, called the Float ; whence it is laded into leffer troughs or moulds, each of which contains about three hundred of Metal. called Slabs, Blocks, or Pieces of Tin, in which fize and form it is fold in every market in Europe; and on account of its fuperior quality is known by the name of Grain Tin, which brought a price formerly of feven shillings, that is further advanced, the laft two or three years, to ten or twelve shillings # hundred more than Mine Tin is fold for, becaufe it is fmelted from a pure Mineral by a charcoal fire; whereas Mine Tin is ufually corrupted with fome portion of Mundick, and other Minerals, and is always fmelted with a bituminous fire, which communicates a harfh fulphureous injurious quality to the Metal.

CHAP. III.

Of Bounds and the Manner of taking a Set or Grant for Mining; of Sinking of Shafts, Driving of Adits, Digging and Raifing of Ores, and Working the Mines, &c.

DREVIOUS to the working of a Tin Mine, a Grant or liberty must first be procured from the lord of the foil, if it is in Several and not bounded; but if the ground is in Wastrel and bounded, no liberty from the lord is necessary, but from the Bounder only. These Bounds are limited portions or pieces of land, enjoyed by the owners of them in respect of Tin only; and by virtue of an ancient prefcription or liberty for encouragement to the Tinners. They are limited by holes cut in the turf, and the foil turned back upon the turf which is cut, in form of a mole hill, and directly facing another of the like kind; thefe are called Corners of the Bounds, containing fometimes an acre, fometimes more, and often lefs. By drawing ftraight lines from the Corners, the extent of these Bounds is determined; in like manner as in geometry, by drawing ftraight lines from three or four points, the extent of a triangular or quadrangular fuperficies is known.

138 OF BOUNDS; OF TAKING SETS,

By observing the legal forms, if the land is neither bounded nor inclosed, but a Wastrel or common, then may any one mark out Bounds there, and fearch for Tin; but, in compliance with the Stannary laws, whoever intends to cut a Tin Bounds muft first give three months notice of his intention in the Stannary court, and to the lord, for him to fhew caufe why it shall not be done. By this procedure, the lord is advertifed of a certain lofs to himfelf, whence he prefents an inftrument, praying for liberty and enrolment of fuch Bounds within that Stannary, to his own behoof and benefit; whereby it is pretty clear, that new Bounds are at this day very feldom cut, to which the late gentlemen Stannators no doubt had an eye; becaufe it is no uncommon thing for Bounders who have no title to any part of an eftate above-ground, to grant fets for Tin without the leaft exception in favour of the Lord whole effate on the green fide is oftentimes damaged by the deftruction of the foil and the levelling of his fences, and fo forth. The damage, however, is fometimes little to the lord of the foil, who has a fifteenth part of all that rifes, which is fome compensation for his los.

It may be very difficult to afcertain the precife date when Bounds first commenced; but by confulting fome manufcripts which were lent me by Francis Gregor, Efq; of Trewarthenick, whofe father had been an able and upright vice-warden of our Stannaries, I observe that the Tinners wrought for their Tin by cuftom, until the 33d of Edward the first, which was fixtyfour years after the Jews were banished, when they procured their charter, which was obtained at the follicitation of the lords of Trethewy, Bofwithgy, Treverbyn, Prideaux, Trenans, Auftell, Tremedry, Tregarrick, and Milliack, who obliged their lands to pay affent, and do fervice to the law courts crected by the charter. I elfewhere find by fome manufcript papers of John Cooke, Efq; one of the Stannators for Blackmore, 11th of Charles the first, " That by occasion of certain duputes, " and the Tynners having greate profitts by their Tynn wrought " from time to time by cuftom, untill the 33d year of king " Edward the first, A. D. 1305; it was then thought good for " the Tynners to procure by charter from the prince, freely to " grante unto them libertye to digg and fearch for Tynn in any 66 place where Tynn mighte be found; and a court to deter-" mine all matters and caufes between Tynners." Accordingly I find this liberty expressly granted in the faid charter, which fays, "We have granted alfo to the Tynners, that they may " digge Tynn and turf for the melting of the Tynn, every " where

AND WORKING OF MINES. 139

"where in our lands, moores, and waftes; and of all other "perfons whatfoever, in the county aforefaid." Mr. Beare alfo, in his Bayliff of Blackmore a manufcript of ancient note, in his difcourfe upon what the Tynners did before the charter was granted, fays, "That they always ufed to worke, and fearch for Tynn in wafterall grounds, and alfo in the prince's Severall, where any Tynne mighte be gotten; having likewife libertye to digge, mine, fearch, make Shafts, pitch Bounds; and for Tynne to worke in places of their moft advantages : excepting only fanctuary grounde, church yards, mills, back houfes, and gardens; paying only to the prince or lord of the foyle, the fifteenth part to and for the toll of their "Tynn."

The fum of all the intelligence I can procure, inclines me to judge, that all Tin was at first the posseficient of him who had the government of the county, and from whom the liberty was granted, (or from the king) immediately to the fearcher. (Plow. Com. Pearce's Stannary Laws; Sir John Doddridge.)

Without determining when a cuftom of that kind commenced, it is very natural to fuppofe, that those grants were limited and circumfcribed within certain Bounds, beyond which, as at this day, the fearchers dared not to pass. The acquisition of this valuable property, could not admit of its being in common; but under certain limits, and prefcriptive forms, it must have been kept feparate and divided between the fundry proprietors; in order that each perfon might know and preferve his own property. Whatever modes of partition the moderns might have thought of, there yet feems none more fimple and decifive than those here described, which have existed from their first adoption to the prefent hour. Notwithstanding this, by the negligence of fome owners of Bounds, the knavery of others, and the glorious uncertainty and chicane of the law, no Stannary affairs are fo fertile of wrangles and disputes as those which relate to Tin Bounds.

The first institution of those customary tenures, for the encouragement of fearching for Tin, was laudable and wife; but the late increase of Tin and discovery of Lodes, together with the prefent improvements in Mining, very much diminish the necessity of this kind of encouragement. On the contrary, from very

140 OF BOUNDS; OF TAKING SETS,

very good reafons I can affert, it would be well for this country in general, if Tin Bounds were totally obliterated.

To preferve the right of a Bounds, it ought to be renewed once every year, which is performed in different Bounds on different faints days, as St. John, St. Peter, St. Paul, &c. by the fervant called the Tollur, the Renewer, or the Bounder, who cuts out a turf from each hole or corner, which he places upon the top of the little bank formed by the turfs already laid there, and declares the renewal to be on the behalf of fuch perfon or perfons, the Bounds owners; from whence he generally goes to fome houfe of entertainment, and takes a dinner, and other refrefiment, in order to celebrate and commemorate that annual renewing day.

In Several, no man can fearch for Tin without leave first obtained from the lord of the foil, who, when a Mine is found, may work it himfelf, or affociate partners, or fet it out at a farm certain, or leave it unwrought at his pleafure. In Waftrel, it is lawful for the bounder, or any other perfon having liberty from him, to dig and fearch for Tin, provided that he acknowledges the lord's right, by fharing out unto him a fifteenth part of the whole. Then it is lawful for the Bounder to take out one-twelfth, or in fome places by peculiar cuftom onetenth of the remainder. Tinners may drive an Adit through others Bounds without their liberty, only as a paffage for their water ; but if they break Tin or difcover a Lode in their drift or finking of Shafts, they have no benefit of the faid Tin or Lode, but fhall leave it wholly to the owners of the Bounds within which it is.

The ufual grant for Tin where it is not bounded, is the fame as for Copper; and the acknowledgment, Difh, or Dues paid to the lord, is commonly one-fixth, feventh, eighth, ninth, even to one-twelfth, or lefs under fome peculiar circumftances; only that the dues for Copper are payable in money, and for Tin in the Stone or Mineral Ore, and fometimes in white Tin or Metal. This grant by leafe, is called a Set for Tin or Copper, and runs for one and twenty years certain. But a Set of a Bounds for Tin, though verbal, is perpetual, and never ends while it is wrought according to the laws and cuftoms of the Stannaries; that is, if the Tinner has been in quiet poffeffion for the fpace of one year and a day, he may ftill keep his holding at five fhillings expence annually, laid out upon the premifes. This is

AND WORKING OF MINES. 141

is a very injudicious indulgence, and it is an injurious licence for the benefit of the Bounds owners. I can answer for the truth of this, and so can almost every other Bounds owner in the county; it being no rare thing for a Tinner to keep possession of a Bounds Set, like the dog in the manger.

I do not fuppofe the prefent methods for working of Tin Mines, by deep Shafts, and by Driving and Stopeing under the firm ground, has been practifed more than three hundred years paft. Prior to those means for raising of Tin, they wrought a Vein from the bryle to the depth of eight or ten fathoms, all open to grass, very much like the fosse of an intrenchment. This was performed by meer dint of labour, when men worked for one-third of the wages they now have. By that method they had no use for foreign timber, neither were they acquainted with the use of hemp and gunpowder.

downwards the inviting rich flones of Tin fome Lodes m

This foffe they call a Coffin, which they laid open feveral fathoms in length eaft and weft, and raifed the Tin-ftuff on Shammels, plots, or ftages, fix feet high from each other, till it came to grafs. Those Shammels, in my apprehension, might have been of three kinds, yet all answering the same end. First, they funk a pit one fathom in depth and two or three fathoms in length, to the east and to the west, of the middle part of the Lode difcovered; then they fquared out another fuch piece of the Lode for one or two fathoms in length as before, at the fame time others were still finking the first or deepeft ground funk, in like manner; they next went on and opened another piece of ground each way from the top as before, while others again were still finking in the last and in the deepest part likewife : in this manner they proceeded flep after flep; from which notion arifes the modern method of Stopeing the bottoms under-ground. Thus they continued finking from Caft to Caft, that is, as high as a man can conveniently throw up the Tin-ftuff with a fhovel, till they found the Lode became either too deep for hand work, too fmall in fize, very poor in quality, or too far inclined from its underlie for their perpendicular workings. Secondly, if the Lode was bunchy, or richer in one part than another, they only laid open and funk upon it, perhaps in fmall pitches not more in length than one of the Stopes or Shammels before defcribed. The fhortness of fuch a piece of Lode would not admit of their finking Stope after Stope; it was then natural and eafy for them, to fquare out a Shammel on one fide or wall of their Lode, and fo to make a landing place

0 0

for

142 OF BOUNDS; OF TAKING SETS,

for their Tin-ftuff caft after caft. Thirdly, if the Lode was wide, and the walls of it, and the adjoining country, very hard folid ground, it was in fuch cafe more cafy for them to make Shammels or ftages, with fuch timber, &c. as was cheapeft and neareft at hand.

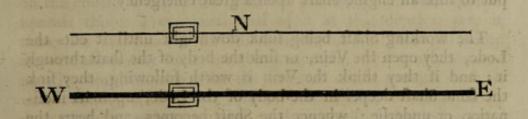
This, with Streaming, I take to be the plain fimple state of Mining in general, three centuries ago; and from hence is derived the custom of Shammeling both above and under-ground at this time; for in the clearing of Attle, (Deads) or filling the Kibble with Ore, the Miners prefer a Shammel, which is a stage of boards, for the more light and easy use of their shovels.

But as this manner of working was irreconcileable with the difcovery and raifing any Tin-ftuff below a certain very fhallow depth, it became neceffary to contrive fome other way to follow downwards the inviting rich ftones of Tin fome Lodes produced. The method of Shammeling, even in those moderate times, has been expensive, where a very fmall Lode of Tin occurred in a hard country. To remove a dense hard ftratum of rocky overburden, must be very fatiguing and perplexing; therefore they found it most adviseable to fink Shafts down upon the Lode, to cut it at fome depth, and then to Drive and Stope east and west upon the course of the Lode: in time, no doubt, such improvements prefented, as rendered that the cheapest and most established cuftom of Mining.

The fpeculative reader may be apt to imagine, that we can trace, and diffinguifh, the different advancements which have been made in Mining, by the depth and proportion of old Shafts, &c. But it is not fo; for Shafts, and other workings of the Mines, depend upon the fame, and yet different contingencies, in one and the fame Mine. It is very likely, that a hundred years fince, a Shaft would not be funk in a certain place but fifteen fathoms deep, from the quantity of water; where it now may be done beyond fifty fathoms, without a drop. The reafon of this is not becaufe the fkill of the prefent occupiers is greater than that of the former; but becaufe the adjoining ftrata or country is Bled, as we call it, by Adits, and fundry other drifts and levels, driven through them pofterior to that time.

Having fhewn how Sets for Tin and Copper are granted, and how Tin was anciently fought for, at a time, indeed, when Copper Copper was as well known to be in Terra incognita, as in Cornwall, we ought to proceed to the difcovery of the Lode : but as this has been defcribed elfewhere, we shall now fet forth the first arrangements for working a Mine; in order to which, the principal thing to be thought of is a Shaft to cut the Lode, at twenty or thirty fathoms deep, if it is possible to be done. Here it is neceffary to form fome judgment of the inclination or underlye of the Lode, before we attempt to fink a Shaft : for inftance, if the Lode underlies to the north about three feet in a fathom, and a Shaft is defigned to come down upon the Lode in twenty fathoms finking, the Miner must go off north from the back of the Lode full ten fathoms, and there pitch his Shaft; by which means he is certain to cut the Lode in the Shaft about twenty fathoms deep; becaufe for every fathom the Lode defeends in a perpendicular line, it is also gone three feet to the north of the perpendicular.

But to render this the more confpicuous, let the line E W reprefent the back or furface of a Lode pointing eaft and weft, and whofe underlie is north : by finking a Shaft upon this back, it will foon be deferted by the Lode, which is gone further north three feet for every fathom that is funk upon that line; fo that when the Lode is twenty fathoms deep, it must be gone north to the imaginary line N, where another Shaft must be funk to cut the Lode at that depth.



A proper working Shaft, upon which a Whym may be erected if neceffary, fhould be fix feet long and four feet wide, or more where large water barrels may be wanted; and the harder the ground is, the longer and wider the Shaft ought to be, that the men may have the more liberty to work and break it, the area of a large fhaft being more eafy to rip up where the ground is hardeft, than of a fmall one where it is more confined together, and breaks in fhreds of ftone, &c.

144 OF BOUNDS; OF TAKING SETS,

In many parts of the Mining diffrict, the north or the fouth channel appears to full view; and it is a maxim among the Miners, when they erect their windlafs upon a Shaft, to place it true to the horizon; in order to which they make an obfervation in a line to the fartheft diffance they can fee, which is always the fame height as the eye of the obferver, either upon the higheft hill, or with the edge of the water.

A Shaft that is defigned for a water engine, may ferve, if it is of the fize of the largeft working Shaft; but a fire engine Shaft ought to be, at leaft, nine feet square, or ten feet by eight, or in fact to contain three Shafts in one, which must be partitioned into three compartments, all the way down from grafs to the deepeft bottom of the Mine. One half is divided for the pumps and engine work; three feet in length of the other is proportioned for a foot way, to go down and rectify the pumps when amifs; and the remainder is divided alfo by a partition of boards, for a whym Shaft to draw the Deads and Ore from the Sump of the Mine. If the ground is hard and very wet, or the water very quick upon the men in finking, there ought to be eight men employed to fink a working Shaft; that is, two men in a corps of every fix hours; and in a fire engine Shaft, there should be fixteen employed in the fame manner : but if the ground is tender, and there is no hindrance by water. fix men in the first, divided into three corps every eight hours, are reckoned fufficient; yet I have known four and twenty men put to fink an engine Shaft upon a great emergency.

The working Shaft being funk downright until it cuts the Lode, they open the Vein, or fink the body of the fhaft through it; and if they think the Vein is worth following, they fink the fame Shaft deeper in the body of the Lode, upon its inclination or underlie; whence the Shaft becomes, and bears the name of, an Underlier : at the fame time they turn houfe, as they call it, from the bottom of their perpendicular, or from the top or beginning of the underlie. So that when the Lode is well impregnated, they turn houfe by driving or working horizontally on the course of the Vein, either to the east or to the weft, or both, as they find it most likely to answer their expectations, in order to make a fuller trial and difcovery. Where the Lode anfwers well in thus driving upon it, they continue to do fo, till they are prevented by want of air; or till the end of their workings is too far from the Shaft, and the expence of rolling back the fluff to the Shaft is great and incommodious;

incommodious; then it is proper to put down another Shaft as before defcribed, or more to the north, becaufe it will be more convenient, the longer it continues downright. Mean while, they are mindful to fink their first Shaft in order that they may work away the Lode from thence in Stopes, and have a little Sump or pit in that place as a bafon for receiving the water of the Lode, whence they discharge it to grass by the easiest method they can devife : for most Lodes have streams of water running through them; and when they are found dry, it feems to be owing to the waters having been forced to change their course, either becaufe the Lode has ftopped up the old paffages, or becaufe fome new or more eafy ones are made, whereby the Lode and ftrata adjacent to it are bleeded as we term it. However, they are often hindered from going down deep enough to find any great quantity of Ore, by the burden of water that most Veins abound with ; therefore, if the Mine is not encouraging, they give over any further purfuit; but if it feems likely to prove well, and the Lode lies in an afcending ground, they quit the Vein for the prefent, and go down to the most convenient place in the valley, and from thence they bring a Trench, Drain, or Conduit, which they call an Adit, Tye, or Level; and fo they work and drive this paffage through the hill in a right line to the Lode, with very little lofs of the level they began from.

Where the Adit is intended only for the fake of unwatering one particular Vein, it is frequently advifeable to bring it home on the courfe of it, if the fituation of the ground will admit, becaufe this is a continual trial of it at that depth : yet, if there are many Lodes not far afunder, an Adit brought home athwart them may fometimes be preferable, if it can be conveniently complied with; for the fituation of the ground muft be well confidered, to judge how to drive home the moft fhort, deep, fpeedy, and cheap Adit, with the moft probable fuccefs.

If the hill takes its courfe eaft and weft a confiderable length, and the difcovery of the Vein is very far from a valley at either end of the hill, there may be no choice in the matter; for the fhorteft and cheapeft Adit will of courfe be driven from the north or fouth, unlefs moorftone or ireftone ftrata intervene. It then behoves the adventurers to feek for a Crofs-Goffan, where it lies convenient in diffance from the difcovery, to bring home the Adit in; and provided the Goffan does not exceed three feet in width, it is reckoned very favourable, becaufe the

Adit

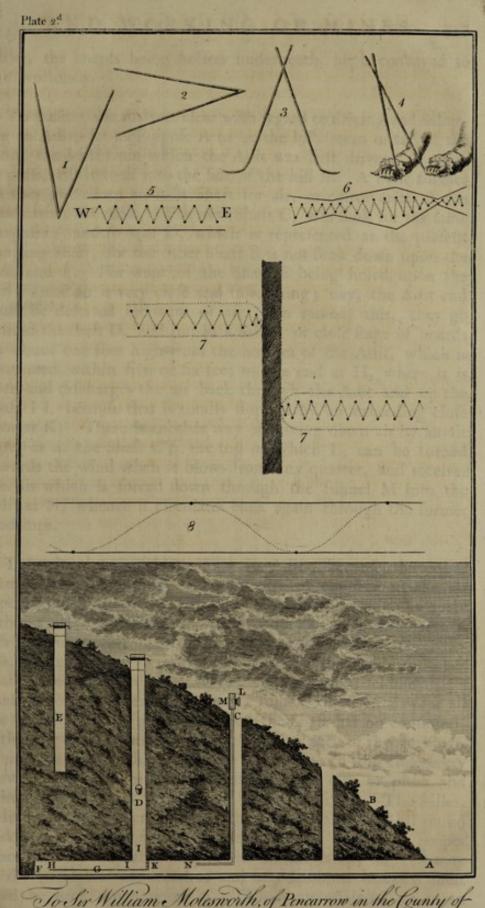
146 OF BOUNDS; OF TAKING SETS,

Adit may be wrought through the body of it, without the ufe of timber and boards to fupport and keep it up. On the contrary, most Crofs-Goffans are too wide to break down the whole breadth for an Adit; and therefore they drive on the eaftern or weftern fide of it, which ever is most to their liking, and at the fame time break down a fmall thickness of its contiguous wall, fo that they are fure to cut all Veins, and branches of metallick Veins, in their paffage to the Mine; by which means, as in driving levels acrofs the country out of those crofs-courfes, many more valuable Lodes have been difcovered, than those they were driving to unwater. Nevertheless that fide of the Adit which is in the body of the Goffan, muft be braced up, and bound with boards, as must likewife its back or top, otherwife the hinder part of the level may fall in and occafion a choak in it. Yet there are fome few Goffans that will ftand without any fupport.

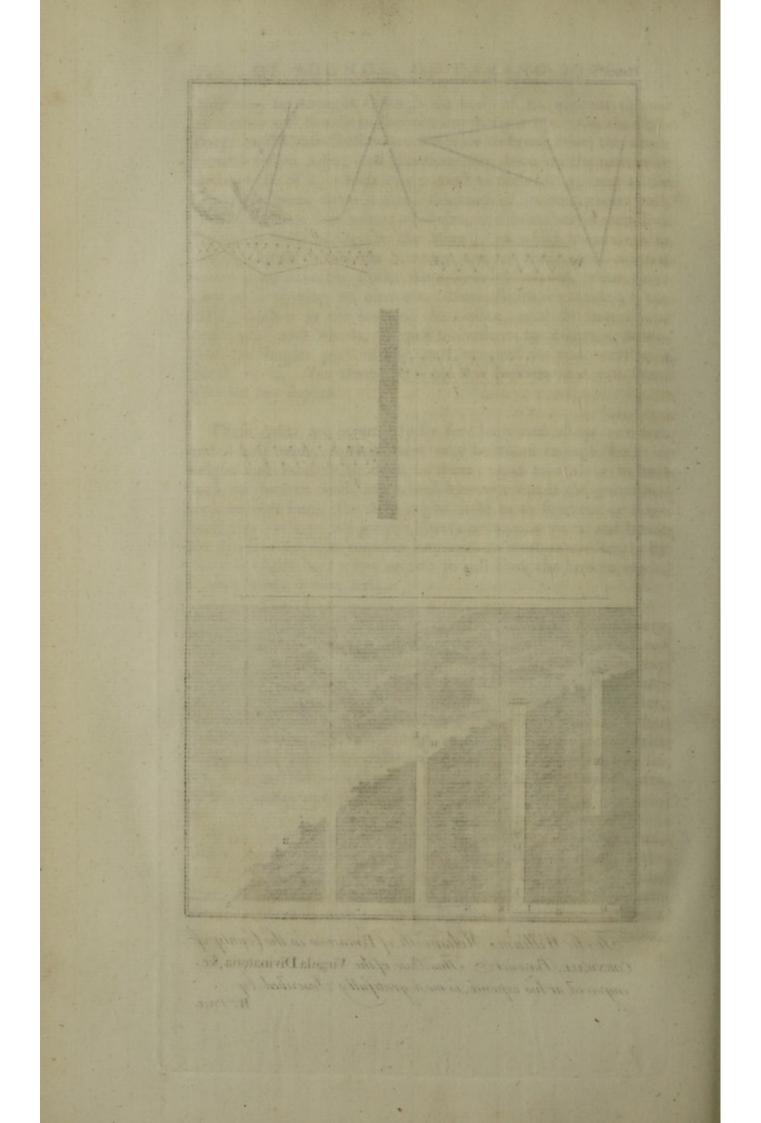
Thefe Adits are commonly fix feet high and about two feet and a half wide, fo that there may be room enough both in height and breadth to work in them; and alfo room to roll back the broken deads in a wheel-barrow : but if the ground or rock be very hard, the Adit ought to be more fpacious or large each way, to give the greater liberty or room to work and break the ftone. An Adit requires four men to work it conftantly by day and night, and a boy or two to roll back the broken work, if they break it very faft.

The neceffity for Shafts in driving an Adit, occurs very frequently to fupply the workmen with air, and for the convenience of winding up the deads. Where the country is very hard, the Shafts fhould be forty fathoms diftant from each other; and where the ground is feafible or moderately tender, they may be twenty fathoms diftant; but in this, as in all other parts of Mining, the adventurers muft be ruled by the varieties of place and other circumftances. An Adit Shaft fhould be fix feet long and three feet broad, which generally employs fix men to work it day and night.

When the Miners want air by being a great way under-ground, and cannot conveniently put down a new Shaft; then, if the Adit be high enough, they lay boards on the bottom of the Adit, from their laft Shaft along to the Adit end, and fo ftop them down clofely with clay or earth, by which contrivance, called a Saller,



To Sir William Molesnorth, of Pencarrow in the Country of CORNWALL, Baronet. This Plate of the Virgula Divinatoria, &c. engraved at his expence, is most gratefully Inscribed, by W."Pryce.



AND WORKING OF MINES. 147

Saller, the boards being hollow underneath, air is conveyed to the workmen.

To make these matters clear with regard to driving and Sallering an Adit, let us suppose A to be the lost flovan or tail of the Adit, the level from which the Adit was first driven, all open to grafs, till it took into the fide of the hill B. A little further on they put down an Adit Shaft for air, or conveyance of the deads from the Adit. The next Shaft C, was funk for the fame purposes; and fo was D, which is represented as the present. working Shaft, for the other Shaft E is not funk down upon the Adit end F. For want of the Shaft E being holed upon the end F, the air is very close and fuffocating; nay, the Adit end must be deferted for want of air. To remedy this, they go behind the fhaft D, and put in a Saller, or close ftage of boards G, about one foot high from the bottom of the Adit, which is continued within five or fix feet to the end at H, where it is open and difcharges the air back through the Adit and up the Shaft I I, becaufe that is totally ftopped by an exceeding clofe door at K. There is another way of forcing down air by an air pipe, as at the Shaft C; the top of which L, can be turned towards the wind when it blows from any quarter, and receives the air which is forced down through the funnel M into the Adit at N, whence it circulates back again through the former workings.

This air pipe is feldom used in Adits, because the Saller is more cheap and eafy, the difference of expence in the air pipe being confiderable where an Adit Shaft is thirty or forty fathoms deep; befides, the Saller under the workmen's feet is lefs incommodious, than the funnel over their heads : neverthelefs, this air pipe is of indifpentable use in the finking a Shaft that is void of circulation of good air, and it is feldom that a Shaft of forty fathoms depth can be funk without an air pipe all the way down from grafs, provided the Shaft has no communication, by drift or Gunnies, with fome other parts of the workings. It must be noted, that great care is requisite to stop close every crevice of the air pipe, or the Saller, with clay or pitch and oakum, fo that not a breath of air fhall efcape. The Saller, indeed, may be covered clofe with turf and earth laid all round and upon it; whereby no air can have vent but at its proper place H. By duly attending to this circumftance, an Adit may be driven beyond one hundred and fifty fathoms, before a Shaft need be funk down upon it. This is an affair of no mean consequence,

148 OF BOUNDS; OF TAKING SETS,

confequence, where a Shaft muft be funk very deep in exceeding hard ground.

Sir Robert Moray, in the Philofophical Tranfactions No. 5, has communicated a method practifed at Liege for driving of Adits without air Shafts, by crecting a chimney thirty feet high, at the tail or loft flovan of the Adit, from whence an air pipe is continued through the Adit ; whereby all foul air at that place is invited or drawn, by the fire, from the working part or end of the Adit unto the chimney, where it enters under the grate filled with live coal and fufpended in the middle of the chimney. This may ferve, where the air is rendered noxious by fulphurcous or vitriolick effluvia, to carry it off by the funnel into the chimney ; but in our Adits we have no vapourous fumes to difcharge. With us it is an abfolute want of air, or circulation thereof ; fo that our relief is only acquired by pouring in a frefh current of air, and continuing the circulation as freely and uniformly as poffible.

The numerous little eminencies that compose the face of our country, where the Mines are fituate, afford us great advantages for Adits to unwater the Veins contained in them. Though we feldom fee an Adit half a mile in length, there are two or three of three times that length, and those are the longeft I know of. At Friberg in Saxony, they have very extraordinary works of this kind, particularly that called the Prince's Level, one of the greatest works in those parts, confidering the time, labour, and expence neceffary to work a passage under-ground, for about five English miles in length.

The labour and expence of driving this level, muft have been great and tedious, where it happened in fuch exceeding hard ground as we fometimes meet with here : for although I have known an Adit end driven feveral fathoms at four fhillings a fathom in Pot Grouan, that is, foft grouan; yet I have paid twelve guineas for the fame Adit, that we have driven many fcore fathoms for lefs than one; fo various and uncertain are the ftrata of the earth in thefe parts. The greateft expence for the ground difcovered, that I ever heard of in driving an Adit, was in the old Pool, two miles off, where Mr. Baffet paid five and thirty pounds # fathom for the driving of feveral fathoms, through an Ireftone ftratum; which great price anfwered fo badly for the contractors, that they were very much injured by the undertaking. The moft defirable ground to drive an Adit in,

AND WORKING OF MINES. 149

in, where it cannot be brought home upon the Lode itfelf, or a crofs-courfe, is a tender feafible Killas of eighteen shillings of fathom. This ground needs no timber to fupport it, and can be fpeedily fpent or worked at the rate of eight or ten fathoms monthly. if they think proper.

If an Adit is fet by the fathom, and the ground proves hard, the workmen are often regardless of driving in a direct straight line, and are apt to drive irregularly for the advantage of working in the fairest ground; but this makes a reckoning of more fathoms to the adventurers difadvantage, than they ought in juffice to be accountable for; therefore it is the most prudent method, when an Adit is fet by the fathom, to agree, that the meafurement shall be on the grass or surface, because then if the workmen drive out of the way it will be their own lofs. cirbt

draw water or work.

In bringing home thefe levels, the natives of Cornwall never confider the expence fo much as the time it may be performed in :rindeed, it is an axiom in Mining, that the quicker an Adit is driven, the lefs must be the expence. Some levels have taken thirty years to complete them; and I have been concerned in one that took feventeen years to bring it home to the Mine. Yet notwithstanding all difadvantages, fundry levels have been carried across as meer feeking adventures, for the fake of difcovery, without being bound for any particular Mine; and fome of them, by patience and perfeverance, have amply rewarded largenets of the barrels, and the depth the W. szirqrana ant

I must allow that fuch adventures are very laudable; for if a level forms an horizontal acute angle with the perpendicular fection of the fummit of a hill, at the charge of three thousand pounds in fifteen years driving, though without the fuccess defired, it is likely to prove an useful undertaking for posterity, who may reap the advantage of it, when they want levels to unwater veins that may be discovered in other parts of the hill. The expence of an adit is flow and fmall; therefore it is eafily borne. Two or three hundred pounds a year in driving an Adit, is fcarcely felt by eight or ten perfons, than whom feldom fewer are concerned; and this too upon the chance of finding a vein, or veins, that may throw up an amazing profit prefently after difcovery, by an advantage in the very means of difcovery itfelf. Here booting and the second shade

An Adit being driven home to the Mine, the water feldom fails of draining and falling into it; fo that the Lode is unwatered as deep as the level of the Adit, to which depth, or yet a greater, the men are at liberty to fink and drive on the Lode if they think proper.

With all the skill and adroitness of our Miners, they cannot go any confiderable depth below the Adit, before they muft have recourfe to fome contrivance, for clearing the water from their workings. The hand pump, and the force pump, will do well for fmall depths, and are neceffary in the first finkings into the Lode, before the Stopes can proceed. Next to thefe, the water is drawn to Adit by fmall water barrels; but if the water exceeds a certain number of barrels, in a core of fix or eight hours, they give over drawing by hand, and erect a Whym, which is a kind of horfe engine to draw water or work, and fometimes both, especially in the infancy of a Mine. A common Whym which ferves both purposes, confifts of a perpendicular axis, whereon a large hollow cylinder of timber turns, called the Cage, round which the rope winds horizontally, being directed down the Mine by two pullies fixed in what are termed Puppet Heads over the mouth of the Shaft : this axis has a transverse beam, called the Arm infixed ; at the end of which are placed two horfes that go round upon a platform named the Whym-round, and draw more or lefs according to the number of their circumvolutions in any given time, the largenefs of the barrels, and the depth the Whym is to draw. For drawing of water, this engine can only work in a perpendicular Shaft; but for winding of work or deads, it can be used to draw upon the underlie of the Lode.

Another water engine is the Rag and Chain, which confifts of an iron chain with knobs of cloth ftiffened and fenced with leather, feldom more than nine feet afunder: the chain is turned round by a wheel of two or three feet diameter, furnifhed with iron fpikes, to inclose and keep fteady the chain, fo that it may rife through a wooden pump of three, four, or five inches bore, and from twelve to twenty-two feet long, and by means of the leather knobs bring up with it a ftream of water anfwerable to the diameter of the pump, and in quantity according to the circumvolutions of the wheel in any given time. Several of thefe pumps may be placed parallel upon different Stulls, Sallers, or Stages of the Mine, and are ufually worked by hand like those in our navy. The men work at it naked excepting their loofe

loofe trowfers, and fuffer much in their health and ftrength from the violence of the labour, which is fo great that I have been witnefs to the lofs of many lives by it.

A rag and chain pump of four inches diameter, requires five or fix frefh men, every fix hours, to draw twenty feet deep; and to keep it conftantly going, twenty or twenty-four men muft be employed monthly, at forty or fifty fhillings each man. The monthly charge of one of these engines cannot be less than fifty or fixty pounds; and they are now pretty generally laid afide on account of the great expence, and the deftruction of the men. Nevertheless the motion of the rag and chain, when it is conftant, is so quick, that it will discharge a quantity of water, even exceeding that of a wheel and bob engine, whose pump is 10 inches bore; and it may be usefully applied to draw water from fundry parts, such as dippas or little pits of a Mine, which have no communication with other aqueducts to the grand machinery for delivering of the water to Adit.

Where the rag and chain pumps are unequal to the work, and too chargeable for the Mine to repay, they may have recourfe to the whym again; and inftead of drawing with fixty gallon barrels as at firft, they may put in larger ones to the amount of 120 gallons in each barrel drawn by the additional help of two horfes more. This draught muft be within twenty fathoms, and not lefs than two barrels a minute, to be worth the charge.

The water wheel with bobs, is yet a more effectual engine ; whole power is answerable to the diameter of the wheel and the fweep of the cranks fixed in the extremities of the axis. Over them two large bobs are hung upon brafs center gudgeons fupported by a ftrong frame of timber, and rife and fall according to the diameter of the fweep of the cranks, or of the circle they defcribe. To each crank is fixed a ftraight half fplit of balk timber, that communicates with each bob above : at the other hand or nofe of the bob over the Shaft, a large iron chain is pendent, fastened to a perpendicular rod of timber that works a pifton in an iron or brafs hollow cylinder, called the Working Piece : the quantity of water exhausted, will be in proportion to the bore of the working piece, and the number of times which the embolus works up and down in a given space. The water engine wheel at Cooks Kitchen Mine, is forty-eight feet diameter, and works her tiers of pumps of nine inches bore, which

which being divided into four lifts, draws eighty fathoms under the Adit. If the ftream of water were fufficient to fill the buckets of the wheel, fhe would draw forty fathoms deeper with the fame bore; and I have been well informed, that the power of a forty-eight feet wheel, is equal to the diameter of a fortyfeven inch fire engine house cylinder: whence this kind of engine is the most eligible, where grass water is plenty, and to be had for a small rent.

The number of ftamping mills adjacent to the Mines, and the value of water for the various ablutions of Tin and Copper Ores, render every fmall rivulet of fome confiderable confequence to those through whose lands the water happens to flow. Many of our country gentlemen have made great rents of their water courses, when they have been diverted from their grift mill tenants; and some of them, without any recompence made to the leffees, have received fifty pounds a month, several years, for a small mill stream of water to drive one of those engine wheels upon Mines in their own lands.

rag and chain pu

Happy would it be for the Mining intereft, if our fuperficial ftreams of water were not fo fmall and fcanty; but the fituation of our Mines, which is generally in hilly grounds, and the fhort current of our fprings from their fource to the fea, prevent fuch an accumulation of water, as might be applied to the purpofe of draining the Mines; and of courfe the value of water is the more enhanced. There are very few ftreams, which are fufficient to answer the purpose in fummer, as well as in winter, fo that many engines cannot be worked from May to October; which is a great lofs at that feafon of the year, when men can work longer at grafs, and with more vigour, than they can in fhort days and cold weather. Yet the innumerable Adits driven into the earth, afford tolerable fupplies of water to those ftreams, and are of fome importance to the unwatering of the Mines. By the fuperior address of our Miners, the rivulets are often extended many miles to drive an engine; and are then returned as far back again as poffible, to ferve other Mines and ftamping mills; befides, the moifture of our air and fituation, which is directly exposed to the great western ocean, as well as to the British and Briftol Channels, causes abundance of rain, and contributes not a little to fwell our fmall rivers after the autumnal equinox. I a ni nwob has ou show anoder

water engine wheel at Cooks Kitchen Mine, is forty-cight feet

tuB never, and works her tiers of pumps of nine inches bore,

But where the fituation of a Mine will not admit of a water engine, or where the ftream is infufficient, the laft refource is that most useful, powerful, and noble machine, the fire engine, of which we have feveral that are perhaps the largeft in the kingdom. It is the most admirable curious and compounded machine amongst all that owe their invention to the difcoveries of modern philosophy, and affords the greatest advantages to mankind. The marquis of Worcefter, in his century of inventions published in the year 1663, is probably the first that propoled railing any great quantities of water by the force of fire converting water into fleam; but captain Savery was the first who erected an engine for this purpose in the form we have fince had them, and which has been lately improved by Mr. Blakey, though not to a degree of power fufficient to unwater a deep Mine.

Mr. Newcomen, and Mr. J. Cawley, contrived another way to raife water by fire, where the fteam to raife the water from the greateft depths of Mines is not required to be greater than the prefiure of the atmosphere; and this is the ftructure of the prefent fire engine, which is now of about feventy years ftanding.

Let us suppose a pump, or tier of pumps as we fay, to be twenty-five fathoms deep, whofe cylindric diameter of its full column of water is feven inches and a quarter, and of the weight of 3,000 lb. Now if the rod of this pump were hung by a chain to the nofe of the lever or bob, h h, as at H; and at the other end, another power were applied, as at L, with a fuperior force; the pump might be worked, and the water raifed by that power. It appears, this power cannot be fupplied by the ftrength of man, or beaft; for it will require one hundred men to pull down the bob, each pulling with the force of 30 15, and one hundred men to relieve them when weary. But as the pump in a Mine muft not ftand ftill, there should, for fuch hard labour, be a fresh corps of one hundred men every four hours at leaft, which would amount to fix hundred men every twenty-four hours. If we allow horfes, and one horfe equal to five men, there must be twenty horses working at a time, and twenty more to relieve them every four hours, where the draft muft be fo conftant and exceffive ; which will amount to one hundred and twenty horfes every twenty-four hours; and fo great a number, though lefs expensive than men, will be found too great for most Mines, if it were possible to apply them

them to that use. I produce this example, to shew the prodigious force that is required to draw water in the fmall epitome of a Mine; for the diameter of the pump given, and the depth of twenty-five fathoms, bear the leaft analogy to the depth of our Cornish Mines, whose fire engine house cylinders are generally from fifty-four to feventy inches diameter. Now allowing 8 15 to each fquare inch, clear of friction, in the power of a fire engine house cylinder of feventy inches diameter; the number of pounds avoirdupoife within its extent of power to lift up or pull down, are equal to 30,784 lb. The human power equal to this will require the ftrength of 1,026 men every four hours, or 6,156 men the day and night; or 1,230 horfes. A fixty inch cylinder, alfo, which will lift 22,616 th, is equal to 4,518 men, or 900 horfes, every twenty-four hours. Some other power therefore muft be applied ; which may be effected as follows. B is a large boiler, whofe water, by the fire under it, is converted into an elaftick fleam. (See plate III) The great cylinder CC is fixed upon it, and communicates with it by the pipe Dd; on the lower orifice of which, within the boiler, moves a broad plate, by means of the fteam cock, or regulator E 10, ftopping or opening the paffage to prevent or permit the fleam to pafs into the cylinder, as occafion requires. The diameter of the pipe D is about four inches.

The fleam in the boiler ought always to be a little ftronger than the air, that, when let into the cylinder, it may be a little more than a ballance to the external air, which keeps down the pifton at the bottom d n. The pifton being by this means at liberty, the pump rod will, by its great weight, defcend at the opposite end to make a stroke, which is more than double the weight of the pifton, &c. at the other end. The end of the lever at the pump, therefore, will always preponderate and defcend, when the pifton is at liberty. The handle of the fteam cock E 10, being turned towards n, opens a pipe D to let in the fleam; and being turned towards O, it fhuts it out, that no more can enter. The pifton is now raifed towards the top of the cylinder at C, and the cylinder is full of fleam. The lever Or must then be lifted up, to turn, by its teeth, the injecting cock at N, which permits the water, brought from the ciftern g by the pipe g M N, to enter the bottom of the cylinder at n, where it flies up in the form of a fountain, and ftriking against the bottom of the pifton, the drops, being driven all over the cylinder, will, by their coldness, condense the steam into water again, and precipitate it to the bottom of the cylinder. them

Mr. Beighton made an experiment to determine the rarity of fteam, and found the content of a certain cylinder of fteam was 113 gallons; and fince there were 16 ftrokes in a minute, therefore 113x16 = 1808 gallons of fleam & minute. He alfo observed, that the boiler proportioned to that cylinder, required to be fupplied with water at the rate of five pints minute : and fince 282 cubick inches make a gallon, 351 make a pint, and $5 \times 35^{\frac{1}{2}} = 176^{\frac{1}{2}}$ in five pints : also the cubick inches of fteam are $1808 \times 282 = 509856$; if then we fay, as 1761: 509855 :: 1: 2893; or one cubick inch of water is expanded into 2893 inches of fteam; confequently the fteam in the cylinder is reduced to the part, when turned to water by the jet of cold water; and therefore a fufficient vacuum is made in the cylinder, for the pifton to defcend, unballanced, by the preffure of the atmosphere. The pifton being forced down, raifes the other end of the lever or bob, and confequently the box of the pump under-ground, which brings up and difcharges the water at adit, the fame as at p. Now this whole operation of opening and fhutting the fteam regulator and injection cock, will take up but little more than three feconds; and will, therefore, eafily produce 16 ftrokes in a minute.

That the ciftern g may always be fupplied with water, there is an arch fixed near the arch or nofe of the bob H, from whence another pump rod k, with its box and valve, draws water from the level of the adit in the fame engine fhaft, and forces it up the pipe m m m into the ciftern g, which, therefore, can never want water.

That the leathers of the pifton C may be always fupple and fwelled out, fo as to be conftantly air tight, a fmall ftream of water is fupplied from the injecting pipe M by the arm Z. On the top of the cylinder is a larger part or cup L, to hold the water that lies on the pifton, left it fhould overflow when the pifton is got to its greateft height, as at W; at which time, if the cup be too full, the water will run down the pipe V to the wafte well at Y.

The water in the boiler, which waftes away in fteam, is fupplied by a pipe I i about three feet long, going into the boiler a foot below the furface of the water. On the top of this pipe is a funnel I, fupplied by the pipe W with water from the cup of the cylinder, which has the advantage of being always warm, and therefore not apt to check the boiling of the water. That the

the boiler may not have the furface of the water too low, which would endanger burfting; or too high, which would not leave room enough for fteam; there are two gage pipes at G, one going a little below the furface of the water when at a proper height, and the other ftanding a little above it. When every thing is right, the ftop cock of the fhort pipe being open, gives only fteam, and that of the long one water; but, if otherwife, both cocks will give fteam when the furface of the water is too low, and both give water when it is too high; and hence the cock which feeds the boiler at I, may be opened to fuch a degree, as always to keep the furface of water to its due height.

The cold water, conftantly injected into the cylinder to condenfe the fteam, is carried off by the eduction pipe d T Y, leading from the bottom of the cylinder to the wafte well Y, where going a little under water, it has its end turned up, with a valve Y, to keep the air from prefling out into the pipe, but permitting the injected water coming the other way to be difcharged, whereby the cylinder is kept empty.

Left the fteam fhould grow too ftrong for the boiler, and burft it, there is a valve fixed at h, with a perpendicular wire ftanding up from the middle of it, to put weights of Lead upon, in order to examine the ftrength of the fteam pufhing against it from within. Thus the fleam is known to be as ftrong as the air, if it will raife up fo much weight on the valve, as is at the rate of fifteen pounds to an inch fquare, because that is the weight of air, nearly, on every fquare inch. When the fteam becomes ftronger than is required, it will lift up the valve, and go out : this valve is called the Puppet-Clack. The fteam has always a variable ftrength, yet never one-tenth ftronger or weaker than common air; for it has been found, that the engine will work well when there is the weight of one pound on each fquare inch of the valve : this fhews, that the fteam is then one-fifteenth part ftronger than the common air. Now as the height of the feeding pipe, from the funnel F to the furface of the water G s. is not above three feet, and three feet and a half of water is one-tenth of the preffure of the air; if the fleam were one-tenth part stronger than air, it would push the water out at E; and fince it does not, it cannot be ftronger than air, even in this cafe, where, the regulator being fhut, it is most of all confined. When the regulator is opened, the fteam gives the pifton a pufh, which raifes it up a little way; then filling a greater space, it comes

comes to be of the fame ftrength with, and fo a ballance to, the atmosphere : thus the piston, being at liberty, rifes to the top W. The fteam, now expanded into the whole capacity of the cylinder, is weaker than the air; and would not fupport the pifton, were it not for the greater weight at the other end of the lever, which keeps it up. The fteam, each ftroke, drives the injected water of the preceding ftroke out of the eduction pipe dTY; and would itfelf follow, and blow out at the valve Y, which is not loaded, if it were ftronger than the air, which it never does. If it were exactly equal to the ftrength of the air, it would just drive all the water out at Y; but could not follow itfelf, the preffure being equal on each fide the valve by fuppofition. If it be weaker than the air, it will not force all the water out of the pipe at dTY; but the furface will fland, fuppofe at T, where the column of water TY, added to the ftrength of the fteam, is equal to the preffure of the air. When the fteam is one-tenth weaker than the air, the height T Y =three feet and a half. Now, fince the whole perpendicular diftance from d to Y is but four feet, and the fteam always fufficient to expel the water; it is plain, it can never be more than one-tenth part weaker than the air, when weakeft.

There is air in all the water injected; and though that air cannot be taken out or condenfed with the fleam, yet will it precipitate through the fleam to the bottom of the cylinder, as being much heavier: for fleam is to water, as 1 to 2893, in its denfity; but the denfity of air is to that of water, as 1 to 864, nearly; therefore the rarity of fleam is to that of air, as 2893 to 864: the air will, therefore, fall through the fleam to the bottom, and from thence be driven out through a fmall pipe opening into the cup at 4, on which is a valve. Now when the fleam first rushes into the cylinder, and is a little flronger than the outward air, it will force the precipitated air to open the valve at 4, and make its efcape; but the fleam cannot follow, because it is weaker than the outward air, as the pisson gives it room, by ascending, to expand. This valve, from the noise it makes, is called the Snifting-Clack.

Among the great improvements of this engine, we may reckon that contrivance by which the engine itfelf is made to open and fhut the regulator and injection cock, and that more nicely than any perfon attending could poffibly do it. For this purpofe, there is fixed to an arch 12, at a proper diftance from the arch P, a chain, from which hangs a perpendicular piece or working S f

beam QQ, which comes down quite to the floor, and goes through it in a hole, which it exactly fits. This piece has a long flit in it, and feveral pin holes and pins, for the movement of fmall levers deftined to the fame office of opening and fhutting the cocks, after the following manner: between two perpendicular pieces of wood, on each fide, there is a fquare iron axis A B (plate III, fig. 2) which has upon it feveral iron pieces of the lever kind. The first is the piece C E D, called the Y, from its reprefenting that letter, inverted by its two fhanks E and D; on the upper part is a weight F to be raifed higher or lower, and fixed, as occasion requires. This Y is fixed very fast upon the faid iron axis A B.

From the axis hangs a fort of an iron flirrup IKLG, by its two hooks IG, having on the lower part two holes K L, through which paffes a long iron pin L K, and keyed in the fame. When this pin is put in, it is also paffed through the two holes, in the ends E N, of the horizontal fork or fpanner E Q N, joined at its end Q to the handle of the regulator V 10. From Q to O are feveral holes, by which the faid handle may be fixed to that part of the end which is most convenient. Upon this axis A B, is fixed, at right angles to the Y, an handle or lever G 4, which goes on the outfide of the piece Q 2, Q 2, and lies between the pins. Another handle is alfo fastened upon the same axis, viz. H 5, and placed at half a right angle to the former G4; this paffes through the flit of the piece Q 2, Q 2, lying on one of the pins. Hence we fee, that when the working beam goes up, its pin in the flit lifts up the spanner H 5, which turns about the axis fo fast as to throw the Y, with its weight F, from C to 6, in which direction it would continue to move, after it had paffed the perpendicular, were it not prevented by a strap of leather fixed to it at œ, and made faft at the ends m and n in fuch a manner as to allow the Y to vibrate backwards and forwards about a quarter of a circle, at equal diffances, on this fide and that of the perpendicular.

In the reprefentation we have given, the regulator appears open, its plate T Y being fhewn on one fide the pipe S, which joins the cylinder and boiler. The pifton is now up, and alfo the working beam near its greateft height; the pin in the flit has fo far raifed the fpanner H 5, that the weight F on the head of the Y is brought fo far from n, as to be paft the perpendicular, and ready to fall over towards m, and, when it does fo, it will by its fhank E, with a fmart blow, ftrike the iron pin K L, and and drawing the fork horizontally towards the beam Q, will draw the end 10 of the regulator towards 6, and thut it, by flipping the plate Y under the holes of the throat pipe S. Immediately after the regulator is fhut, the beam rifing a little higher, with its pin s on the outfide upon the lower part, lifts up the end k I of the handle of the injection cock, and opens it by the turning of the two parts with teeth. The jet immediately making a vacuum, the beam again defcends, and the pin r depressing the handle k 1, shuts the injection cock; and the beam continuing to defcend, the pin p bears down the handle G 4, and throwing back the Y, its fhank D throws forward the fork NQ, and again opens the regulator to admit. All the parts now begin afresh to operate; and fresh steam. thus is the engine most wonderfully contrived to work itfelf. After the engine had been made, as above defcribed, for many years, it received another improvement of very great advantage; and that was, inftead of feeding the boiler with warm water from the top of the cylinder by the pipe W (fig. 1) above, and F f below, it was supplied with the fealding hot water which comes out of the eduction pipe d TY, which now, inftead of going to the wafte well at Y, was turned into the boiler on the top part; and as the eduction pipe before went out at the fide of the cylinder, it was now inferted in the bottom of the fame : and though the prefiure of fteam in the boiler, be fomewhat greater in the cylinder, yet the weight of water in the eduction pipe being added to the force of fteam in the cylinder, will carry the water down continually, by overcoming the refiftance in the boiler. (Martin.)

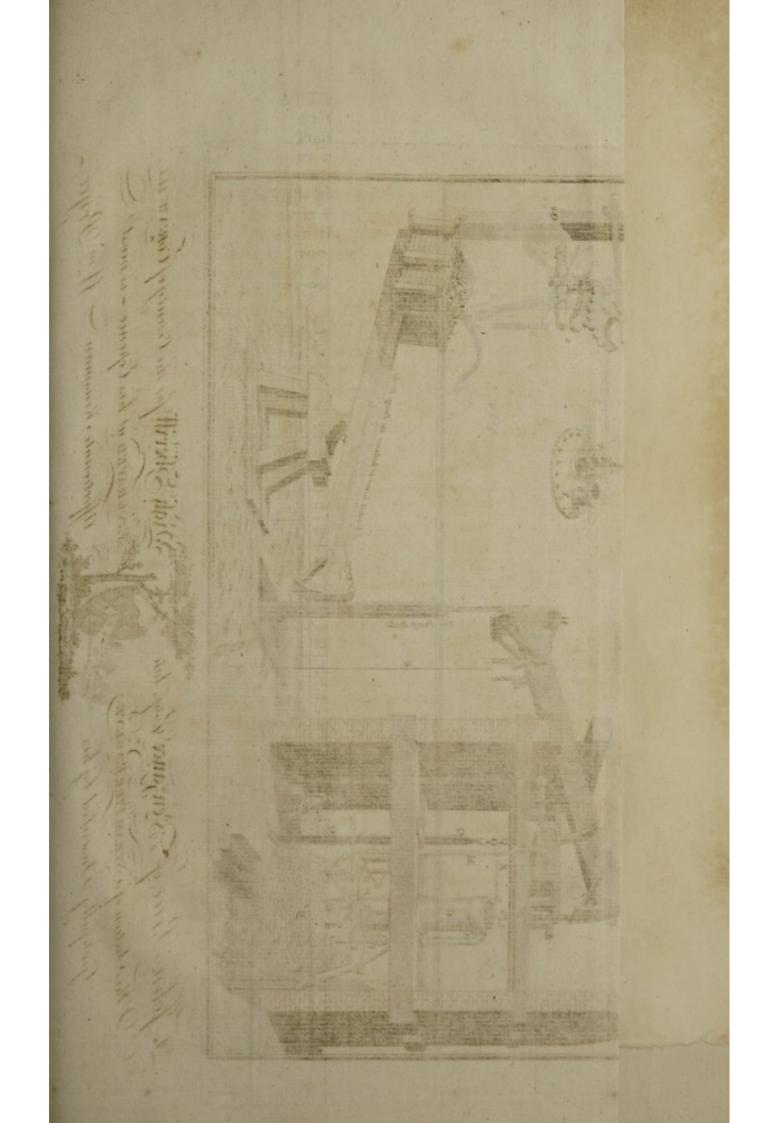
To this defcription of the fire engine, I shall add a most curious and ufeful table of the calculation of the power of fire engines for the various diameters of the house cylinder, and bore of the pump or pit-barrel, that are capable of railing water, at any depth between 2 and 876 fathoms. It was composed by Mr. John Nancarrow, jun. and is founded on this principle, that the ale-gallon of 282 cubick inches of water, weighs ten pounds three ounces, avoirdupois; and a fuperficial fquare inch is prefied with the weight of fourteen pounds thirteen ounces of air, when of a mean gravity. But allowing for feveral frictions, and to give a confiderable velocity to the engine, it is found by experience, that no more than eight pounds of preffure must be allowed to an inch fquare on the pifton in the cylinder, that it may make about fixteen ftrokes in a minute, about fix feet each ftroke. The use of this table is easy : if I want to know the power

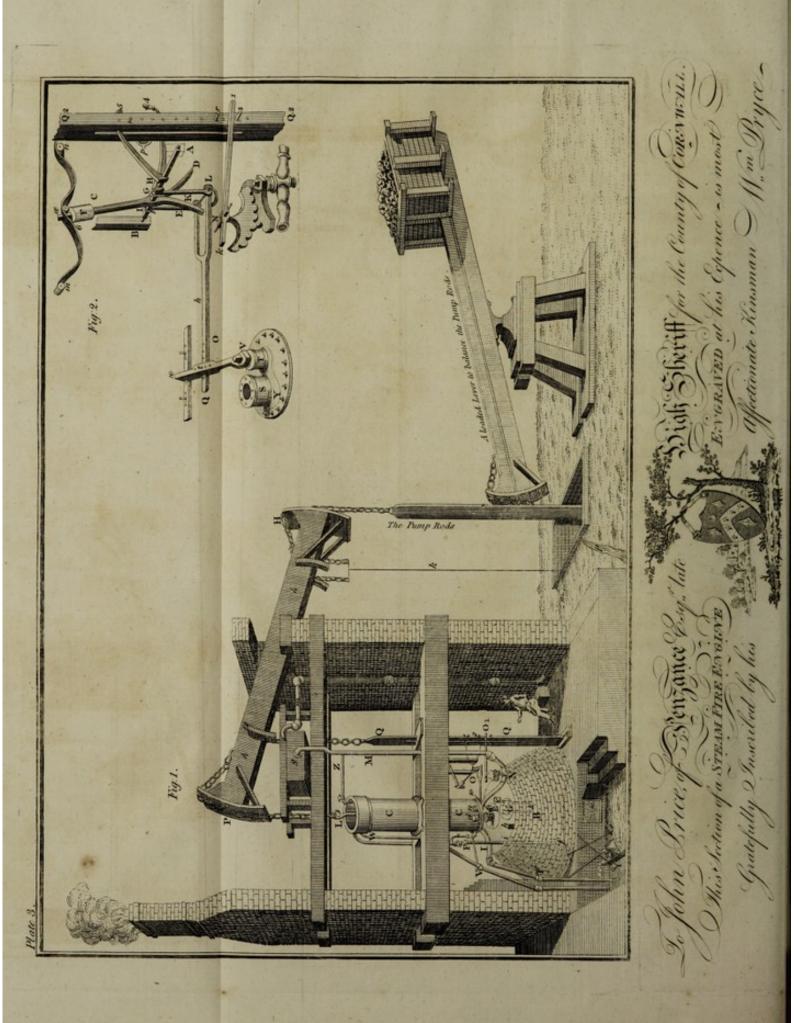
power of a 60 inch. houfe cylinder, to work a pit-barrel or working piece of 12 inches diameter; I look in the first column for the diameter of the house cylinder, till I find the No. 60: I then go on in that line to my right, till I come under 12 of the uppermost line, which is the diameter of the pit-barrel or working piece, and there find 79, the number of fathoms an engine of that power will draw; that is, a house cylinder of 60 inches diameter, will draw with a 12 inch. box, 79 fathoms.

The Mine being fupplied with a power for the difcharge of the water, and the adventurers refolving to prove it at a good depth, they fink down the engine Shaft continually, or keep it lower than their workings upon the courfe of the Lode, with which it has always a deep communication, that the water may readily flow to the engine pumps, and be drawn to Adit. The bottom of the engine Shaft, while it is deeper than the workings upon the Lode, is properly the Sumph or Sink of the Mine ; and this fhould ever be the cafe, for the Mine to be in regular courfe of working: but when an engine is worked to the full extent of its power, it is common to fink a Sumph in the Lode itfelf, and draw the water from thence by a force pump (or any more convenient hand machinery) into the engine Shaft; this, however, is feldom done unlefs a Mine is foon to be fet idle. If the Lode underlies north, the engine Shaft ought to be at a good diftance north from the back of the Lode; becaufe, while the engine is drawing the water out of the Shaft, the Lode is ftill coming nearer to it by every fathom of Lode or ground that is broke away, until at laft the Lode underlies into the Shaft itfelf; and in process of further finking the Mine, the Lode which was before to the fouth of the Shaft, is gone through to the north of it; fo that the deeper either of them is funk, they are more and more diftant from each other, and become at last very expensive and incommodious from the unavoidable neceffity they are under, of continually driving a Crofs-cut, or Drift, from one to the other, that the water may flow into the Sumph for its difcharge to Adit. This is an evil that cannot be prevented; for, in all deep Mines, their engine Shafts, at laft, must be very distant from their Lodes, unless the underlie is trifling, and the Lode very little removed from a perpendicu-This Crofs-cut or Drift of Communication is fometimes lar. very tedious and expensive, where the ground is hard, the water quick, and the engine almost at the extent of its power.

01 70000 T T:

From





A TABLE, fhewing, at one View, the Diameters of the Houfe-Cylinders of Fire-Engines, from 20 to 100 Inches; the Areas, in fquare Inches, for each refpective Diameter; and the Number of Pounds, Avoirdupois, fuch Cylinders will lift, allowing 8 Pounds to a fquare Inch clear of Friction: to which are added, the different Depths, in Fathoms, each Cylinder will lift a Column of Water, with Pit-Cylinders or Working-Pieces from 6 to 24 Inches diameter. At the Bottom of thefe Columns is given the Number of Ale-Gallons lifted in each of thefe Working-Pieces when the Engine makes a fix Feet Stroke; and the laft Column to the Right-Hand, fhews the Number of Ale-Gallons contained in the whole Tier or Lift of Pumps, anfwering to Houfe-Cylinders of any Dimensions, from 20 to 200 Inches diameter.

| Diameter of the Heafe- Cylinder, | Its Area In fquare Inchet. | N* of Pennis Avoirdupeisal- lowing 8 lb, to every 64, Inch. | | Diameters of the Working-Pieces or Pit-Cylinders. | | | | | | | | | | | | | | | | | | |
|--|----------------------------------|--|-------------|---|-------|-------|-------|--------|------|-------|------|-------|-------|-------|-------|-------|-------|--------|-------|----------------|-------|--------|
| | | | 6 In. | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 1 |
| 20 | 314 | 2,513 | Fath. 35 | 26 | 20 | 15] | 12] | 101 | 84 | 71 | 61 | 51 | 5 | 41 | 38 | 31 | 3: | 23 | 2 * | $2\frac{i}{T}$ | 2 1/8 | 2.46,4 |
| 25 | 490 | 3,920 | 55 | 40 | 31 | 241 | 20 | 161 | 134 | 111 | 10 | 81 | 71 | 61 | 6; | 51 | 5 | 41 | 45 | 31 | 31 | 384,3 |
| 30 | 706 | 5,648 | 79 | 58 | 44 | 35 | 28 | 231 | 191 | 16‡ | 141 | 12 1 | 11 | 91 | 81 | 78 | 7 | 61 | 5% | 51 | 5 | 553,7 |
| 35 | 962 | 7,696 | 108 | 79 | 60 | 48 | 39 | 32 | 27 | 23 | 20 | 17 | 15 | 131 | 12 | 11 | 97 | 84 | 8 | 7 1 | 61 | 754,5 |
| 40 | 1256 | 10,048 | 140 | 103 | 79 | 62 | 50 | 41 | 35. | 30 | 26 | 22 | 20 | 17 | 15 | 14 | 111 | 114 | 10 | 91 | 81 | 985,1 |
| 45 | 1590 | 12,720 | 178 | 131 | 100 | 79 | 64 | 52 | 44 | 38 | 32 | 28 | 25 | 22 | 20 | 18 | 16 | 14 | 13 | 12 | 11 | 1249 |
| 50 | 1963 | 15,704 | 218 | 162 | 123 | 97 | 79 | 65 | 54 | 46 | 40 | 35 | 31 | 27 | 24 | 22 | 20 | 18 | 16 | 15 | 14 | 1539,6 |
| 55 | 2375 | 19,000 | 265 | 196 | 149 | 118 | 96 | 79 | 66 | 56 | 49 | 42 | 37 | 33 | 30 | 26 | 24 | 21 | 20 | 18 | 16 | 1862,7 |
| 60 | 2827 | 22,616 | 316 | 233 | 178 | 141 | 114 | 94 | 79 | 67 | 58 | 50 | 44 | 39 | 35 | 31 | 28 | 26 | 23 | 21 | 20 | 2216,2 |
| 65 | 3318 | 26,544 | 371 | 273 | 208 | 165 | 134 | 110 | 93 | 79 | 68 | 59 | 52 | 46 | 41 | 37 | 33 | 30 | 27 | 25 | 23 | 2602,3 |
| 70 | 3848 | 30,784 | 430 | 316 | 242 | 191 | 155 | 127 | 107 | 91 | 79 | 68 | 60 | 53 | 48 | 43 | 38 | 35 | 32 | 29 | 27 | 3018 |
| 75 | 4417 | 35,336 | 495 | 364 | 277 | 220 | 178 | 147 | 123 | 105 | 90 | 79 | 69 | 61 | 55 | 49 | 44 | 40 | 37 | 33 | 31 | 3464,3 |
| 80 | 5026 | 40,208 | 560 | 413 | 316 | 250 | 202 | 166 | 140 | 119 | 103 | 90 | 79 | 70 | 62 | 56 | 50 | 46 | 42 | 38 | 35 | 3941,9 |
| 85 | 5674 | 45,392 | 634 | 467 | 356 | 282 | 228 | 188 | 158 | 134 | 116 | 101 | 89 | 79 | 70 | 63 | 57 | 52 | 47 | 43 | 40 | 4450,1 |
| 90 | 6361 | 50,888 | 710 | 522 | 400 | 316 | 255 | 210 | 177 | 151 | 130 | 113 | 100 | 88 | 79 | 71 | 64 | 58 | 53 | 48 | 44 | 4989 |
| 95 | 7088 | 56,704 | 792 | 583 | 446 | 353 | 285 | 235 | 197 | 168 | 145 | 126 | 111 | 98 | 88 | 79 | 71 | 64 | 59 | 54 | 50 | 5559,1 |
| 001 | 7854 | 62,832 | 876 | 646 | 494 | 390 | 315 | 260 | 218 | 186 | 160 | 140 | 123 | 109 | 97 | 87 | 79 | 71 | 65 | 60 | 55 | 6160 |
| | - | | 7,22 | 9,82 | 12,82 | 16,24 | 20,04 | 2.4,26 | 28,8 | 33,88 | 39,3 | 45,12 | 51,37 | 57,91 | 64,94 | 72,39 | 80,21 | \$8,43 | 97,06 | 106,07 | 115,5 | |



From the level of the Sumph if it is out of the Lode, or from the Sumph itfelf if it is in the Lode, they turn houfe, and drive on the courfe or body of the Lode to break Ore, or to fee if they can meet with any in extending the bottom or deepeft part of the Mine.

Now if the Sumph proves good for Ore, they not only turn houfe, in order to make room and lengthen the bottom of the Mine; but they likewife ftope or break away the Lode in the following manner: the Sumph being in the Lode, one man with a pick-axe breaks away about two feet of the upper part of the edge of the Sumph or pit, ftill driving on, on the courfe of the Lode; and when he makes room, another follows him in like manner, and then others; fo that this ftoping is not unlike the hewing a flight of fteps in a rock, where each man works away the ftep above that which he ftands on.

But if the Ore is not generally plenty in the Lode, and only in uncertain branches, then they often follow thefe branches of Ore, both upwards and downwards. Thofe fmall pits they make in digging down after the Ore, and all other pits that are made below in following the Ore, though they are large, are all called Dippas, provided they are not deeper than the Sumph, nor funk down to drain the Mine as Sumphs are. But this way of finking many Dippas, is apt to diforder a Mine, and put it out of a regular courfe of working; and often prevents the difcovery of Ore, which may lie hid in many places in a Mine, that do not feem worth the charge of breaking that part of the Lode which appears poor and barren; however, if a Mine is on the point of being left off, then it cannot be improper to work in Dippas, where the Ore lies, in order to make the moft of it.

It often happens that a Lode five or fix feet wide, may have a branch or leader on one fide of it, very rich for Tin or Copper, while the reft of the Lode is very poor and dry. This rich part may be one foot wide, or it may be fcarcely fix inches; fo that if it is not a working big, or there is not fufficient for a man to work on Ore exclusive of the barren part, he breaks down, if in an end, or digs up, if under his feet, all the poor part by itfelf, in length, or depth, according as he chufes, or is directed; whereby the rich Ore is left ftanding clean from any other mixture: this he afterwards breaks and keeps by itfelf, whence it is then brought up to cleanfe and drefs.

Tt

This

This feparation or breaking the bad from the good Ore, they call Dyzhuing the leader, or making a Dyzhu; and the good Ore that is thus exposed, is called a Dyzhu, from the Cornish British Dyzhui, to discover unto. This method of proceeding is very useful, to prevent the more valuable part of the Lode from being mixed promiscuously with the barren part, which would increase the charges of dressing the Ore, and of confequence diminish its value by the deads and waste that would neceffarily be mixed with it if the Lode was broken altogether.

But though the utility of this method muft be very obvious to the reader, Dizhuing the Lode in whole, is popularly underftood in the following manner : when the whole Lode is rich, and perhaps not above fix or twelve inches big, it will be impoffible to break the Lode away clean and free from wafte of the adjoining country without it is first Dizhued : accordingly they observe which of either wall or fide of the Lode is the most fair, and eafily to be broken, and purfuant to that or any other contingent circumftance, they break down first of all fome part of one wall and contiguous stratum by the Lode, as hath been before defcribed, and afterwards the Lode being thus far Dizhued is taken down clean by itfelf. On the contrary, if one part of the Lode is very rich and fair, but fmall, and the reft of it is dry, barren, large, and hard, they commonly dig out first the pith or richer part of the Lode, which they call Hulking the Lode; fo that in fuch cafe, the poor part which is left flanding may not improperly be named a Dyzhu of the dead unprofitable part of the vein ; which, if it is very hard, they usually deftroy or break down by a charge of gunpowder.

For the more eafy comprehension of the reader, it is to be observed, that Hulking of Lodes, is the term most generally used in driving a high end, or finking a high stope of the Lode; and that Dyzhuing the Lode or the Leader, is most used where the barren part of the Lode, or the adjoining country, is very fair, or more so than the rich part of the vein. The interchange of terms, arises from the converse of the foregoing contingencies; for Hulking the Lode, is only useful where the country, or barren part of the vein, is much harder than its richer parts.

In Dyzhuing or Hulking the Lode, a fuper abundant quantity of deads muft confequently incommode the workmen, and fill up the Mine, if not fpeedily drawn up to grafs or difpofed of in fome vacant place. The drawing fuch portions up to the furface,

furface, muft be very tedious, and as coftly as drawing up equal quantities of the richeft Ores. Now in order cheaply and fpeedily to difpole of their refuse or deads, if the Mine has been worked any tolerable depth, they lay over their heads, acrofs the fiffure or evacuated workings, great beams of timber mortifed into the folid rock ; and acrofs upon those beams, firm planks of deal, which make a ftage or gallery, denominated a Stull, from the British word Astel a board or plank. Several of these Stulls are made in different depths of Mines, that are of any ftanding; and we find they are many ways useful to the Mine and workmen; for by fuch coverings over head, the workmen are oftentimes preferved from great danger by the falling of Scals, or the tumbling down of rocks and ftones from various places of the workings over them. These Stulls are doubly ufeful to the Mine; for all the deads or refuse part of the workings before mentioned, are conveniently thrown to Stulls, as they fay, to the faving of much labour and great expence; and at the fame time, when thus filled with Attal or deads, they help to prop or keep open the Mine from being crushed together by the incumbent strata or country. One only inconvenience, that I know of, refults from the making of Stulls in a Mine; that is, they often ferve for concealing Ore under-ground, which the combined knavery of the workmen, with the connivance of the captains, may place there till it fuits their opportunity to remove it for their own advantage to mix with Ore upon tribute, where they are largely concerned. All publick undertakings are more exposed than private ones, to the peculations of difhoneft fervants.

In fome Mines, where Ore is broken more fpeedily than it can be drawn up to grafs, (and I have known fome Lodes fo fair and rich that one pick-man would keep a whym conftantly going) it is neceffary for them to have a place under-ground, diffinct from the Shafts and Stopes of the Lodes, for lodging their Ore, till they are at liberty to bring it to grafs; particularly where they are driving a drift either upon Ore or deads. This place, if it is dug out of the folid rock or country, they call a Plot, or cutting a Plot. The Plot (commonly called the Plat) is feldom under twelve feet fquare and fix feet high; but it may be much larger according as circumftances require. At the entrance or beginning of almost every Drift, a Plot, or chamber, is convenient to lodge the broken fluff on, almost as foon as it is broke, that it may not incommode the working of the drift end; and it is also more necessary at the top of the Little-

Little-Winds or under-ground Shaft, that communicates with the fide or bottom of the upper or grafs Shaft. It may appear ftrange to fome of my readers, how Shafts under-ground, like those above, can be neceffary or even practicable; but it is very true, that few Mines are without many of them; and that, in the workings of former times, they were more numerous than grafs Shafts.

The under-ground Shaft or Winds, is worked by hand, with a windlafs only; and its area is not fo large as the grafs or working Shaft; whence it is corruptly abbreviated the Little-Winds. Now that we may understand how necessary the Little-Winds is to the working of a Mine, the reader will be pleafed to remember, what I have before hinted, that Lodes in their underlie, go away from the Shafts, in which the work or Ore is brought up : the Shafts are thereby rendered useles in course of time, and therefore it is commonly requifite to fink down new Shafts, and cut the Lode at a deeper underlie, that they may draw up the work perpendicularly with greater facility. But those Shafts in deep Mines, are often costly, and troublefome to be funk, from the furface of the earth ; either by means of the water that falls into them, the intense hardness of the ftratum they must cut through in finking, or by means of loofe foft ground, that requires much timber and boards to line the Shaft from top to bottom. When they find any of these difficulties very great, they fink a Little-Winds in this manner: they go down in the grafs Shaft, from whence the Lode is gone fo far as the Shaft is perpendicular, or as far as they think proper; from thence they work in a drift or horizontal line, till they come as far over the underlie of the Lode, as they like : there they cut a Plot; and in the middle of this Plot they fix a windlafs or winding tackle, and fink down their Little-Winds or Shaft until they cut the Lode in it, or to the depth they intended. If the Plot is not fufficiently large after the Winds is funk, they make it wider, for holding the work they wind up from the deeper workings; whence the men roll it away in wheel-barrows to the grafs Shaft, where is another Plot, Saller, or ftage of boards, to place it on, from whence they draw it up to the furface at their leifure. Hence it appears, that both the grafs Shaft, and Little-Winds, are put down in ftrait lines; and they would be parallel to each other, had the Winds been continued up to the grafs or furface; but the line, or drift of communication common to both, is horizontal and at right angles

Little-

angles to each other; and goes from the foot or fide of the grafs Shaft, to the top of the Winds.

We may conclude, that the number and neceffity of thefe under-ground Shafts in a Mine, greatly depends upon the horizontal tendency of the Lode : for if a vein goes down nearly perpendicular, the grafs or working Shaft will answer its purpofe very well; but if it inclines faft, or underlies a fathom in a fathom, that is, if for one fathom in perpendicular depth which the Lode is funk upon, it is gone likewife a fathom to the north or fouth, the use of the Winds foon becomes necesfary. And though there is a great expence in finking thefe under-ground Shafts, and cutting of Plots, yet their usefulnefs counterballances it, where a great wafte of ropes and expence of draft are occafioned by dragging upon the long and flat underlie of a deep Mine. In deep Mines, fome whym ropes coft fifty or fixty pounds; and perhaps cannot be used with fafety beyond two months if daily employed, on account of the great wear by dragging fifty or fixty fathoms upon the inclination of the Lode; befides the expence of putting four horfes to draw half the work, which two, but for the depth and impediment, might perform; it being well known, the Kibbal in fuch cafes feldom comes up half full to grafs. Neverthelefs, thefe with many other difficulties are to be borne with in deep Mines inclosed by denfe ftrata; and it must of confequence follow, that the Winds is more eligible in a fair and feafible country.

When a Mine is wrought very deep, it requires too much time to let many men down through the working Shaft, which is appropriated to the bringing the work or Ore to grafs; and therefore their underlying Shafts, which are become ufelefs, and out of course of working, are converted into a foot way. To make a good foot way, they build a Saller or landing plot of boards, on which they reft the foot of a long ladder, the other end whereof reaches up to the top of the Shaft at the furface; then, from the foot of the ladder, they have an horizontal paffage to another deeper Shaft on the underlie of the Lode, where they have another Saller or landing place, and fix another ladder to defcend deeper; and thus they proceed, till they have ladders enough to go down to the bottom of the Mine. Yet it is very common in great Mines to have foot ways by ladders in their engine Shafts, which not only ferve the purpofe of going down into the Mine, but also of inspecting every Uu crevice

crevice of the pumps that have loft water, that they may rectify them when any misfortune happens. Those ladders in the engine Shafts are of various lengths; but at the foot of each ladder there is placed a Saller for it to reft upon, above which, the top of the next ladder prefents itself.

Either in driving an Adit, or finking a Shaft in loofe mouldering stratum or country, they are often obliged to bind and fecure them with timber, to prevent the country from running into the workings, and thereby choaking them. If the ground is very loofe on all fides, they make a Durns, as they call it, which for a Shaft is fquare like the frame of a window, and for an Adit is the fame as a door cafe. Between the Durns and the country they thruft in deal boards, whofe extremities length ways are just placed behind each Durns; by which means the loofe ground is kept fecure from filling the workings and deftroying the men. This, in an Adit, or any other drift, is called Binding or timbering of it; but in a Shaft, it is Collaring the Shaft; and indeed every Shaft, before it is funk into the hard rock, or while it is in the rubble of the country, must be thus Collared; and the top is thence usually denominated The Collar of the Shaft.

All deep Mines likewife require to be well propped and fupported with ftemples or maffy pieces of wood, which being boarded over make Stulls, as I have already obferved. Thefe ftemples or pillars of wood, which fome call Lock-pieces, are generally placed perpendicularly, one end being fixed under the upper or hanging wall of the Lode, the other end refting on its underlying wall; fo that these pillars fuftain and keep up, not only the roof or hanging wall of the Lode, but also the prodigious weight of the impending ftrata or country. I have feen those massive pillars crushed almost together in some Mines, by their incumbent roof, and have been filled with horror at their appearance; and in other Mines, where the Lode has been wide and but little inclined, they have appeared like the pillars which form the aile of a venerable piece of Gothick architecture. But to fave the charge of the timber, and coft of breaking the fruitlefs part of the vein, they often leave pillars of the Lode unbroken and flanding, efpecially if they are poor in nature, and of a hard ftony confiftence; and by driving holes through those pillars, which are called Arches of the Lode, they preferve a communication with the reft of the workings.

crevice

It requires much judgment to know when to use timber, and when to do without it; for an unfkilful perfon may at a great charge use timber where it is not wanted; or may apply it fo injudicioufly, that it may not answer the purpose for which it was defigned. In this branch of Mining, indeed, many expert Miners are not verfed; and therefore it is generally undertaken by perfons who have made it their fludy and employment; who are ufually called Binders and Timbermen; and who, according to their reputed excellence, have very great wages; for without a proper application of timber, both the workmen and Mine may be crushed together and destroyed. Of such an event we have had too many inftances; but if a Mine that has fuffered thus, is worth the charge of recovery, new Shafts may be funk down from grafs, till they come under the old bottoms, and by leaving over head a firm back or feparation, to fupport and keep up the run of the former workings, it will be again in as good a ftate as a new Mine.

If only fome part of a Mine falls in, or a ftull runs; that is, if it breaks down, and fills fome of the bottoms with deads; it is ufually cleared by fhutting of Attal; which is performed by introducing upright Durns, and driving deal boards pointed at one end, between those Durns, and the loose Attal; and at the fame time clearing and shoveling away the deads as fast as they can conjunctively proceed with Durns and Laths; by which latter name they call deal boards. By this process they carry a drift of communication through their Attal, to different parts of the Mine.

The great expence in hydraulick machinery that fome very deep Mines are chargeable with, very often induces the adventurers to ftop their workings for fome time, till they bring home a new and deeper Adit. Accordingly they look out for a place to take a level from, that will neither be expensive, nor flow in the driving; and they put more or lefs force upon the Adit, as they are more or lefs earnest in the work. When they refolve to be expeditious about it, they are not fatisfied with driving one fingle end, but fink many intermediate Shafts between the loft flovan or tail of the Adit, and the Mine. In this matter, if they do not reflect maturely, and confider, whether they can fink fo many Shafts, without drawing much water. they may feverely pay for their improvident temerity. The greateft accuracy, skill, and circumspection are necessary in dialing with a compass for an exact and absolute level between the

the Shafts and the Adit end. A fmall error will be of great, very great ill confequence; fo that none but fenfible, experienced Miners, ought to be trufted with fo momentous a transfaction.

The new Adit is feldom or never deeper, than the bottoms of the Mine; therefore the holding this deep level to the houfe of water, is very dangerous. All the former workings, if the Mine has been fet idle, muft of neceffity be filled with water to the level of the first or old Adit. The whole Mine then becomes a houfe of water, according to the common expression; and fuppofing they were abruptly to hole the Adit, or make a communication from it to the former workings, without any precaution; then the great weight and prefiure of the water, would force its way through fo precipitately, that the ftream would inftantaneoufly fill the Adit, and the men could not efcape drowning. Therefore, whenever they are apprehenfive of coming towards a Gunnies, or hollows of a Mine filled with water, they bore a hole with an iron rod towards the water, about a fathom or two, or fo many feet, further than they have broke with the pick-axe according to the denfity, or different texture of the ftratum in their Adit end. As they work on, they ftill keep the hole with the borier before them that they may have timely notice of the burfting forth of the water, and fo give it a gradual vent or paffage, which will foon enlarge itfelf, and drain the Mine, when once it begins to pipe out of the borier hole into the Adit. Yet notwithftanding all this care and prudence, they are often in imminent danger of their lives, and are fometimes loft by the fudden eruption of the water. This very hazardous bufinefs is generally undertaken by enterprizing workmen for the confideration of an advanced price ; and I have met with feveral inftances of its being attended with fatal confequences.

In fome places, efpecially where a new Adit is brought home to an old Mine, which has not been wrought in the memory of man, they have unexpectedly holed to the houfe of water, before they thought themfelves near to it, and have inftantly perifhed. Some have driven by the fide of the houfe of water, and have perifhed alfo by its unexpected eruption. But I think where they are tolerably acquainted with their fituation, much danger may be avoided, by keeping three or five borier holes before them, radiated or difplayed above and below, to the right and to the left, from the center of the Adit. This advice however

however may not be relified by those who are impatient to be rich, and value a little money more than the lives of their fellow-creatures.

rom Grats to

It often happens, however, where they are driving home an Adit upon the course of the Lode, that the water, as they come near the old workings, zighyrs away by flow degrees, through the Adit end, if it is tender and porous; and instead of holeing to the house of water, they very happily hole to Learys, or the old Gunnies, or excavated parts of the Mine.

The new Adit being holed in to the old workings, they immediately prepare to draw out the water; and when the bottoms are forked, or quite unwatered, they proceed to clear them of all flime, fludge, and attal, that may have fallen into them fince the Mine was knocked or fet idle. Afterwards they fink, flope, and drive in various parts of the Mine, according to the beft of their judgment, and in the manner before deferibed. The reader will conceive, that almost every Mine, from variety of circumfances and natural contingencies, will require a different management, and method of working; and that one certain mode for working two different Mines is impracticable. We have only to remark, that no Mine can be well wrought without using the forementioned general methods, however varied they may be in the manner and application.

New fire engine^x Clack pumps.

A General

170 A GENERAL DISPLAY OF A MINE.

- A General Difplay of a Mine, by Notes of Reference to and an Explanation of every Part of a whole Sheet Parallel-Section of Bullen-Garden Copper Mine; wherein is exhibited all the Machinery, and Workings, from Grafs to the Sumph, fhewing every Pump, Saller, Ladder, Drift, Stope, End, Winds, and Stull, in the Mine.
- 1,2 The weftern water engine tyes, or pumps, which deliver the water to adit.
 - 3 The ciftern into which the water runs, from the old fire engine rofe pumps 17.
- -mi yout 4 A fmall bore, or fmall pump. Jib/ was ad T
- 5 A ciftern : the water which comes from Dolcôth Mine through the level 6, runs into this ciftern ; it then afcends through the fmall bore 4 into the ciftern 3, whence it is drawn to adit by the pump 2.

beding 6,610 An aqueduct or level from Dolcoth Mine. lo flod

7,7,7,7,7,7 Poles, or pump rods. , ovisonoo lliw sohar of L

Tib a stin 8 st Old fire engine tye pumps. has aportalization to

terent management, and methorins for shT are that one

aldsords 10m A pump, that conveys the water from the role

- revenue Libo Old fire engine role pumpsot and guild suprisu
 - Clack door piece, and iron pump or cylinder 121 inches diameter.
 - 12 A ciftern.
 - 13 Old fire engine crown lift.
 - Clack door piece, and iron pump or cylinder 121 inches diameter.
 - 14 A ciftern.
 - 15 Old fire engine lilly pumps.
 - 16 New fire engine tye pumps.
 - Clack door piece, and brafs pump or cylinder 11 inches bore or diameter.
 - 17 A ciftern.
 - 18 New fire engine role pumps.
 - Clack door piece, and brafs cylinder or pump 11 + inches bore or diameter.

19 A ciftern.

- 20 New fire engine crown pumps.
- > Clack door piece.
- 21 Ciftern.

22 New

A GENERAL DISPLAY OF A MINE. 171

New fire engine lilly pumps. alles goab add 22

Launders, to convey the water from the rofe 23,23 abod one in a ciftern 9, to the western water engine.

- Wooden pumps, to convey the water from the 24,24
 - Eaftern water engine great tye pumps. 25
- 26 Ditto little tye pumps. Both thefe tyes or lifts draw to adit all the water from the ciftern 9, which comes to them through the wooden R,R Triangles, rope, and 1,24,24 sqmuq ine pumps,

 - A brafs cylinder or pump, 11 inches bore. 27
 - Ditto, 101 inches. . adod anigas Teste 8,8 28

A ciftern. 20

- 30,30 A fhallow level or aqueduct, that conveys the water, after it is difcharged from the eaftern water engine wheel, to the top of the weftern water engine wheel, to work that alfo.
- The old level or adit. 31,31
- The new level or deeper adit. 32,32
- A level to Dolcôth fire engine fhaft. 33,34
 - Huel-Bryant drift, or a deeper level driving to 35 Dolcôth.
 - A drift. 36
 - Kemps end. 37
 - The broad ftull. 38
 - The long faller. 39
 - A winds or windlafs, to draw deads, or attal, 40 from the fumph to the ftull.
- A winds to draw attal from the bottoms to the 41,42 ftulls.
- Drifts, driven to the north branch. 43,43
- A ftull and way to the top eaftern end. 44,44,44
 - A drift to fouth Entral Mine. 45
 - Foot-ways and ladders. 46,46
 - The deep weftern end, or ftool. 47
 - 48 Weftern bottoms.
 - Western shaft bottoms. 49
 - Sumph fhaft weftern bottoms. 50
- AH 51 The fumph.
 - Sumph fhaft eaftern bottoms 52
 - South fhaft bottoms. 53
 - 54 Tyacks bottoms.
 - Eastern bottoms. 55

The 56

172 A GENERAL DISPLAY OF A MINE.

56 The deep eaftern end, or ftool.

57 A horfe in the Lode.

48,49,50,51,52,53,54,55 The breadth or bignefs of the Lode, in the deep bottoms.

A,B,C,D,E,F,G,H,I,K,L,M Stopes on the Lode.

"A thallow level or equeduce, that conveys the

N,N Fire engines.

0,0,0 Whyms.

P,P Capitans.

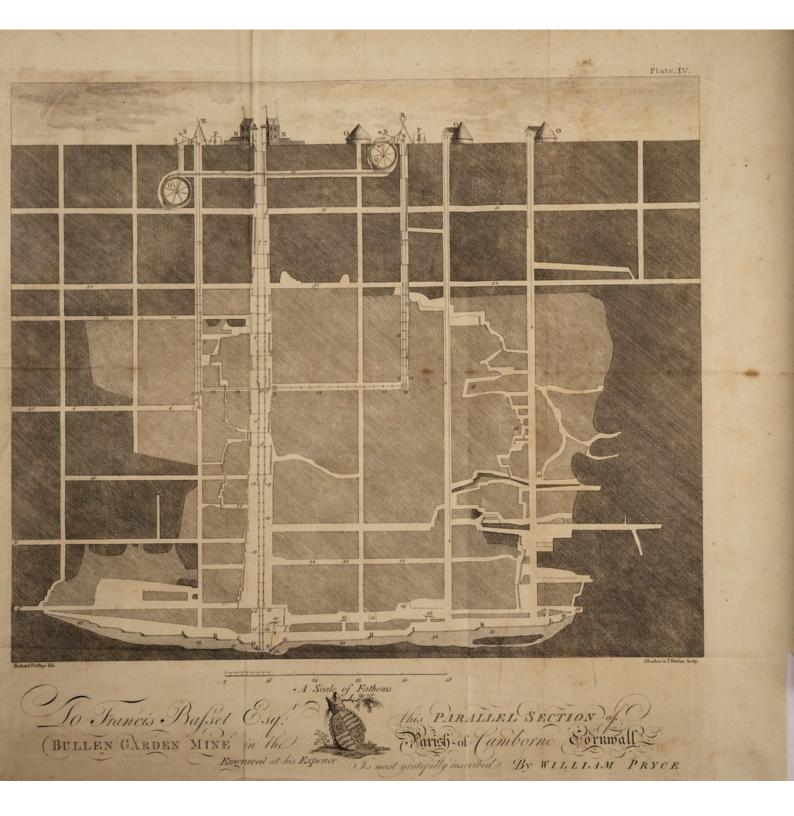
Q, Q Water engine wheels.

R,R Triangles, rope, and sheaf, for raising the pumps, changing boxes, &c.

S,9 Water engine bobs.

CHAP.





or great skill; but sheVI w . A A H D occupied indifferently cither by fuch, or by the labouring Miners, and frequently by

Deep chargeable Mines are carried on by perfons of fortune

General Observations on Mines, and the Management of them.

turcre, they are always filled In-adventurers ; and those w

TA GERERAL OBSERVATIONS ON

HAVING treated, in the preceding chapter, of the manner of working Mines, I fhall now make those observations, which are consequent to the working of some Mines, and not of others; and likewise circumstantially explain the arrangement and conduct of the labourers in their several departments.

Mining is fo expensive in its operations, and fo uncertain in its fuccefs, that few or none of our Cornish Mines are carried on at the rifk of one or two perfons. Where there are fo many blanks to one prize, it would be gaming in the extreme, for any perfon fingly to begin a feeking adventure; or indeed, to take up any thing of the kind, which is not already difcovered, and likely to be rendered profitable almost to a certainty : and, upon this ground, it generally happens, that the charges of our adventures are borne by many partners, from four to ten, fixteen, twenty-four, and thirty-two. The fhares in these adventures, are often fo fractional and intricate, that a ftranger, though a tolerable arithmetician, would be greatly at a lofs to divide and appropriate the Doles or fhares, with that precifion, which is familiar to many illiterate Tinners, who can caft a piece of ground, and affign the proportions of a parcel of Copper or Tin Ore, with the utmost accuracy, by the help of

The principal manager in the Mine, is the Purfer, or Bookkeeper; who keeps all the accounts, and receives and pays all the money. This perfon is ufually one of the adventurers; and is chofen by the reft, for the administration of their affairs, during the intervals of their monthly-meetings; at each of which, a ftate of the transactions and accounts of the Mine is produced, and after it is regularly examined and passed, the total charge is divided according to the Doles or shares, of which each adventurer is obliged to pay his respective quota. The adventurers prefent at these monthly-meetings take into confideration the most effectual methods of working the Mine; and their determinations, which are fettled not by voices but shares, are conclusive for the whole body.

Deep

174 GERERAL OBSERVATIONS ON

Deep chargeable Mines are carried on by perfons of fortune or great skill; but shallow Mines are occupied indifferently either by fuch, or by the labouring Miners, and frequently by both. When the Book-keepers, or any other officers, by fupplying coal, ropes, candles, or other materials, are part adventurers, they are always fliled In-adventurers; and those who live at a diftance from the Mine, or have no immediate intereft by fupplying the works with Materials, are called Out-adventurers. By the Stannary laws, indeed, the latter have the fame privilege of fupplying a Tin work with men or materials in proportion to their refpective Doles; and when this is exercifed in opposition to certain In-adventurers, it is productive of much jealoufy and conteft; fo that it is more advantageous to Mines, when they are difintereftedly carried on, and fupplied with Materials, by perfons who have no property in them. In this cafe, the bickerings of contending interefts are prevented; and the Out-adventurers are fatisfied, that too many materials are not crouded upon the Mine by favour and connivance : and yet it is but reafonable, that those adventurers who are in trade, fhould have the preference in fupplying a Mine with Materials, when it can be done with probity and honour.

In large and important Mines, befides the Book-keeper or Cashier, there is a superintendant over all, called the Captain; who having the direction of the works both above and underground, ought to be an experienced practical Miner, and to understand every diffinct branch of the bufinefs. Under him, are the Bottom-Captains, whole bulines is to fee that the common men perform due labour down in the Mine, and that they do not promifcuoufly confound the good and bad Ore together, but break them feparately, or as nearly fo as poffible; and alfo, the Grafs-Captain, who directs the feparation of the Ore again above ground, fo that the beft or most folid parts of it be made fit for fale, especially if it is a Copper Mine, for which reafon, fome call him the Dreffer: but whether as Captain or Dreffer, having little more to do, than to direct the repair of what goes amifs in the Bal or Mine, among the horfes, whyms, carriers, fmiths, carpenters, &c. if he can keep a tolerable journal or day book, he alfo delivers materials to the men, fuch as gunpowder, candles, shovels, pick-hilts, &c. and is on that account often called the Material-Man.

Though it is much to be feared that adventurers are often injured by difhoneft captains, in conniving at the impositions of the

MINES, AND THEIR MANAGEMENT. 175

the common men; yet I must declare my opinion, that many private peculations originate from the parfimony of the mafters themfelves. It is an aphorifm in Mining, that "A Tinner has " nothing to lofe;" but upon tribute or fearching for Tin upon the mere strength of his labour, he puts himself in the way of fortune, to enrich him by one lucky hit. It is faid, "A Tin-" ner is never broke till his neck is broke;" for though he may lofe all his labour this month upon tribute, the next may amply repay all his lofs with profit. I, therefore, reckon a Tinner upon tribute, if he can clear thirty fhillings monthly, with the chance annexed of gaining four times as much, is better off than a captain at forty shillings without any further chance. There will never be occasions wanting for bad men to decoy fervants, and alienate them from their bounden duty to their masters : accordingly, Takers of ground by the fathom in finking, stoping, or driving, and likewife Takers upon tribute, invite the captains to drink with them, upon free coft, at publick houses; which leads to a further progress in deceit and corruption, till the incautious captains are feduced from their integrity by the prefents of the Takers, whom they fuffer to mix and manage the Ores in fuch manner as will most conduce to their own advantage; and to measure the ground which is wrought by the fathom, to the lofs and injury of the adventurers. Inftead, therefore, of allowing the captains to draw the work with their own horfes, and to fell the workmen materials and provisions, the adventurers in every Mine of great confequence, ought to give them handfome wages, with a ftrict prohibition not to have any private intercourfe with the Takers.

But, inftead of dwelling on the faults of this ufeful body of men, which are not greater than those of others who are equally defitute of the advantages of Christian inftruction and good example, and which the wisdom and generofity of their masters might in a great measure restrain; we ought rather to confider the number and feverity of their distresses, and the most probable means of affording them effectual relief.

The principal part of thefe arifes from the cafualties that continually befal them, and require the immediate application of chirurgical aid. It is common for the owners of a Mine to oblige the men to deposit twopence Ψ month with the purfer, for the payment of the furgeon belonging to the Bal; and as all who work lefs than five stems, and generally all labourers at grafs, are exempted from this contribution, it is levied only upon

176 GENERAL OBSERVATIONS ON

upon those who are in constant and imminent danger : and for this fum of two fhillings & annum from each contributor, the furgeon undertakes to attend at all times however unfeafonable, and at all places however diftant, and to perform all operations, and furnish all medicines. This kind of contract has subfifted near-fixty years; but unfortunately for those unhappy labourers who may hereafter want affiftance, the furgeons begin to be weary of it, and are gradually declining a practice, which, useful and important as it is to the fufferers, affords no recompence in any degree adequate to their own fkill, labour, and expence. Suppose, for inftance, that a Mine employs three hundred men who contribute to the payment of the furgeon; twopence monthly from each, amounts to thirty pounds annum. Now, in the course of a year, it is three hundred to one, that the trepan, or the crooked knife, will be wanted, not only once or twice, but very often ; befides the ordinary accidents of burns, wounds, contufions, luxations, or fimple and compounded fractures, where the knife is fpared ; and the blafting one or both eyes, and the two laft fingers of the left hand, by gunpowder. An accident of confequence may require at leaft fix weeks daily attendance five or fix miles diffant from the furgeon's refidence; an accident of the like nature may require the fame attendance, at the fame time, a road five or fix miles diametrically oppofite : and is there a recompence for all this attention and labour, that is likely to fecure the continuance of it?

We wifh not that any Mine fhould be attended by one particular furgeon : we know it is for the advantage of a patient in the progrefs of his cure, to be under the care of that furgeon to whom his own affection or opinion moft inclines him; and when the cure is completed, or the furgeon has done all in his power to effect it, let his bill be difcharged by the purfer of the Mine, purfuant to flated prices. If this, or fome plan like this, is not adopted, the poor labourers muft perifh very faft for want of neceffary help; for to fuppofe a continuance of the prefent method, is paying no compliment either to the underflanding of our furgeons, or to the compaffion and prudence of the Mine adventurers.

But the most effectual relief for all these evils, is a publick hospital. In almost all the large and opulent counties in England, hospitals are erected nearly upon the same plan as those in London : and it is strange, that a county so large as Cornwall, fo

MINES, AND THEIR MANAGEMENT. 177

fo opulent, and abounding with fo many accidents that require the greateft care and expertnefs in furgery, fhould be fo long without a charity of this kind : I am forry to obferve, it is no proof of the wifdom and generofity of its nobility and gentry.

If the annual proceeds of this county in Tin, Copper, and Fish, are rated only at £,400,000, it is generally known, that feven-eighths of that fum are produced from the Mines, by a bufinefs the most hazardous under the fun to health and life. As a maritime county, it has a great commercial intercourfe with the whole world, by exportation of Tin, Fifh, and Oil, and the return of Salt, Hemp, Iron, Timber, &c. : and the conveyance of our Copper Ores coaftways, and the return of Coal and Lime, together with our fisheries, and the number of foreign packet boats at Falmouth; keep up no inconfiderable fleet of thipping, and form a valuable nurfery of feamen. Surely then, the Mining part of this province muft be the most proper and eligible fituation for an hofpital, for fick and wounded Miners and Sailors. And as Redruth is fituated on the narroweft part of the county, is the center of Mining, and within two hours diftance from our most frequented fea ports; all these circumftances combine to prove the expediency of erecting a county hospital close by the town of Redruth.

When an accident happens in a Mine, the poor fufferer languifhes till the arrival of the furgeon, who is generally fent for in fuch hafte and confusion, that it may happen, he is not provided with every thing proper to administer prefent relief. I have been called to a perfon fupposed to have a compound fracture of the leg, by a fall twenty fathoms under-ground, and have brought a fuitable apparatus; when the case has proved to be a fractured skull, and the leg was only foratched. The patient is then conveyed fix or feven miles to his own hut, full of naked children, but defitute of all conveniencies, and almost of all neceffaries. The whole, indeed, is a scene of fuch complicated wretchedness and distress, as words have no power to deforibe.

How comfortable then, must it be, to fuch miferable objects of compassion, to be carried to an hospital furnished with every necessary to effect his cure, and every convenience to alleviate his diffress! The fame trouble which removes him from the Mine to his wretched hovel, brings him to the place built and furnished for his peculiar benefit.

The

178 GENERAL OBSERVATIONS ON

The more I confider this matter, the more I am convinced, the accomplishment of it may be well and certainly effected. A voluntary fubscription among the nobility and gentry; the lords, bounders, and Mine adventurers ; the Tin and Copper companies; the merchants and owners of fisheries; and every rank and degree of those, who are any ways concerned and connected with the county ; would raife a fufficient fum, to build and furnish a large commodious hospital; which, afterwards, may be almost wholly maintained and supported by the monthly contributions of the Miners, failors, and fifhermen. Suppose the whole body of Miners, including all who work at grafs as well as under-ground, men, women, and children, in drefling of Tin and Copper Ores, either in the Bals, or at the stamping mills, were taxed at only threepence a month each : fuppole they amounted only to 20,000, and the failors and fifhermen to half that number; the whole would raife an annual income of £4,500, free of all drawbacks, and exclusive of the revenue from legacies, and annual donations and fubfcriptions. Hoping an object fo interefting to the wife and wealthy part of the county will meet with fpeedy attention and effectual encouragement, I return to our principal fubject.

When a Mine is incumbered with much water, it occasions a confiderable increase of labour and coft; it then becomes neceffary to use all poffible dispatch and diligence in working the Mine, and raifing the Ore without any interval. When the pick-axe ought to be kept conftantly at work, it is usual to work stopes or drift ends by double pick-men; allowing two men to each pick by day, and as many by night, if they work twelve hours core. Those long cores, however, are now generally abolifhed : when they were cuftomary, they were nothing more than a pretence for idlenefs; twelve hours being too many for a man to work under-ground without intermiffion. Accordingly, when a pair of men went under-ground formerly, they made it a rule, to fleep out a candle, before they fet about their work; that is, if their place of working was dry, they would lay themfelves down and fleep, as long as a whole candle would continue burning; then rife up and work for two or three hours pretty brickly; after that, have a touch-pipe, that is, reft themselves half an hour to imoke a pipe of tobacco; and fo play and fleep away half their working time : but Mining being now more deep and expensive than it formerly was, those idle cuftoms are superfeded by more labour and industry. Conformable to the humidity or driness of the place, the

MINES, AND THEIR MANAGEMENT. 179

the denfity or fairnefs of the ground, and the diftance from the fumph, it may be more or lefs neceffary, to work in cores of fix or eight hours with double picks. To work with double pick-men, they allow two men to one pick in this manner : in ftoping or driving fair ground, one man works two hours, and then gives the pick to his companion to work with for the fame time, and he that ftands by rolls or carries off the broken Ore or ftuff as there is occafion ; and thus they work and carry off alternately. So likewife in boring of rocks for blafting with gunpowder, one man holds the fteel borier, whilft the other beats it with a fledge of fix pounds weight : the latter having had the hardeft tafk, when the hole is bored to its intended depth, refigns the remainder to the perfon who had only held the borier, who charges the hole, fires it, and works away the fhattered rocks.

After this manner they work out their core till fresh men come under-ground, and relieve them in place : but sometimes they are necessitated to work confiderably longer than their stated hours; and then they are faid to make a stem, or part of a stem, or to work a stem out of core; for which they are entitled at the month's end to an additional pay for so many stems as each man makes, over and above his stated time of working : but as this is an inlet to many impositions, it ought not to be allowed except upon a great emergency.

A Lode that is large, fair, and rich, will fometimes produce Ore in fuch quantities, that the men cannot wind it up, and dispose of it, as fast as it is broken; and the want of more plots and room to hold it, greatly retards their operations. this cafe, the owners fet the winding up of the work fo broken, on the Whip; that is to fay, over and above the men's flated wages, they give them a fmall gratuity for every hundred kibbals of Ore that are brought up to grafs out of core : but, in this winding by the whip, a strict attention should be paid to the filling the kibbals to the brim, and also to making a lawful tale of five fcore to the hundred, for reafons too plain to be mentioned. This method, however, is only purfued in fhallow Mines, or at leaft where Whyms are not crected. Whyms or engines drawn by horfes, have larger kibbals; and can difcharge more work, not only for that reafon, but because they may be kept conftantly employed where the quantity of Ore or fluff is very great.

It is a good and a cuftomary way for the owners to fet their dead ground, either in or out of the Lode, to be funk, driven, ftoped, or cut down, by the fathom : but if there is no choice in respect of faving the Ore clean, or the like, they fet it to be funk, driven, floped, or cut down upon Tut; and in fuch cafe the Miners take what they term a Tut-bargain ; that is, a piece or part of unmeafured ground, by the lump, for fuch price as can be agreed upon, expressing the fituation and supposed dimensions of the ground. This is not only beneficial to the owners, but alfo to the workmen : every one knows, that a labourer employed for daily hire, will not execute that quantum of labour for his mafter, that he will upon his own rifk and account; and, therefore, it is profitable for the Mine owners, to fet all their work upon Tut, that can with propriety be fo fet ; and it is likewife an incitement to the industrious Tinner, to acquire additional gain confistent with a good confcience, and his duty to his employers.

Under certain reftrictions, it is also many times proper, to fet an end to drive, or a shaft to fink, at fuch a price & fathom, for as many as can be driven or funk for one month; or to drive fo many fathoms certain. For inftance : I have plain feafible ground in my working fhaft, that I am finking to cut the Lode upon its underlie. I fet it to fink by two men in a core of every eight hours; and supposing the men to deferve f, 3 & fathom, I conclude they may fink four fathoms in one month, which will amount to £ 12 between fix men, for which they find every thing but running tackle. Candles and fmith's work deducted, it may be, those workmen may clear for their labour thirty shillings each, which every good labouring Tinner well deferves : but fuppofing that an alteration of ground may be expected in my favour, I fhall then be unwilling to fet by the month, and will allow them to fink two fathoms only at that price; whereby I have it in my choice to fet for a lefs price, if the ground becomes more fair after the flipulated fathoms are funk. In much harder ground, that deferves fix pounds & fathom, though the fame men may fink three fathoms, amounting to £18, yet their gain will be no greater than in the former cafe, on account of their additional coft in fmith's work, gunpowder, &c. The fame will hold equally true in driving or ftoping : but matters of this kind are fo complicate and various, that it would be an endlefs task to explain them all. and w bevolutes vitrashnoo

When

When they fet a Lode to be broken by the fathom, they are particular in expreffing its fituation and other circumftances, as all fuch tranfactions are or ought to be determined by a publick furvey. Sometimes they fet it by the cubick fathom; for though they muft often break it irregularly, becaufe the Lode may be fmaller in fome places than in others, and by means of pillars or arches which they often leave ftanding; yet when the contract is finished, they measure the breadth, length, and depth of each particular place, and adding these together, and dividing the amount by two hundred and fixteen, the quotient is fupposed to shew the number of cubick or folid fathoms, broken by the labourers.

But it is much more ufual to fet the breaking of the Lode by the fquare, or fuperficial fathom; ftill remembering the depth that muft be broken, as they work along. When the bargain is performed, the captain measures the length and breadth of each particular place; and adding the particulars into one fum, and dividing that by 36, the quotient gives the contents in fquare fathoms. If the men are deficient in the depth they were obliged to carry with them, they ought to make it good, before the agreement can be faid to be performed. In breaking of folid ground, however, they are generally compelled to carry or work the Lode, &c. by a certain breadth or width, called the Gunnies; that is a Gunnies of either three, four and a half, or fix feet wide; which are denominated by fome, a fingle Gunnies, a Gunnies and a half, or a double Gunnies wide. A Gunnies is expressive of any certain measure in breadth. Now with respect to the measure of ground fo broken, it is more mafterly and concife, to take the dimensions in feet and inches, which may be reduced into fathoms by the following plain examples.

Suppofe

Suppose a piece of ground measures as follows : viz.

| | Feet | In. | | Fath. | Feet | In. |
|---------|------|-----|---|-------|------|----------|
| Length | 27 | 4 | | 4 | 3 | 4 |
| Depth | 8 | 9 | | I | 2 | 9 |
| Breadth | 4 | 6 | - | Gun. | Feet | In. 0 |

Q. How many are the Fathoms, at three feet to the Gunnies?

Method of Solution.

| | Fath. | Feet | In. | | Fath. | Feet | In. | and the second second for the second |
|---|----------|---|-----|---|---------|--------|-------|--|
| | 4 | 3 | 4 | | by I | 2 | 9 | A CONTRACTOR OF THE OWNER OF THE |
| ÷ | I | 3 | I | 4 | | | | |
| - | | 2 | 3 | 4 | | | | |
| ž | | 1 | I | 8 | | | and a | |
| | 111 | 100 00 00 00 00 00 00 00 00 00 00 00 00 | - | - | Gun. | | | |
| | 6 | 3 | 10 | 4 | by 1 | I | 6, | which is a Gunnies and half. |
| ě | 3 | I | II | 2 | | | | particular blade ; and ad |
| | La trant | | | - | | Fath. | Feet | In. |
| | 9 | 5 | 9 | 6 | Content | 9 | 5 | 91, at £3 \$ Fathom. |
| | ibeli | | | | | liev o | i an | Amount £29 18 4. |

Suppose a piece of ground measures as follows : viz.

| | Feet | In. | | Fath. | Feet | In. |
|---------|------|-----|---|-----------|------|----------|
| Length | 19 | 9 | - | 3 | Line | 9 |
| Depth | 4 | 4 | - | 0 | 4 | 4 |
| Breadth | 5 | 6 | - | Gun. I | Feet | In. 6 |

Q. How many are the Fathoms, at four feet to the Gunnies?

Method of Solution.

| | Fath. 3 1 | 1 3 | In. 9 10 3 1 | 6 | by | Fath. o | Feet 4 | In. 4 | | |
|-----|-----------------|--------|--------------------------|-----|----|------------|-----------|----------|------|----|
| I I | 2 | 2 | 36 | 2 0 | | Gun. I | | | | |
| ŝ | | ĭ | 9 | 4 | 9 | | T | Tath. | Fcet | In |
| | 3 | I | 7 | 4 | 3 | Co | ntent | | I | |

Suppofe

Suppofe a piece of ground measures as follows : viz.

| werl ; o | Feet | In. | three | Fath. | Feet | In. | |
|----------|------|-----|--------|-------|-------|-----|------|
| Length | 13 | 10 | bee | 2 | I and | 10 | nort |
| Depth | 9 | 8 | no Tto | I | 3 . | 8 | |
| Breadth | 8 | 2 | | IG | 2 | 2 | |

Q. How many are the Fathoms, at fix feet to the Gunnies?

| | Fath. | Feet | In | | 1 | Metho | | Solution | |
|------|-------|-------|----|----|----|-------|-------|---------------|-----------------|
| | 2 | I | 10 | | by | I | 2 | 8 | iori y |
| ž | I | 0 | 11 | | | | 3 | 1 | |
| - 10 | | I | I | 10 | | | | | |
| | 192 | 10.52 | 4 | 7 | | Gun. | Feet | In. | .ni |
| | 3 | 4 | 3 | -5 | by | I | 2 | 2 | 10 6 |
| ÷ | I | I | 5 | I | 8 | | | | 10 1 3 |
| ž | | | 7 | 5 | 1 | 8 | e fal | | |
| | 5 | 0 | 3 | 11 | 9 | 8 | Conte | Fath. nt 5 | Feet In. • 4 |

Further, If a plot be nineteen feet ten inches long, eleven feet feven inches broad, and ten feet three inches high, how many folid fathoms are therein, and what is the amount of the charge, at two pounds eighteen fhillings and fixpence Ψ fathom ?

| and the state | Feet | In. | | Fath. | Feet | In. | |
|---------------|------|-----|-------|--------|------|-----|--|
| Length | 19 | 10 | | 3 | T | IO | |
| Breadth | II | 7 | | I | 5 | 7 | |
| Heighth | 10 | 5 | -22-3 | or Tak | 4 | 5 | |

Method of Solution.

| | Fath. | Fcet | In. | Fath. Feet In. |
|---------|--------|-------|-------------|---|
| 2 | 3 | 1 | to by | the Captain who takes cov. of die, fara |
| | la ibn | | | worthy of truff; for the great inconven |
| 14 - 10 | | | | Tut-work or bargains by the lump, or b |
| | 6 | 12 | 6 28 51 81 | Fath. Feet In. sovorg bourg and it |
| - | 311 | I abo | 1 8 10 | mult any from it, and leave it on the adven |
| H-H | press | 2 | | then no fatisfaction to be had of the Tak A |
| 4 | 12101 | di ui | 646 | they have not whetewith to make relific ?; |
| be | in | Vone | 5 8 4 | o 8 at £2 18 6 # Fathom. |
| | mpen | o rec | in order to | Amount L32 I 71. |
| | nguon | 11 | rounance. | the damage mat may enlue on non-per |

But

But where there is no refpect to breadth, it is ufual to call it a fuperficial or common ground, in ftoping particularly. Suppofe, for inftance, a ftope of ground measures fixteen feet nine inches long, and feven feet three inches deep; how many fuperficial fathoms are therein, and what is the amount at three pounds twelve fhillings # fathom?

| | Feet | In. | | Fath. | Feet | In. |
|--------|------|-----|---|-------|------|-----|
| Length | 16 | 9 | - | 2 | 4 | 9 |
| Depth | 7 | 3 | | I | I | 3 |

Q. How many are the Fathoms?

Method of Solution,

| 1 0 14 | Fath. 2 | Feet 4 2 | 9 | by 6 4 6 | Fath. | Feet | In. 3 | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | |
|--------|------------|----------------|---|----------------|-------|------|----------|---------------------------------------|---|
| | 3 | 2 | 3 | at | £3 | 12 | 4 | Fathom. | 5 |

We may with certainty pronounce, there can be no flated rule given for the value of fetting ground to break by the fathom; for fome may be wrought for four fhillings Ψ fathom, and other ground may require twenty or thirty pounds.

> It may be floped for 10s. or £4, It may be driven for 5s. or £10, And funk for 5s. or £25, and even more Ψ fathom.

12

0.

3

It may probably anfwer better in other countries, to fet the ground to break on the monthly account or wages, provided the Captain who takes care of it, is a man of integrity and worthy of truft; for the great inconvenience that attends this Tut-work or bargains by the lump, or by the fathom, is, that if the ground proves hard and chargeable in the working, the labourer has no ability to go through with it, and confequently muft run from it, and leave it on the adventurers hands. There is then no fatisfaction to be had of the Takers of the bargain, becaufe they have not wherewith to make reflitution; and, therefore, to obviate this lofs, fome adventurers infert a provifo in the agreement, that a quarter or fome other part of the money fhall be referved, till the bargain is completed, in order to recompenfe the damage that may enfue on non-performance. Though I have

have feen this forfeiture imposed in feveral Mines of great importance, I must take the liberty to disapprove of it, for reasons that will plainly fhew its infufficiency. A fhaft may be fet to fink ten fathoms at twenty fhillings & fathom ; and the Takers may be obliged to forfeit one quarter of their earnings, if they run from or defert their bargain. Perhaps the first fix fathoms may be funk for five fhillings each ; that is, the Takers have fo far earned fix pounds; but the remainder of the bargain, being four fathoms, may require twelve pounds to finish it, by an alteration to harder ground. Now, in this cafe, if they defert their bargain, and incur the forfeiture, they are only entitled to four pounds ten shillings; and this they will readily accept of, as they may have earned that money in a few ftems; while the adventurers are obliged to refet the fhaft to another Pair of men, at the advanced price of three pounds & fathom. Hence it may appear to be the intereft of the adventurers to fet the ground by the lump, or the fathom, when the ground in a fhaft or any other part of a Mine is fair and tender, and not when it is hard and chargeable to be wrought; as in one cafe, the Miners will undertake it at an easy rate, but in the other they will make a large demand, upon a fuppofition, or at leaft a pretence, that the ground may still continue hard. But inftead of this it would be more easy for the men, and more fecure for the owners, to fet as many fathoms at a flated price as can be funk in a month : the men cannot gain great wages, nor fuffer great lofs : and as ground that is very ftiff or denfe, requiring ten pounds to fink a fathom, may alter, and be fet for a lefs value, it would be prudent in the adventurers to fet but one or two fathoms at that price. These matters, however, from the great interchange of circumftances in different Mines, are too intricate to be difcuffed in this place; and I wifh I may not have incurred the cenfure of fome Captains, for having fo far interfered in the cunning workmanship of their of tons of Lode and Strate broken annually mour C.rabro

The quantity of ground that is broken annually in Cornish Mining, if it could be calculated, would appear incredible. But though it is not in my power to afcertain this matter, yet, for the entertainment of my curious readers, I will attempt to calculate the quantity of metallick Lode broken annually in Cornwall, by the returns of white Tin and fine Copper.

We will fuppofe the average produce of the county to be three hundred weight of Tin in one hundred facks of Tin-ftuff. B b b Allowing

Allowing one fack to weigh one hundred and a quarter, then one hundred facks will be fix tons five hundred weight; confequently there must be one ton of Tin produced out of fortyone tons thirteen hundred weight. The county has been found to produce, annually, for fome few years past, about three thousand tons of pure Tin-metal; which multiplied by fortytwo tons of Tin-stuff as above, gives the total sum of one hundred and twenty-fix thousand tons of Tin-stuff Ψ annum.

four fathoms, may require twelve pounds to mail it, I

The Copper Ore fold upon an average for the laft ten years, is about twenty-four thoufand tons & annum, which produce nearly three thoufand tons of fine Copper. Now let it be fuppofed, that two tons of merchantable Ore are produced from every one hundred facks of one hundred and a quarter each as above: then twenty-four thoufand multiplied by fix and a quarter, is equal to one hundred and fifty thoufand tons of rough Lode. To fum up all, for about fix thoufand tons of pure Metals, we must dig and drefs (the far greatest part by ftamping mills) two hundred and feventy-fix thoufand tons of Lode.

If this quantum of Lode which is worth the charges of dreffing, is annually digged and raifed from our Tin and Copper Mines, how much greater must that quantity be, which is not alive, but is a dead wafte or ufeless refuse? I will venture to affirm, it may be a portion far greater than the foregoing : but fuppofe it to be equal, the fum will then be five hundred and fifty-two thousand tons of Lode. Now we all know, the tons of Strata, or country, which are broken every year, must be immenfe, when we confider the number of Shafts, Winds, Adits, Drifts, Plots, &c. that are continually finking, driving, and cutting around us. I cannot form a method of calculating this; but if, with the former fum, we make this equal to two millions of tons of Lode and Strata broken annually in our Cornish Mining, I believe my countrymen will not think that I have exceeded the bounds of truth. All this will ferve to fhew the vaft employment for men and cattle in our Mine country; which I am very confident might be much increased, and of courfe be of more national utility, provided we had a market and a price for our respective Metals; but as the cafe now ftands, we labour under every difficulty and difadvantage that can militate against us, which, as it is now most feverely felt by the commonalty of Cornwall, muft be hereafter felt by the community in general.bnud ono ni ni 1 of the webnud B b b When

When a Mine is in due courfe of working and produces Ore, the adventurers fometimes find it better to fet the Mine on Tribute, than to work it on their own account. The manner of fetting or leafing a Mine on Tribute, is this; fome able Miner takes the Mine of the adventurers for a determined time, that is, for half a year, a whole year, nay even for feven years, as was the cafe at Bullen-Garden, and the means of her difcovery. If it is a Tin Mine, he articles first to pay the Lord, or the Lord and Bounders if any, their fhares or Doles, free of all coft, in the ftone made ready for the ftamping mill. This must be fuch a proportion of all Tin-ftuff as shall be raifed during the limited time. Of the remainder, he pays the adventurers one moiety, or one quarter part, according to the agreement, it being more or lefs in proportion to the richnefs of a Mine. For example : In a Tin Mine not bounded, the Lord grants for, perhaps, one-feventh : now the Tin-ftuff, when it is properly fized to ftones not larger than a man's fift, is divided into feven Doles or piles; the Lord's Agent, Steward, or Toller, cafts lots upon these Doles by written tickets, fix marked A, and one L, and which ever of them falls to his lot L, on that Dole he puts the turf, and upon the turf a ftone. Three and a half of the fix A Doles remaining may belong to the Tributor, and the other two and a half to the adventurers, which also is transacted by dividing and caffing lots as before. Where a Tin Mine is in waftrel and bounded, the manner of dividing and caffing lots, and dreffing, all the Ore that can be made a .xalqmoo arom si

In moft Tin bounds, the Lord's part is one-fifteenth of the whole, and the Bounders part is one-twelfth, commonly only one-tenth of the remainder. For inftance: The Tin-ftuff is divided into fifteen Doles, one of which is marked by the Lord's Agent, as above, after the lots are caft; then fourteen Doles remain, two of which are equally fubdivided and carried to the other twelve. One of thefe, by lot as before, belongs to the Bounders; and that very likely muft be fubdivided again and again, it being for the moft part the property of feveral perfons.

Of the eleven Doles to be divided among the adventurers and the Tributor according to the articles of their agreement, the adventurers shall have three Doles and one quarter of a Dole, and the Tibutor seven Doles and three quarters : they then cast eleven lots, viz. three marked A, seven marked T, and one blank, and where this blank falls, that Dole is redivided into four parts, and lots are recast upon it; one A the adventurers part,

part, and three T the Tributors. This, however, is not all; the adventurers three doles and a quarter are again divided into eighths, fixteenths, thirty-feconds, and fixty-fourths, and even much fmaller fractions, that each may know and carry away his own.

The Tributor again has feveral perfons concerned with him, who redivide their feven Doles and three quarters in like manner : and thus are these fractional complicated divisions, which at first fight would puzzle the most expert arithmetician, effected by our illiterate Tinners upon the fimpleft plan, and with the utmost dexterity, dispatch, and accuracy. To any other but a Cornish reader, it may appear strange, that fo much trouble fhould be taken in dividing and redividing the Tin-ftuff in this manner, when it might be carried and returned altogether, and the proportions reckoned in money; but this cannot always be done; for ftamping mills are numerous, and the feparate eftates of feveral people, whofe value rifes in proportion to the use and employment they have for them; therefore if the Tin-ftuff is rich, every one is ready to carry off his refpective Dole or fhare, immediately after it is divided out, and the lots are caft.

The fetting of a Copper Mine upon tribute, has this difference: the Tributor is at the fole expence of digging, raifing, and dreffing, all the Ore that can be made merchantable; and the proceeds of fales are received by the adventurers, who pay the Lord his one-feventh, one-eighth, or one-tenth part, which ever it is, in money. If it is one-eighth, that is two fhillings and fixpence out of every pound or twenty fhillings, of the remaining feventeen fhillings and fixpence the adventurers may have eight fhillings, and account to the Tributor for the refidue, which is nine fhillings and fixpence: and thus, it is faid, "Petherick Kernick of Hantergantick, Abednego Baraguanath of Towednack, Dungey Crowgie of Carnalizzy, and Degory "Tripeoney of Gumford, have jointly taken a Copper Mine " upon tribute for nine and fixpence out of the pound."

When the adventurers thus fet a Mine to farm, they oblige the Taker or Tributor to keep the Mine in good repair, and well fecured with whatever timber is needful; the putting of which into the Mine, ought to be according to the fkill and difcretion of a perfon deputed for that purpofe by the adventurers. They also ftipulate with the Taker of the Mine upon tribute,

tribute, to work it regularly with a certain number of men; but not in dippas, holes, and corners, to encumber the adventurers, at their re-entrance into the Mine, with the charge of breaking and clearing the barren part or deads, which the Tributor would otherwise leave under-ground. It is very reafonable that the Tributor should be obliged to deliver up the Mine in good order and condition, at the expiration of the time specified; and that the adventurers should referve to themselves and agents, a power of going down into the Mine at will, to examine if the premises be duly complied with and fulfilled.

So far we have been fpeaking of a whole Mine, taken upon tribute; but it is much more common, and has been always the cafe in large Mines, to fet feveral parts of them in fmall portions of ground called Pitches. A Tribute-Pitch, confifts of a few fathoms in length on the courfe of the Lode: two Pitches may meet half way between two Shafts, and draw their Ore to that Shaft, with which either of them are connected. If a Pitch is high up in the Mine at a fhallow level, it is called a Pitch upon the Backs; but if lower down, in or joining with the bottoms, it is called a Bottom-Pitch. The time they contract for is generally four months, and to work the Pitch at all working times, in a regular manner with a certain number of men. The Tributor is obliged to work one month, or forfeit to the owners twenty fhillings for every man he is obliged to employ; in lieu thereof, if he does not chufe to continue at the month's end, he declines the occupation of his Pitch, and forfeits to the adventurers all the Ore which shall be broken.

The boxes and clacks or values of the engine pump often go amifs, and if they are not made of good leather well fewed, a misfortune of that nature will happen almost every day; fo that every method must be contrived, to have affistance at hand to man the capstan, while a clack or a box is changing. Accordingly, a Tribute-Taker, as well as every other Miner in a Bal, obliges himfelf and partners to lend a hand gratis at the capstan whenever required, upon the penalty of two shillings and fixpence for each perfor respectively who results his affistance. Without a regulation of this kind, a Mine would be in danger of fetting idle, for want of neceffary help: but when they cleanse a boiler, which is once a month; or drop pumps, that is, let them down into the Mine; the adventurers charge each man at the capstan a stem or a day's hire, and give them fome

additional recompence if the weather is fevere, or they make a long day's work.

The Takers of Tribute-Pitches in a Copper Mine, are likewife obliged to mix their Ores with those of other Pitches, or with the owners Ores; and to fample the fame according to the will and difcretion of the Captains; elfe the parcels of Ore would be very fmall, where they may be twenty Pitches upon tribute in one Mine. Before the parcels are mixed together, they take from each a fair honeft fample, and mark them A, B, and fo on, which they call private famples. The affay-mafter, who buys at the publick ticketing or fale a mixed parcel of Ore, hath these private famples given to him, which he affays for two fhillings and fixpence each with all the judgment and dexterity he is capable of, to make the most of each; and it is a very rare thing for any complaint or diffatisfaction to arise from the appropriate difpensations of our affayifts, fo expert are they in their bufinefs.

The use of private famples is this: though the fundry parcels of Ore which are mixed together for fale, may appear nearly of one value at fight, yet it must necessarily follow, that fome difference will arife from different management in the dreffing and other accidental caufes. In a mixed parcel of fifty tons, A may have twenty of fifteen pounds value & ton; B may have twenty-five of fourteen pounds ten fhillings; and C may have five of fixteen pounds # ton, according to the private famples; yet the grofs fifty tons may fell for fifteen pounds five shillings & ton. Nevertheless the amount must be divided among the Tributors according to the felling price, fubject to a regulation by the private famples; that is, the excefs or diminution, for what it fells, must be proportioned by the produce of the private famples; for, if fifty tons fell at fifteen pounds five shillings, the amount is equal to feven hundred and fixtytwo pounds ten shillings. Purfuant to the above private famples sit ta site f. baad a barf of anothing ban libraria asgiida

A's 20 tons at 15 - = 300 -B's 25 - 14 10 = 362 10 C's 5 - 16 - = 80 -

sail agoing q The amount at 742 root douby the lood to shall

which is 20 fhort by the private famples.

This is called £ 20 increase by 762 10 which it fold for.

man no the appliance from or a day's hire, and give them fome

Now

Now the method of proportioning this twenty pounds increase, is done by the rule of three direct, thus :

| nome io | inerq. | a la cala la cala da c | 10 | add 20 | 0 | - aller an |
|------------------|--------|--|-----------|------------|----|---------------------------|
| If 742 If 742 | 10 | 20 20 | 362 | B 9 | 15 | 4 increafe of increafe |
| If 742 | 10 | £. 20 | £. 300 | A 8 | I | 71 increase |

Here it is evident, that if the Adventurers were to account to the Tributors at the private prices, they would deprive them of twenty pounds of which they ought to have their refpective proportions, it being the abfolute value for which the commodity was fold. Alfo, by mixing thefe three parcels, they have altogether brought a better price by twenty pounds, than if they had been fold feparately.

The interchange of terms in this matter is very applicable, and eafy to be reconciled; for in cafe of a decreafe, that is, if the felling price had been feven hundred and fixty-two pounds ten fhillings, and the private famples had exceeded that by twenty pounds, making the whole feven hundred and eightytwo pounds ten fhillings, then the method of folution would be the fame by the rule of three, deducting each ones particular fhare, according to the amount of his Ore.

We may further illustrate this matter, by entry of an account of Ores, fold and proportioned to the Lord, Adventurers, and Tributors.

| Quantity | Price Ton | To wh | om fold | Amount | Lord's pt. 1-feventh | Adventur. net part |
|--|--------------------|-----------------------|-----------------------|--------------------------|-------------------------------|--------------------------|
| Tons 🕁 Q. 21 10 2 | £. 10 - | Cornifb Co | pperComp. | £. 215 — | L. 30 14 3 | £. 184 5 9 |
| the pound, | Tributo | or's Acco | unt of th | he above | Ores. | Ore wron |
| Quantity | Price | Amount | Increase | Amount | Tributors Part | Tributors Money |
| Tons \bigoplus Q. A 10 10 2 B 11 | £. 11 — 8 10 | L. 115 10 93 10 | L. 3 6 4 2 13 8 | L. 118 16 4 96 3 8 | S. S. 5 from 20 10 - 20 | L. 29 14 1 48 1 10 |
| 21 10 2 | S | old at £10 | ₽ Ton | £215 | | awo smil. |

By

Dolcôth Copper Ores weighed the 24th of March 1777.

3.

By this time, I prefume, the reader has a pretty clear conception of the affair, and that each fhare of the \pounds 215 ftands thus:

| The | Lord's one-feventh - | £30 | 14 | 3] | 649 T |
|-----|--------------------------|-----|----|----|-------|
| The | Tributors | 77 | 15 | II | £ 215 |
| And | the Adventurers net part | 106 | 9 | 10 | 545 1 |

The fpirit of adventure hath many times fo prevailed among the lower people, that very large fums have been won and loft by this kind of gaming, much to the injury of the cafhiers, who can have no recompence from poverty and rags. It is a method that will always answer for the adventurers, provided the Takers upon tribute will execute their part and fulfil their articles of agreement, which it is difficult for the adventurers to compel them to perform. These reasons have induced the adventurers in fome Mines, to fet their Tin and Copper Ore to break by the fathom; and I believe it is productive of more certain wages to the men, and larger quantity of Ore to the owners; which is of confiderable importance to a Mine, obliged to fupport a monthly charge of eighteen hundred or two thousand pounds. It would be well if the Takers of Pitches on tribute, would allow fo much in their calculations for the decay of a Lode; for it is generally known those people commonly take a rich bunch of Tin or Copper Ore upon tribute according to its full value in fight, not confidering, perhaps, that it is almost impossible for such to be richer; and that it is great odds whether it may continue half fo rich for the limited time. This want of precaution plunges them into many difficulties, when an alteration of the Lode happens from riches to poverty : and, indeed, any perfon may conclude, that little more than common wages can be gained, by working a Pitch for twelvepence in the pound. Neverthelefs, I have known feveral wrought at that value; and many fcore tons of Copper Ore raifed out of North-Downs Mine at tenpence, for which a shaft in that Mine bears the name of Tenpenny-Shaft (fee North-Downs plate). But my readers will wonder more when I declare, that I have known feveral hundred tons of Copper Ore wrought and dreffed for fivepence halfpenny in the pound, at Huel-Virgin Mine : this, however, must be understood to have been the cafe, when the commodity brought a better price by thirty & cent. than it now bears : which observation fuits with the decreafed value of Tin as well or more fo; for it is equally true, that where I have been formerly concerned, as part owner of a Tin Mine, we have fet a Pitch to be wrought for

for three fixty-fourths of the whole, or three-eighths of oneeighth in the ftone, before it was made merchantable, by the additional expence of carriage, ftamping, and drefling.

ten hundred wei

With refpect to the plan laid down by Miners for calculating the charge, at which they can work this or that Pitch, it is much the fame as that for floping of ground by the fathom. For inftance : if a Tin Lode is a three feet Gunnies wide, a fathom in depth and length of that bignefs will produce fifty kibbals of Lode, which when fpaled may amount to one hundred facks of Tin-ftuff fit for the ftamping mill. This, when dreffed, shall produce three hundred weight of white Tin, which they call " being worth three hundred weight of Tin a " hundred ;" that is, for every hundred facks of Tin-ftuff, it will yield three hundred weight of Tin-metal, worth, we will fay, three pounds & hundred weight, that is, nine pounds. The Tin in the leavings of which (a term that will be more eafily comprehended, by turning to the chapter upon dreffing of Tin) at five shillings & hundred weight, or more commonly expressed "at fifty shillings & thousand" or half ton, is fifteeen shillings. The Lord's part, dues, or land-dole, is one-fifteenth of the whole, that is to fay, fix two-thirds facks; the Bounder's or toll part is one-tenth of the remainder nine one-third facksthefe fixteen facks being taken from the hundred, the refidue becomes eighty-four; worth, at the above calculation, feven. pounds eleven fhillings and threepence, and the leavings at fifty fhillings & thousand twelve shillings and fourpence-in all for eighty-four facks eight pounds three shillings and feven pence.

| Now the charge of working the fathom, is | |
|---|---------------|
| Raifing, fpaling, and dividing | |
| Filling the facks and loading the horfes | 0 2 0 |
| Carriage, stamping, and drefling (the expence | Now the exton |
| which is different as the Mine is more or | lefs of bluow |
| diftant from the mill) we will allow to be only | |

Carriage to fmelting-house and expense fais to on on the first

In all 2 9 0

So that the Tributor must have two Doles and three quarters out of nine Doles, to get wages; which two Doles and three quarters are worth two pounds nine shillings, according to the above calculation.

Ddd

ARUSA

Again,

Again, if a Tin Lode is only fix inches big or wide, one fathom may produce twenty facks of Tin-ftuff, worth fix pounds, at the rate of "a thoufand Tin a hundred;" that is, at the affignable quantity of ten hundred weight of Tin-metal for every hundred facks of Tin-ftuff. The Land-dole, or Lord's part, being one-fifteenth, is one fack and one-third; the toll or Bounder's fhare, is one-tenth of the remainder, which is one fack two-thirds and one-fifth. Thefe three facks and one-fifth taken from twenty, the remainder is fixteen and four-fifths of a fack, value five pounds and ninepence. The leavings at forty fhillings for ten hundred weight of white Tin (the richeft Tin generally yields the pooreft leavings, which will be fhewn hereafter) will give fix fhillings and threepence, which added to five pounds and ninepence make five pounds feven fhillings.

The expence of working the fathom will be filling, Spaling, and dividing 0 1 8 Filling the facks, loading the horfes, carriage, ftamping, dreffing, and fmelting-houfe expences 0 2 6

The Taker or Tributor must, therefore, have three doles out of nine, to get a livelihood.

in all 114 2

storid bus and thread thread

In all

2

On the other hand, if a Copper Lode is wrought a three feet Gunnies wide, one foot of which is worth faving for Ore; allowing the whole Gunnies to turn up fifty kibbals of ftuff, fixteen of them may produce one ton of Copper Ore worth fix pounds.

Now the expence of working the fathom of Lode would be \pounds i io o Drawing or raifing the broken fuff or Lode \circ 7 o Dreffing the Ore at eightpence in the pound \circ 4 \circ

o a s lla ni

A PARTS

Which divided by fix, the quotient will be fix shillings and tenpence, the money the Tributor ought to have in the pound sterling to gain bare wages.

Again,

I O

Again, fupposing the Lode to be fix inches big or wide, the Gunnies must be two feet big, and one fathom in length and depth of the Lode, to make a ton of Copper Ore worth twelve pounds.

The expence of digging the fathom f_{1} 7 0 Drawing the broken fluff thirty-four kibbals 0 5 0 Dreffing the Ore at threepence in the pound 0 3 0

In all 1 15 0

Which being divided by twelve, the quotient will be two fhillings and eleven pence, the money the Tributor ought to have in the pound to earn a living.

Ć H A P. V.

Of Damps in Mines, and of Levelling and Dialling Mines, Adits, &c.

Unon the whole

TN a treatife on the wholefomenels and unwholefomenels of air, Mr. Boyle makes it appear, that they depend principally on the impregnation received from fubterraneous effluvia, a caufe generally overlooked; and it is probable, that most of the difeafes which phyficians call new, are caufed by fubrerraneous freams. In general, though the wholefomenefs of the air in fome places may arife chiefly from the falubrious expirations of fubterraneous bodies, yet is the air depraved in far more places than it is improved, by being impregnated with Mineral emifions. Indeed among the Minerals known to us, there are many more noxious than wholefome; and the power of the former to do mifchief, is more efficacious than of the latter to do good, as we may guess by the small benefit men receive in point of health by the effluvia of any Mineral or other known Foffil, in comparison of the great and fudden damage that is often done by the fumes of Mundick, Arfenick, Vitriol, Sulphur, and other deleterious Minerals. (Boyle, Boerhaave). And though these Minerals are mostly found in Mines, pits, and other places deep under-ground, yet they are commonly fcattered on the banks of those Mines at the furface, in all places productive of Minerals as our county is.

Hence

Hence it may, perhaps, be no difficult matter to fhew, that an alteration of the common air by an uncluous vapour of the vitriolick kind, raifed by an unfeafonable warmth, and too great a proportion of watery and other groffer particles mixed with it, may be the caufe of those epidemick difeases, which are usually called Nervous and Malignant, Bilious and Putrid.

The Mineral effluvium then, acting on the fluids in a degree fhort of extinguifhing life, is abforbed into the habit, infects the blood, and from that minute the whole frame becomes more and more feeble : whence it will be eafy to deduce all the fymptoms which accompany a flow continual nervous fever. (Huxham).

It is well known, that this contagion in the blood and animal fpirits will produce in different perfons very different diforders, though they may juftly be attributed to one and the fame caufe; nay, in the fame conflictution, by length of time, and the folution of the red blood globules, a flow nervous fever will terminate in the highly putrid and malignant : yet the latter may be immediately derived from the fame fpring, and fhall vary only in a vigorous conflictution with rich blood, or in a weak lax habit and very incompact craffamentum. Upon the whole, then, it is not ftrange that those different diforders are frequently confounded, as the fame conflictution of the atmosphere contributes to both.

a caufe generally overlooked ; and it is probable, that molt of I was drawn into the particular confideration of these matters, by our endemick fevers in the fpring of the year 1773, and my peculiar lot to fall in with those of the worst kinds: fo prevalent were they indeed, that I may venture to affirm out of three thousand inhabitants here, not less than half the number were manifeftly affected in a greater or lefs degree with febrile fymptoms of the nervous, bilious, or malignant kind; and though not above fourteen perfons died, yet we have many who may lament the effects of those diforders to the latest day of their lives. In the year 1752, nervous and malignant fevers were reckoned mortal in this parifh, and particularly in families where a fimilarity of conffitution equally favoured the production of one diforder. I then knew three brothers to have died of a putrid malignant fever, out of four which had the difeafe; yet these men all lived in separate houses, at a quarter of a mile's diftance; and had the leaft intercourfe with each other that ever I observed in perfons to nearly allied : I take this to be

be a great inftance of the efficacy of contagion in one derivative habit of body. Some part of our Mining diffrict is ever molefted by fuch violent fevers: one or other of the parifhes of St. Agnes, Kenwyn, Kea, Redruth, Gwenap, Stithyans, Wendron, Sithney, Breage, Crowan, Gwinear, Camborne, and Illugan, have epidemick fevers always among them.

Mineral exhalations are allowed to be one caufe of contagion, and, Mr. Boyle fays, even of the plague itfelf : my principal defign, therefore, is to prove the obnoxious fituation of our Mine country to those dangerous difeases; and from thence to infer, that they are with us the peculiar production of Mineral effluvia. If this is not the cafe, I fhould like to be informed what occafions those diforders to rage with fuch violence among us, and be endemial to our Mining parifhes? Perhaps it may be faid, they are produced by the unwholefome and uncleanly manner of living among the Tinners. But I have known them to originate in the most cleanly healthy families; nay, it is notorious, that the more regular livers, and more delicate inhabitants of this town, have more generally and powerfully experienced their attacks.

In December 1772, particularly at the time of the poll for a knight of the fhire, we had a warm moift atmosphere for three weeks, without rain, or a currency of air fufficient to blow out a lighted candle. Soon after, nervous and malignant fevers were very rife, and were generated I apprehend by those Mineral effluvia, which, in that month, by means of the foregoing conflitution of the atmosphere, were fuspended for a confiderable time, and particularly affected those perfons whose nervous fyftem was very weak and lax, or those of quick and lively fenfations; while fuch as were athletick, robuft, and fanguine, generally efcaped their peftilential influence. Again; it was obfervable, that the weather, in December 1774, and in the beginning of January following, was unfeafonably warm, ferene, and mild; the air for three weeks before was fcarcely agitated by one breeze, but continued, all that time, warm, moift, and vapid. The writer then predicted the confequential malignant effects which happened foon after; and he thinks any one may foretel the eventual incidents that muft follow fuch continual unfeafonable weather, in a country teeming with Metals and Minerals. But it is time to come nearer to the point in hand, and to fhew, that we are obnoxious to poifonous Damps underground, notwithstanding the preconceived notion of many to the

Eee

the contrary. If it is possible for the superficial Mineral steams of our earth to be thus destructive among us, how much reason have we to conclude, that many instantaneous deaths from Damps in the Mines, are more eminently occasioned by sufpended mineralick vapours of the most deleterious miasm.

In those Mines which are replete with Mundick and Copper, and where some parts are not supplied with a sufficient current of air to disperse the effluvia, I have known several men and boys perish in a few months : and though some may linger for a longer time, they are generally grieved with nauseas and reachings to vomit, oppression upon the breast, lassified and torpor of the limbs, till at lass the whole habit becomes tabid, and they die hectick or confumptive.

It is a miftake, that "Damps in our Cornifh Mines are never "fo venomous as to be immediately fatal." I have known many inftances to the contrary; particularly one, in a fhort Drift, by the fide of an Adit, which carries a large ftream of water, a father and fon, with other perfons, were walking through the Adit, when the fon ftepped into this old fhort Drift, and inftantly fell down dead: the father on obferving this, followed the fon to give him fuccour, and fhared the fame fate: their companions feeing this misfortune, avoided the danger, and cautioufly recovered the bodies for interment. To what lefs caufe can we attribute this fudden deftruction, than to a venomous damp in this particular place; which the famous Grotta dè Cani, fo named from its mortiferous effects upon dogs and other animals, cannot exceed ?

Mr. Jeffop, in the Philofophical Transactions, observes, that there are four forts of Damps: the first is the ordinary fort; the figns of its approach are the candles burning orbicularly, the flames leffening by degrees, till they quite go out; and fhortness of breath: fuch as escape fwooning, receive no great harm thereby; but those that fwoon away, and escape an absolute fuffocation, are, upon their first recovery, tormented with violent convulsions: the ordinary remedy is to dig a hole in the earth, and lay them on their bellies, with their mouths in it; if that fails, they supply them with large quantities of good ale; and if that miscarries, their case is concluded desperate.

The fecond fort of Damps is called the Peafe Bloffom Damp, becaufe it is faid to fmell like that bloom : it always happens in the

the fummer time; and is obferved in Mines, that are not infected with any other. It is not reckoned mortal; but on account thereof, many Mines lie idle for the beft and moft profitable feafon of the year, when the fubterraneous waters are loweft.

The third is the moft extraordinary, and moft peftilential of all; and those who pretend to have seen it, for it is visible, defcribe it thus: In the highest part of the roof or backs of large Drifts, which branch out from the Mine or main workings, fomething round is often seen hanging, about the bigness of a football, covered with a skin of the thickness and colour of a cobweb. This, they fay, if broken by any accident, immediately disperses itself, and suffocates all the company: therefore, to prevent its ill effects, as soon as it is observed, by the help of a stick and long rope, they break it at a distance; after which, the place is well purified by fire, before they venture in again. It is afferted, that the steam, arising from the bodies of the Miners, and from the candles, ascends into the highest part of the Drifts, condenses there, and in time contracts a film, which at length corrupting, it becomes pestilential.

The fourth is that vapour, which, touched by a candle, prefently takes fire, giving a report like a gun, and producing the effects of lightning.

Thefe pernicious Damps in Mines, fhew abundantly, that nature affords inflammable air in fome cafes; and we find by experiments, that art can do the fame, and that, probably, on the fame principles; for if you mix Iron filings, oil of vitriol, and water, by the addition of common air it will become inflammable. Sir James Lowther having collected the air of fome Damps in bladders, preferved it fo well, that when brought up to London, it would take fire at the flame of a candle, on letting it out at the orifice of a piece of tobacco pipe. It is well known to all that are verfed in chymical experiments, that moft Metals emit a great quantity of fulphureous vapours, during the effervescence they undergo in the time of their folutions in their respective menstruums : this vapour being received into bladders. in the fame manner with the natural air of Sir James Lowther, has been found to take fire, in the like manner, on being let out in a fmall ftream, and anfwered all the phenomena of the natural kind.

We fhall obferve that this inflammable air, the condenfed air N° 3, and the Peafe Bloffom Damp, are never known in our Cornifh Mines; but that the fixable air which is readily imitated by a mixture of oil of vitriol, water, and chalk, and extinguishes candles, is common to fome parts of them.

Dr. Conner in his Differt. Med. Phyf. relates a cafe of fome people digging in a cellar at Paris, for fuppofed hidden treafure: after a few hours working, the maid going down to call her mafter, found them all in their digging poftures, but dead. The perfon who managed the fpade, and his attendant who fhovelled off the earth, were both on foot, and feemingly intent on their feveral offices : the wife of one of them, as if weary, was fitting on the fide of a hopper, and leaning her head on her arm; and a boy, with his breeches down, was evacuating on the edge of the pit, his eyes fixed on the ground : all of them, in fhort, in their natural poftures and actions, with open eyes, and mouths that feemed yet to breathe, but ftiff as ftatues, and cold as clay.

I have known fome inftances in Cornwall fimilar to this; and I prefume it has been often the cafe with us, that people have fallen into a pleafing kind of flumber, from which they never awoke : at leaft I have been told fo, by fome who had experienced the approaches of it upon themfelves, and had the fortitude to shake off that fatal reverie, into which they had been infenfibly drawn. In the Mine of North-Downs, a drift end was in driving, where the air was fcarcely known to be fcanty: one evening, at the ufual hour of relief, an elderly man, called Bamfield, and a boy, came to the Mine, and went down to their place, from whence the other workmen were juft come. Some time after the next hour of relief was elapfed, their partners were furprifed that Bamfield and the boy did not come above ground. After waiting a little longer, they went down, and found the boy in a recumbent pofture; and Bamfield close to the end, fitting fliff upon his breech, with both hands to his forehead, and his elbows refting on his knees, in a kind of fleepy nodding attitude; but both of them cold and ftiff.

A want of air is indeed fo frequent, that few of our Shafts or Adits can be driven or funk to any confiderable depth or length, without fome degree of its ill effects; but as foon as they can conveniently give the Shaft or Adit a free communication of air,

air, they are relieved, and the Damp ceafes. For this purpofe, they fometimes make use of a kind of air pipe, which conveys air down to the labourers : at other times, they fink a fide Shaft ; and as they go deeper in it, they work holes or drifts, as occafion ferves, from the fide Shaft into that which contains the Damp; and this communication between the two Shafts, gives the air a draft or current. But when this want of air happens at the end of an Adit, as it is very usual, they use those methods of fallering, &c. already defcribed, book iii. chap. 3. which fupplies them with air till a new Shaft is funk down upon the end, and holed to the Adit, which gives the men a free refpiration, and liberty of working, till another Shaft is requifite. Sometimes they are annoyed with Damps in dry fhallow pits, which are probably caufed by noxious thick vapours that are emitted out of the pores of the earth; at other times, the Damps feem to proceed from the corrupt effluvia of flagnating waters, that have lain a long time in the Lode or a Shaft. Both thefe Damps are fo thick and heavy, that they kill and fubdue the vivifying fpirit of the air; fo that for want of a fresh fupply, the Miners cannot continue long under-ground.

Befides the finking of Shafts and putting down air pipes or the like, there are fome other things which help to fet the bad air in motion, and fo ferve in part to difpel the grofs unwholefome vapours : thus, the drawing of water out of a Shaft, and the motion of the tackle, or the water that runs in an Adit, will help to diffipate the bad air ; alfo, if faggots on fire or any burning fewel be thrown into a fuffocating Shaft, it will rarify the bad air for a while, and by the admiffion of frefh air the men may work fome time longer, till the Damp condenfes and gets to a head again.

Damps are generally moft common in fummer. About the dog-days we obferve they are not fo eafily remedied by air pipes and fallers, as in the other months; becaufe the earth and atmosphere are greatly warmed by the folar rays, and the air itfelf is fo very calm and ferene, that for want of a due agitation thereof, Damps are occasionally more or lefs, from these circumftances of the feason, and very often in those places which are not affected by them at other times of the year. When they blass rocks by gunpowder they are frequently obliged to come above ground, and wait fome hours before they can venture down again, to work and clear away the stattered ftones. Linden fays, he is fure, the stattered ftones of the gunpowder with the F f f

heat will diffolve and raife up in fumes a great deal of the Terra Mercurialis Metallorum, which will occafion a poifonous Damp; and therefore it is neceffary that the gunpowder fhould be mixed with fomething that will prevent the folution, and fheath and envelope the acid particles of the falt petre and brimftone. Any unctuous or oily body will do it; and will be fo far from being detrimental to the blafting, that it will be rather of fervice to it, becaufe it will add to the ftrength of the gunpowder, and make it do more execution than if it was ufed alone; and not only hinder its fmoke from occafioning any noxious Damps, but deftroy the naturally poifonous qualities that lodge in the cavities of the Mine. The mixture that I would ufe with the gunpowder, is as follows:

Take one pound of gunpowder, one ounce of oil of turpentine, two drachms of camphor, and half a drachm of borax. Mix them well in a marble mortar, and they will be fit for immediate ufe.

Dr. Brown in his Travels and Obfervations on the Mines of Hungary, a book in which are many excellent remarks on Mines and Minerals, and highly ufeful to all concerned therein; fays, that where an air Shaft cannot be conveniently funk, the Germans apply a large bellows with pipes of lead or leather to throw in air to the workmen. In the year 1696 this was put in practice, for the first time, in St. George's Adit in Goon-Laz in St. Agnes, where by reafon of the great depth, (at least forty fathoms from grafs) it was impossible to fink a Shaft, and to have fucceeded without this or fome other invention to convey air. It has been fince tried in other places with the like fucces, as I am informed, for I never faw it put in practice myself; indeed it was invented by the lord St. Albans, before the time of Brown's travels, and practifed in Wales by his fervant Thomas Bufshet, Efq; (Fuller's Worthies in Wales, p. 4).

Now as we fee fome Adits muft have a great many Shafts to convey air to the workmen, as well as to fave the expence and trouble of rolling the broken work a great way back to the laft fhaft; fo it is neceffary likewife for them to underftand the ufe of a dial compafs, to direct them where to put down fuch Shafts as are wanted in their right places. Dialling is requifite in almoft every Shaft they fink on an Adit, or elfe they may dig out of the way to no purpofe; and when they work out of their right way in an Adit, it corrects and rectifies their miftake. Indeed,

Indeed, without Dialling, they would often infenfibly go aftray from the line they had juft begun or proceeded in, and inftead of working forwards towards the Mine, they may inadvertently drive in a contrary direction. It is true, a candle is a great guide to the labourers; for if they work fo ftraight as to fee a lighted candle that is placed where they began, they need fear no error, in cafe they began right; but if they once chance to work awry, and lofe fight of the candle, it is no longer of any fervice for keeping them in a ftraight line.

This art of Dialling is also very useful, in directing them where to fink a Shaft exactly on any part or end in a Mine; and where to fink a Shaft for cutting the Lode, or Gunnies upon the underlie, which Shaft in fuch cafe is called an underlier. It is equally neceffary in other refpects for meafuring the ground to the extent of this or that place or limit; for want of which knowledge, one fet or party of adventurers may injure another, by encroaching on their property. Hence I apprehend, that Dialling, well and truly underftood, is of no little confequence to the different neighbouring Lords and Bounders ; otherwife it would be no difficult matter, for the adventurers to drive and dig promifcuoufly, into the feveral lands and properties of diffinct and feparate perfons, whereby great confusion and lofs might enfue to fome or other of them ; which this art effectually prevents, by afcertaining the just limits of each, and fixing their proper boundaries, through means of a line hung perpendicularly under-ground, with more exactness than is commonly fettled by hedges, ditches, ftones, or land-marks above-ground. Nothing can be more exact than a limitation of property, by the breadth of a fingle line; and yet I really believe a difference of one inch, in fome very rich Mines, might make a difference of feveral pounds to the different proprietors.

This laying out a traverfe or meafure under-ground, cannot, however, be very accurate with thofe, who take no account of the points or angles of the compafs, but in lieu thereof, chalk the bearing of the line they meafure with, on the board the compafs lies in ; for if they are not exceedingly careful and precife in their operations, they may commit almost unpardonable and irretrievable blunders : yet formerly, before penmanship and figures were fo generally understood and practifed among the common Tinners, as they are at prefent, most of our Mines and Adits were dialled for in this manner.

The inftruments ufed for Dialling are, a compafs without a gnomon or ftyle, but a center pin projecting from the middle of the compafs to loop a line to, or flick a candle upon, fixed in a box exactly true and level with its furface, about fix, eight, or nine inches fquare, nicely glazed with ftrong white glafs, and a cover fuitable to it hung fquare and level with the upper part of the inftrument : a twenty-four inch gauge or two feet rule, and a ftring or fmall cord with a plummet at the end of it : a little ftool, to place the dial horizontally : and pegs and pins of wood, a piece of chalk, and pen, ink, and paper.

The method of Dialling an Adit, in order to fink a new Shaft down-right upon its end, is this : first they drop a line or plummet down in their laft Shaft, in the middle of the breadth of the Adit; a man that flands at the mouth of the Shaft aboveground, marks the place of the line there on a deal board flung acrofs the Shaft, while the perfon who dials under-ground observes the spot on which the plummet falls in the Adit; there he holds the end of a fmall cord in his hand, while another perfon carries the other part with him, as far as he can go in a ftraight line, without lofing fight of the Dialler's candle : the cord being drawn ftraight and tight, he holds it in the midft of the breadth of the Adit, while the Dialler fixes the fide of the compass accurately parallel with the line, and notes the bearing of the compass upon paper; and measuring the length of the cord to the other man's hand, he notes the length thereof on paper likewife. In the fame manner the Dialler takes his fecond measurement or draft, by fetting his line and compass afresh, and proceeding as before, till he comes to the middle breadth of the Adit-end. This being done, he comes up from underground, observes the place of the plummet line above at the Shaft, where he fets his compass, and lays off the very fame traverfe at grafs which he took underneath; at the end of which, a new Shaft must be put down, directly on the Aditend. In cafe there are one, two, or many more angles or turns in the Adit, the compass must be refet at each of them, and their bearings or lengths meafured, and taken down on paper; which will exactly anfwer to an experimental Dialler, by laying out the fame traverfe above-ground, as hinted before.

Some, inftead of meafuring each draft or length of cord, untwift it, and faften pins of wood numbered 1, 2, 3, and fo on, at the noted places, which may ferve the purpofe; but I think

think it more regular to take the bearings of the compass on paper, and alfo the refpective lengths, in columns opposite each other. It is also to be remembered, that if the cord be wet in meafuring under-ground, it ought to be the fame in meafuring at grafs, and vice verfa; otherwife it may caufe no fmall error, becaufe when wet it fhrinks, and lengthens when dry.

To know the exact depth of an underlying Shaft, and a Winds, and how far a Gunnies may extend from the bottom of the Shaft to the brace of the Winds; you muft order fome one to defcend into the Shaft : then let your ftring down in the manner of a plumb, through a hole made in a deal board, laid across the brace of the windlass, taking the most convenient place where it will go deepeft, and not touch the fides of the Shaft. Where it touches at the bottom or underlying wall of the Shaft, there let a mark be made with a pick-axe. As the ftring hangs in the Shaft, apply the fide of your dial to it, as horizontally and directly across the Gunnies or excavated Lode (which is here in the Shaft, or the Shaft in the Lode, which you please) as you possibly can, observing what degree the needle flands on, which we will suppose to be fifty-two. This degree you must keep for your square. Then take up the string and meafure it by the two feet rule, noting the length of the ftring on paper in rules and inches, under the word depth, as you are defired to obferve in the following example. You may fuppofe this depth to measure twenty-four rules, which you muft fet down, and the degree fifty-two directly against it.

Then go down to the bottom of the Shaft, where the mark was made. From hence you may begin to take the underlie of the Shaft, by laying a line horizontally across the Shaft from the mark, to the opposite fide, roof, or hanging wall, of the Gunnies or excavated Lode ; applying your dial to the fide of the line, or moving them up and down together, till you fee the needle fland upon your fquare degree fifty-two. Then drop your line and plummet from the roof or hanging wall of the Shaft, till they touch the fide or bottom wall, as you did before from the brace of the Shaft; and where the plummet touches at the bottom wall of the Shaft, make another mark. You must then measure the breadth of the Shaft from the bottom of the last plumb, to the opposite or hanging wall, which we will fuppofe to be one rule twenty inches. Pull up the line, and meafure its length from the rule to the mark below. This measure must be noted under the word depth; because, it is the

the fecond dropping or plumbing of the Shaft; and we will call it fixteen rules. This being noted under Depth, fifty-two under Degree, and one rule two inches under the word Length, as in the following example; you must defcend to the place where the laft mark was made, and lay the line horizontally acrofs the Shaft from the mark to the oppofite fide or wall, applying your dial to the fide of the line, moving them up and down together, as you did before, till you fee the needle ftand upon your degree fifty-two. The line and dial lying thus horizontally by the fide of each other, drop your line as far as it will go before the plummet touches the bottom wall of the Shaft, holding the line at the hanging wall where you will fee it will go deepeft, and not touch the fides. Here make another mark, where the plummet touches; which done, pull up your ftring, and measure this depth, measuring likewife the breadth of the Shaft where you held it : fuppofe you fay, depth twentyfix rules fourteen inches, degree fifty-two, and length or breadth two rules four inches. (See the example following). Here, the Shaft appears to be eight inches wider than it was, eight fathoms, five feet, and two inches higher up at the bottom of the laft drop or plumb; a circumftance very common in all Shafts underlying with the Lode, as in fuch places the breadth of a Shaft must depend upon the width of the Lode, if it is worth the breaking. But to proceed.

In order to make a third drop in the Shaft, before we arrive to the bottom of it (which I chufe to do, that it may appear in a more practical light, as fome Shafts underlie fo faft, as to require a great many drafts before the bottom can be dialled, and its polition and depth alcertained) we will defeend to the mark laft made, where the Shaft is two rules four inches, or four feet four inches wide; and ftretch a line from the mark horizontally acrofs the Shaft to the oppofite wall, applying the fide of the dial as before till the needle stands on the degree fifty-two. The line must then be dropped till the plummet touches the bottom of the Shaft, clear from any contact with its fides. Here, at the plummet, a mark muft be made alfo. Obferving the breadth of the Shaft at the horizontal line, take up your plumb, and measure how many rules it is; fay twenty-eight rules twenty-two inches depth, fifty-two degrees; and the number of inches across the Shaft, fay one rule twelve inches, length, or breadth.

The must be noted under the word depth; becaule, it is

The Shaft being now dialled to the bottom, go down there, and hold the Dial where the mark was made, rectifying the needle to the degree fifty-two. It is many times the cafe, that a fhort crofs length muft be taken, to gain room or liberty to take a long length in a Drift or Gunnies. I will fuppofe it muft be done here; and it is very eafy to be done, as before, in taking the breadth of the Shaft, by applying the ftring or line parallel to the fide of the Dial. At the end of the fhort length, meafure how many rules and inches it is, and fet it down; which you may fuppofe here, one rule ten inches; degree fifty-two.

This fhort crofs length being taken, you proceed to take a long length, upon the course of the Lode or Gunnies, towards the brace of your Winds or under-ground Shaft, by giving your affiftant the end of the line, and directing him to go back into the Drift or Gunnies as far as he can, till the ftring touches fomewhere on the fide of the Drift, yourfelf holding, at the . fame time, one end of the line, in the mark you made at the end of the fhort length. The ftring must touch no where betwixt you and your affiftant. Apply the fide of your Dial to the ftring exactly parallel one with the other: then take the degree the needle ftands on (no matter which it is) fay thirtyfix; and let him that is at the other end of the line drop a ftone to the bottom of the Drift. Measure the string in rules and inches, which you may suppose to be twenty-two rules eight inches, degree thirty-fix. Proceed onwards to the place where the ftone was dropped ; and if there is occasion to take another fhort length or draft, which we will fuppofe, lay the ftring acrofs as before, one end being in the mark, rectifying the needle to fifty-two; which being done, fet down the degree, and this fhort draft over against it. Say only ten inches, where you make a mark as before.

This fhort length being taken, you are now again at liberty to take a long one forwards in the Drift or Gunnies; then let your affiftant take the ftring, and go as far backwards as he can, till the ftring almost touches fomewhere in the middle on the fide: thus, (holding one end in the mark you made last, when you took the fhort length) ftretch the line tight, apply the fide of the Dial to the ftring, and take the degree the needle stands on, viz. thirty-fix: fet down the degree on paper, and bid him make a mark at the end. Measure the line, and note the length directly against the degree (thirty-fix) you took last, which

which may be twenty-four rules fourteen inches to the middle of the brace of the Winds.

The next operation is to take the exact depth and underlie of the Winds, which must be performed by rectifying the needle upon degree fifty-two, the old fquare; but if there be any need to take a fhort length to gain a greater liberty to plumb the Winds, you must take it. Your affistant descending into the Winds, let the ftring down after him, and where it touches on the fide or underlie, let him make a mark ; yourfelf holding a line or one end of your rule in the mark that was made at the Wind's brace, lay the fide of the rule or line parallel to the fide of the Dial, and rectify the needle till it ftands at degree fiftytwo. Note this fhort length on paper, which you may here fuppose to be eight inches. Measure your line; fay twentyeight rules fix inches; fet it down, and the degree fifty-two alfo: which being done, go down to the laft mark, and becaufe the Winds still underlies, put one end of a line in that mark, and ftretch the other horizontally across the Winds to the hanging wall, with the edge of the Dial exactly parallel to its fide, and rectify the needle till it flands upon the degree fiftytwo. Thus let the plummet down from the hanging wall to the bottom of the Winds, if it will not touch the fides betwixt you and the bottom; fet down the length or breadth of the Winds which is two rules, degree fifty-two. Make another mark at the bottom of the Winds where the plummet touched, and meafure the depth of this laft dropping or plumbing, which you may suppose thirty rules two inches : and thus you have finished the plumbing of your Winds.

If you have any further to dial, obferve to take your fquare degree, where there is this occafion; for if you omit taking your fquare, you will lofe yourfelf in the exactnefs of the grounds length, fometimes making it more, and fometimes lefs than really it is, and fo commit very great blunders when you come to dial it above-ground. You muft alfo take care, that you hold your line exactly level, when you take your crofs lengths in drifts, and by that means you will have the exact depth. You muft likewife obferve, that your rule or line lie parallel with the edge of your Dial, that is, equal, at both ends; or elfe you will mifs in taking the true degree. Remember, that under-ground, the Dial is guided by the line; but, above-ground, the line is guided by the Dial. The following example of the foregoing drafts, I truft, will ferve to inform

inform the reader, of the manner in which they are noted on paper.

| Depth | | Degrees | Length | |
|-----------|--------------|---------------|-------------------|--|
| Rules- | -Inches | che courle of | Rules-Inches | |
| 24 | addanse the | 52 | ele trune angrees | |
| 16 | (nilesetic) | 52 | I 20 | |
| 26 | 14 | 52 | 2 4 | |
| 28 | 22 | 52 | I I2 | |
| 200-27 | W-seller 5 | 52 | I 10 | |
| in the | · champ | 36 | 22 8 | |
| The star | Leanth 12 11 | 52 | - 10 | |
| in the st | ins zanil a | 36 | 24 14 | |
| 28 | 6 | 52 | - 8 | |
| 30 | 2 | 52 | ini'ad 2 in al-no | |

Here you fee the depth is one hundred and fifty-three rules, one foot, eight inches. The rule containing two feet, make in all three hundred and feven feet, and eight inches, for the depth of the Shaft and Winds; which, by reduction, make fiftyone fathoms, one foot, eight inches, for the true depth of the Mine at that place.

If you chufe to know how much your Shaft and Winds underlie, you muft add together the lengths that ftand againft your fquare degree fifty-two; in all feven rules, fixty-four inches, which, by reduction, make three fathoms, one foot, four inches, the exact underlie of your Shaft and Winds.

To know the length you have driven in the Mine, without laying it forth above, you muft add up the rules and inches that ftand under the word length, againft your bye degree (thirty-fix) which in this example are only two drafts, viz. forty-fix rules, twenty-two inches, equal to fifteen fathoms, three feet, ten inches, which you have driven in the Mine.

But if you defign to dial and lay it out above-ground, fet the Dial upon the degree fifty-two; and looking in your notes for one rule twenty inches, which was the firft length, put one end of the rule to the hole in the deal board (page) flung acrofs the Shaft-brace, where you held the ftring, when you began to plumb the Shaft. The rule lying to the fide of the Dial, and H h h

the needle being rectified to the degree fifty-two, make a mark at one rule twenty inches upon the ground; and thus you have done the firft degree. In like manner you may do all the reft, if you go over thefe degrees fingly, one by one; but as here are feveral fquare degrees (fifty-two) before you come to any bye one, which goes upon the courfe of the Lode, you may take all thefe fquare degrees together, firft adding their lengths together, to know how many inches and rules they are.

The lengths opposite the fecond, third, fourth, and fifth dergees (fifty-two) are equal to three rules forty-fix inches, which by reduction amount to two fathoms, one foot, ten inches, the exact underlie of your Shaft ; therefore if you first measure out fo much of your ftring or line, and the needle is rectified to fifty-two, bid your affiftant make a mark there: thus you take all the four degrees together and find the mark at grafs, which he made at the bottom of the Shaft. Go to the mark your affiftant made, and look to your notes for your next length, meafuring out fo much upon your cord, viz. twentytwo rules eight inches; then let him go forward with one end, and cause some one to hold the other end in the mark he made laft : look to your notes for your degree over against that length, which is thirty-fix, and rectify your needle to it; let him that has the plummet end of the line, bring the ftring to the fide of the Dial, yourfelf ftanding at fome diffance from him that holds the other end in the mark. The ftring lying exactly even with the fide of the Dial, and the needle flanding upon the bye degree thirty-fix, bid him make a mark at the end of the plummet, and fo you have done that length.

Now go to your laft mark, and put one end of your rule to it, and fet the needle upon fifty-two, laying the edge of the rule parallel to the fide of the Dial. This length being but ten inches, make a mark there.

Look into your notes for your next length, which is twentyfour rules fourteen inches: meafure this out, and let your affiftant go on with the ftring, caufing the other end to be held in the laft mark. Set the needle upon thirty-fix, the degree opposite that length; apply the line exactly parallel to the fide of the Dial and ftretch it tight. At the plummet end of the ftring make a mark, which finisfies another length. Laftly, because the other two lengths are both to be taken upon one degree, and there being no other bye degree between them, you

you may add the lengths together, and take them at once, which are two rules and eight inches, the needle ftanding upon the degree fifty-two. The end hereof is the place at grafs, directly over the mark you made at the bottom of the Winds. Here, if there is a neceffity for it, or it is worth your trouble and expence, you may fink a new Shaft down-right upon the bottom of the Winds, which you may as infallibly depend upon performing, as on any the moft facile transaction in Mining. No one thing is more commonly done; it being often of the laft importance to fink down a new Shaft, and thereby fave the charge of drawing the work by a double draft. It is not always requifite to fink a new Shaft, directly on the Winds; but whenever it is thought fo, the undertakers must first dial underground and afterwards at grafs, before they can prefume to fink a perpendicular Shaft upon the Winds bottom.

Now, to know whether you have dialled this exactly or not, without going over it again, add all your fquare fhort lengths opposite the degree fifty-two together : the fum will be nine rules, fixteen inches; which, by reduction, make three fathoms, one foot, four inches, the exact declination or underlie of your Lode in the Shaft and Winds, from the brace of the former to the bottom of the latter at fifty-one fathoms, one foot, eight inches, the depth of the Mine or Lode in that place. Again, if you chufe to afcertain the average underlie of the Lode, for one fathom with the other, you must work the above drafts by the rule of three direct; by which it will appear, that for every fathom the Lode has been wrought in perpendicular depth, its inclination or underlie is four inches and a half. This underlie is very fmall and fcarcely merits the name in Cornwall, where frequently our Lodes underlie a fathom in a fathom, and feldom lefs than two feet in a fathom. Indeed, fome few Lodes go down in form of a Zig-Zag; and by that means, at a great depth, deviate from a perpendicular very little from the place where they first begin to fink : but this is very rare; and though it may fave coft in not finking many underliers and winds, yet the conveniency is over ballanced by having a lefs quantity of Mineral in a given perpendicular Lode, than in that which underlies one half in the other. That is, a Lode that underlies three feet to the right or left from a perpendicular, will measure nine feet in depth for every fix of a central tendency.

But to proceed: in laying out the drafts upon the furface, you must next add up the lengths you took upon the course or run

run of the Lode, which were but two; viz. twenty-two rules, eight inches, and twenty-four rules, fourteen inches, in all, forty-fix rules and twenty-two inches; which, by reduction, are equal to fifteen fathoms, three feet, ten inches : meafure thefe out with your rule and line, and give your plummet to the affiftant, to go on with the supposed run of the Lode, caufing fome one to hold the other end at the board upon the Shaft brace, where you first began to plumb : then go to the middle of the ftring, and fetting the needle upon the degree thirty-fix, apply the line exactly parallel to the fide of the Dial, and bid the affiftant make a mark at the end : go to this end or mark, and measure out your square lengths, which in all are three fathoms, one foot, four inches : then give your affiftant the end, holding the other end in the mark; fet the needle upon fifty-two, and bid him apply the line exactly parallel with the box, and make his mark. If this mark hit that you made, when you dialled it before, you have done the work exactly; otherwife, you have committed fome blunder, and ought to try it over again : for this rule always holds true when you take iquare lengths, and your lengths forward, on the course of the Lode or any way, by one degree ; as you here took thirty-fix for your degree.

Many more examples in Dialling might be given, fuch as, to dial Shafts and Winds that underlie and beat into the end; to dial in a Gunnies with many crofs drifts and turnings, and afterwards to fquare the fame at grafs, &c. : but as they are already given in Houghton's Rara Avis, and Hardy's Miner's Guide, and as one hour's conversation with practical Miners will illustrate the fubject better than a week's reading, I shall conclude what I have faid on it, with this fingle remark, that the crude, goffany, ferruginous Ores in the Mines, have no influence on the needle of the compais : I have often found, that even the magnet or loadstone will not attract pure Iron Ore (much lefs the ferruginous Ores of other Metals) till they have undergone the fire, by a calcining heat, or fome other process; otherwife, there could be no poffibility of Dialling moft Copper Mines, becaufe they commonly abound with much Iron (Goffan) in Copper Ores.

The other branch of Dialling, is properly filed Levelling; which is an operation to find the inequality, afcent, and defcent, of any ground or hill. Hence it is of great use for all aqueducts to towns, houses, ponds, mills, &c. and particularly in Mining, either either to bring a water courfe to a Mine, in order to erect an engine, or elfe to find how deep an intended adit will be from or to a prefixed or given place. But as the rules of this art are fully laid down in books that treat on land furveying, I need not dwell on it here; efpecially as the two authors above mentioned have deferibed its ufe and application to our fubject. Neither is it neceffary to deferibe the feveral inftruments and improvements that have from time to time been made and ufed in Levelling, fince the Miners, inftead of the true Levelling inftruments, called the air level, or fpirit level, commonly fubftitute (though not to their credit, for the beft may be had at little expence) a water level of their own conftruction; which is generally a clumfy inftrument in form of a fmall narrow trough, an inch wide, and three feet long, planed very exact and true.

To find the fall or declination of the ground, they lay this Levelling inftrument on the higheft part of the ground they are about to level or meafure, and by pouring water into the trough, they eafily perceive when it lies truly horizontal, and then they proceed in the fame manner that is practifed by others who ufe the air level. But when a Mine lies on a fteep hill, and there is room for a proper flation below for taking a juft obfervation by a quadrant of altitude, then the height of the hill (which is the fame as the level or depth of the adit at the Mine) may be eafily found by the rules of altimetry. The theory of thefe operations, however, is not confidered by the Miners; neither is a fmall error difcoverable, becaufe they feldom level any great length of ground at one time, and content themfelves with the common manual operations.

Dr. Halley fuggefted a new way of Levelling which is wholly performed by the barometer, in which the mercury is found to be fufpended to fo much the lefs height, as the place is further remote from the center of the earth. Hence it follows, that the different height of the mercury in two places gives the difference of level. Mr. Derham found, from fome obfervations at the top and bottom of the monument in London, that the mercury fell one-tenth of an inch at every eighty-two feet of perpendicular afcent, when the mercury was at thirty inches. Dr. Halley allows of one-tenth of an inch for every thirty yards; and confidering how accurately barometers are now made, he thinks they are fufficiently exact to take Levels for the conveyance of water, and lefs liable to errors than the common Levels.

Some

OF DAMPS IN MINES, &c.

Some years fince, the reverend Mr. John Pickering, Mr. R. Phillips, Mr. Waltire a travelling lecturer on philosophy, and myself, took the altitude of the higheft eminence of the celebrated Druids hill called Carn Brea, by one of Mr. Waltire's best barometers; when we made the utmost perpendicular height, at the luftration rock basons, three hundred and fixty feet or fixty fathoms from the bottom of Redruth town. Nevertheles, one great obstacle to this way of mensuration in our county, arises from the fudden and frequent changes of our atmosphere, which must influence the mercury, and cause fome difference between the state of departure, and the place of destination, in proportion as the atmosphere alters; fo that this method can be used only in clear, ferene, and fettled weather.

bo while for addy the roles of Thimmer, "The theory of their

withe toy and bolgoon of the monument in London, than the

share which where not done in an include the swoll BOOK

214

BOOK IV.

CHAP. I.

The Method of Sampling and Vanning of Tin-ftuff, with the Stamping, Burning or Calcining, and Dreffing the fame; with the Manner of Dreffing the Leavings, Loobs, &c.

IN-STUFF that lies by the fide of the Shaft, when it becomes a great heap, or if it otherwife fuits the humour of the concerned, is first spalled or broken to the fize of a man's fift or lefs, by which the most indifferent parts are feparated and forted from the beft; fo that perhaps not more than one half of a large heap may be referved for dividing and ftamping. After the Tin-ftuff is thus culled, and properly fized, it is divided out in fmaller heaps by meafure of a handbarrow, that usually contains a fack and a half, or eighteen gallons. These shares, which they term Doles, are parcelled out into fo many different heaps on any the most adjacent parts of the field, fometimes to the great prejudice of the hufbandman, who is not confidered for his damage by the lord of the foil, or the owners of the Mine. The method and number of Doles, into which Tin-ftuff is frequently divided, may be feen in book iii. chap. iv. The parcels being laid forth, lots are caft; and then every parcel has a diffinct mark laid on it, with one, two, or three ftones; and fometimes a bit of flick with the initials of the proprietor's name, or a turf laid on the middle of the Dole. When these marks are fixed, the Doles may continue there unmolefted for any length of time : the property is fettled ; and no one, but the right owner, may add or take from it.

The Doles which are defigned for fale, are very accurately meafured; for as the barrows are carried off for their refpective divifions, one perfon, who is the reckoner, keeps an account by making a notch in a flick for every barrow; and if there be an odd one left, it is equally divided by the gallon, the fhovel, and, when it is rich, even by the handful. The Doles being divided, they proceed to caft lots for that which fhall be fampled.

fampled. This Dole being turned over, equally levelled and mixed, is then divided by a man with his fhovel, into two equal parts, taking a little of the Tin-ftuff from one end to the other of each of those parts to the amount of some gallons if the Dole is pretty large. This quantum is bruifed down by large fledges to the fize of an hazle nut, then equally levelled and divided into four parts, two opposite quarters of which are felected and bruifed over again to a smaller fize. These reductions and smaller divisions are repeated again and again ad libitum; till the quantity designed for sampling, is well mixed, and made as fine as common fand; when each fampler fills his little canvas bag with it, and proceeds to a trial of its value by water, in the following manner.

To make a rough guess or coarse effay, the fampler takes a handful of it, and washes it on a shovel, till the impure earthy parts are carried off by the water from its fides. The more ftony, folid, heavy particles being left behind, they are bruifed by an affiftant, with a fledge on the flovel, till the whole affumes the appearance of mud. This is washed again, till it lofes its muddy afpect; when by a peculiar motion of the fhovel not to be defcribed, the metallick particles are collected together on the fore part or point of it. By repeating these bruifings, washings, and motions, it becomes clean black Tin, fit for the fmelting furnace. This is called a Van (from the French word Avant, foremoft, as I apprehend) it being thrown forth upon the point of the fhovel, by the dexterity of the fample-trier. After the Tin is thus made clean to his mind, he dries it; and if it be as much black. Tin as will entirely cover a good shilling, or rather if it is the weight of a fhilling, he terms it a Shilling Van, which is not rich; but if the Van will cover or equal the weight of a crown piece, it is good Tin-ftuff, and is termed a Crown Van. Now they fay, the Shilling Van will produce one hundred grofs or avordupois weight of block or white Tin; and the Crown Van will yield five hundred weight of block Tin, for every hundred facks in measure, of the respective Doles that the fample or Van is taken from, and fo proportionally on, to the richeft Tin-ftuff called Scove, which is reckoned ten thoufand of white Tin-metal & every hundred facks; or in other words, it will produce one hundred hundred weight of Tinmetal, for each hundred facks of Tin-ftuff; yet there is none near fo rich as this in any quantity, except a particular ftone or lump.

But a measure of a wine half pint is much more exact and true than a handful, to form a judgment from; though the handful be accounted a half pint. The manœuvre is also more nice and true, by using a large shovel, and taking off the fized Tin from time to time on another fhovel, and fo proceeding till all the Tin is reduced clean and to a proper fize. When this is done, dry the Van in a fhovel upon the fire; then take it off and weigh it in a money fcales by pennyweights and grains : for every pennyweight and half the Van weighs, the produce will be one hundred weight of black Tin for every hundred facks of Tin-ftuff; and fo on in due equation: three pennyweights is equal to two hundred weight; fix pennyweights to four hundred weight; twelve pennyweights to eight hundred weight; fifteen pennyweights to ten hundred weight; or, as they term it, a thousand of black Tin a hundred, i. e. for every hundred facks of Tin-ftuff : and if it be Tin worth ten for twenty, or one for two, then the Tin-ftuff is valued at five hundred weight of block or white Tin, for every hundred facks. If the Tin be worth twelve for twenty, the ftuff is valued at fix hundred weight of white Tin a hundred; or if it be worth only eight for twenty, it is only valued at four hundred weight of white Tin a hundred; and fo if the metallick quantity of the Tin be more or lefs, it must be accounted for after that manner.

This black Tin is rather of a liver colour, though called black in contradiftinction from white Tin, or the Metal produced from this black Tin Ore. It is very ponderous; for, in a general way, it may be computed to hold one half clean Metal, and fome of it will produce thirteen, nay even fourteen parts in twenty; whence the term of fo much white Tin for twenty of black Tin, that is, eight for twenty; ten for twenty, which is the fame as one for two; twelve for twenty, and fo on, be it more or lefs given for Metal; in the knowledge of which the fample-triers or Tin-dreffers are very expert, without the ufe of crucible and furnace. Thus if the Van of one hundred facks of Tin-ftuff weighs fix pennyweights, being four hundred weight of black Tin at twelve for twenty, the white Tin or Metal muft be two hundred weight, one quarter, fixteen pounds.

In the preceding manner, they form a near conjecture of the quantity of white Tin that their work or Doles of Tin-ftuff will produce at the fmelting-houfe, when it is dreffed, and brought into black Tin. But if the black Tin is infected with any bad brood or mixture, as Mock-lead, Copper, or Mundick, after K k k the

the Van is bruifed fine and wafhed, they lay the flovel over the fire, and burn the black Tin, continually flirring it till it fmokes no more. Laftly, they wafh it again on the flovel, and fo the brood is carried off by the water, it becoming light by being burnt; for when black Tin is calcined or burned, it ftill retains its fpecifick gravity; but Copper, Lead, and other crude Minerals, become much lighter by torrefaction, and are cafily feparated from the Tin by water.

It fhould be obferved, that each fack ought to hold twelve gallons of Tin-stuff, though they often hold but nine or ten; which want of measure, when known, should be taken into confideration by the Tin buyer.

Now, whoever intends to buy a quantity of Tin-ftuff, either for profit in trade, or merely for the fake of employing his ftamping mills, horfes, and labourers; when his adventure Tin-ftuff falls fhort, which is very commonly the cafe, he must not give the value of its full produce, without deducting what is called the returning charges, that is, the carrying, ftamping, and dreffing thereof. On the other hand, the reader must be apprifed, that the value of Tin-stuff, is short of its intrinsick worth by the Van only; for in the dreffing and management of Tin by ftamping, &c. there are two forts of black Tin to be obtained, viz. the crop and rough, or the crop and leavings of Tin. The first is the prime Tin, immediately feparable from the bafer parts by its fuperior weight and richnefs; the latter is that which is carried off, and mixed with the lighter earthy parts, by its being under fize, and therefore more fusceptible of the force and impression of a determinate stream of water. Such Tin being composed of the most flimy moleculæ, as well as of the larger rough grains, which get through the greater fized holes of the ftamping-mill grate, have very little Tin in them, and must therefore undergo another treatment to get out and cleanfe the Tin. This being called the leavings, muft be accounted for and valued in addition to the crop Tin, in proportion to the denfe or lax confiftence of the Tin-ftuff and the specifick granules or minutiæ of the Tin Ore in the stone. All this depends upon the experienced judgment of the Tindreffer; and it is fo difficult and various a fubject, that a man fimply a theorift in the matter, cannot lay down a certain rule on which another can abfolutely depend. The cuftomary valuation is, by fetting a price upon the leavings of this or that Tin-ftuff, according to fo much the ten hundred weight or thoufand

thousand it makes in crop Tin, from fifty shillings to five pounds & thousand for the leavings. Hence it follows, that the leavings of some Tin-stuff will more than pay the returning charges; but whenever the leavings are rich enough to pay those incumbrances, they pronounce such Tin-stuff to be "Tin in the "Bal;" that is, to be worth four, five, or fix hundred of white Tin & hundred facks by the Van, free of all costs and charges, which the leavings will exonerate.

All things being well confidered, we may conclude, by trying the fample, how to fize a parcel of Tin-ftuff by fuiting it with a grate or holed plate, adapted to the natural grain of the Tin, which is one of the principal articles in dreffing; but of this in its place. Mean while let us observe that the dreffings of Tin in its prefent improved ftate, has been very lately invented; for by Mr. Carew's account, no longer back than one hundred and eighty years, in queen Elizabeth's reign, the manner ot dreffing was exceeding flovenly; and I am very fure, notwithftanding our prefent advance, we are yet at fome diftance from perfection in that art. He fays, " As much almost dooth it " exceede credite, that the Tynne, for and in fo fmall quantitie " digged up with fo great toyle, and paffing afterwards thorow " the managing of fo many hands, e're it come to fale, fhould " be any way able to acquite the coft; for being once brought " above-ground in the ftone, it is first broken in pieces with " hammers; and then carried, either in waynes, or on horfes " backs, to a ftamping-mill, where three, and in fome places " fixe great logges of timber, bounde at the ends with Iron, " and lifted up and downe by a wheele, driven with the " water, doe break it fmaller.

" The ftreame, after it hath forfaken the mill, is made to fall by certainne degrees, one fomewhat diftant from another; upon each of which, at every difcent, lyeth a green turfe, three or four foot fquare, and one foot thicke. On this the Tynner layeth a certayne portion of the fandie Tynne, and with his fhovel foftly toffeth the fame to and fro, that, thro this ftirring, the water which runneth over it, may wafh away the light earth from the Tynne, which of a heavier fubftance lyeth faft on the turfe. Having fo cleanfed one portion, he fetteth the fame afide, and beginneth with another, untill his labour take end with his tafke. After it is thus wafhed they put the remnant into a wooden difh, broad, flat, and round, being about two feet over, and "having

" having two handles fastened at the fides, by which they foftly " hogge the fame to and fro in the water between their legges, " as they fet over it, untill whatsoever of the earthie substance " that was left, be flited away. Some of later time, with a " fleighter invention, and lighter labour, doe cause certayne " boyes to ftir it up and down with their feete, which worketh " the fame effect : the refidue, after this often cleansing, they " calle Black Tynne. But fithence I gathered flicks to the " buildinge of this poor neft, Sir Francis Godolphin enter-" tained a Dutch Mynerall-man, and taking light from his " experience, but building thereon far more profitable conclu-" fions of his owne inventions, hath practifed a more faving " way in these matters, and besides, made Tynne with good " profit of that refuse which Tynners rejected as nothing " worthe." Thus far Mr. Carew.

Seeing that a dreffer's judgment is required in the choice of a grate, I begin with a defcription of that first and necessary part of a ftamping mill, which is a thin plate of Iron one-tenth of an inch thick, and twelve inches long by ten wide. The middle of this, from eight inches and an half by feven inches, is punched full of holes from the diameter of a fmall pin, to that of a large reed; for the larger the Tin cryftals inclosing the Metal are, fo much the more capacious must be the holes, and vice verfa. This holed plate, commonly named the Grate (I prefume from the cuftom formerly of difcharging their ftamped Tin through grates or iron bars) is nailed on the infide of the frame, at Y, plate V, near the bottom where the ftamp heads pound the Ore. The Tin-ftuff being deposited on the floor, at C, called the Garden of the País, from thence it flides by its own weight, the motion of the ftamps tackle, and the affiftance of a fmall rill of water, D, into the box at Y; there by the lifters a, b, c, falling on it, after being raifed by the axle-tree, d, which is turned round by the water wheel, B, it is pounded or ftamped fmall. The lifters are three to each ftamps, made of ash timber, fix by feven inches square, and about nine or ten feet long. They are armed at the bottom with large maffes of Iron called Stamp-Heads, of one hundred and forty pounds weight in each, or more : these are lifted up, and let fall, between two upright parallel planks of oak timber, by wooden knobs or teeth, called Caps, fixed in the barrel of the axletree at proper diffances, and in number proportioned to the circumference of the axis, which goes round by the power of the water wheel. Those caps in their round, take up pieces of

of wood called Tongues, about fix inches projecting from each lifter, which are fixed one in every lifter at a proper place, fo that each cap from the barrel of the axle comes under the tongues, and lifts them up, one after another, in a uniform rotation. Each lifter with its iron head falling upon the Tinftuff, bruifes it down fo fmall, that it is all difcharged through the little holes of the grate. The hinder head lifts first; that falling, forces the Tin-ftuff under the fecond ; the fecond falling, forces it to the third; that falling, forces it on to the fmall holes in the grate, from whence it is conveyed by the fame rill of water before mentioned (which likewife ferves to keep the Ore wet, and the ftamp heads cool) through a fmall gutter, e, into the pit, F, where it makes its first pure fettlement; for the rough metallick part lies at the head, while the loomy part or flime is carried back by the water, to the hinder part, G. Adjoining to this pit is another large refervoir, H, where the flime leavings coming from the first pit, are finally deposited; the remainder which flows over into the river, being reckoned good for nothing.

When the first pit, F, is full, they throw it up, carefully feparating the good from the bad; or in two parts, the head and the tail, according to the diferetion of the dreffer. Then they carry it to the buddle, I, a pit feven feet long, two and a half wide, and two feet deep. The dreffer, or a ftout boy, ftanding in the buddle at I, fpreads the pulverized Ore upon an inclined plane at K, called the head or Jagging board of the buddle, by a fhovel full at a time, in fmall ridges parallel to the run of the water, which enters the buddle at L, and falling equally over the crofs bar M, washes the lighter parts from the ridges, which are moved to the right and left with a fhovel till the water permeating every part feparates the better from the worfe; the dreffer in the mean time lightly fcraping his naked foot acrofs the Tin in the body of the buddle, which raifes the light wafte, in order to its being carried back by the water whilft the Tin remains clean in the head or fore part of the buddle. When the buddle is filled in this manner, if the Tin is of a moderate value it is forted into three divisions; that next the jagging board, K, at g, is the pureft, and called the head or crop, which is faved by itfelf; the middle, at h, is next in degree, being named the middle head, but more commonly the Creafe; and that, at i, being most impure, is by fome called the Hind-Creafe, which is thrown behind the buddle for leavings, and thence called by fome the Tails. If need be, the L11 head

head of the buddle is buddled over again, and fo is the creafe, till it is brought to equal purity with the fore part or head. These buddlings are repeated, till the quantity defired, to a certain standard of purity, is brought about, as they term it, or freed from its waste, which is thrown aside with the tails, and hind-creases, for leavings.

It is then carried to a large vat called a Keeve, about onethird filled with water, where the dreffer ftirs round the water with a fhovel, while another puts in the Tin by a fhovel full at a time, letting it fall down into the water by little and little at the fide of the keeve, wherein it is continually tozed (toffed) or ftirred by the dreffer with his fhovel, till the keeve is almost filled. By this method the fmall wafte that remains among the Tin fwims about in the water. When the toffing is at an end, a boy or two with mallets employ themfelves for a quarter of an hour beating the fides of the keeve, near the top (which they call packing) till the whole is fettled hard, according to the different gravities of its component parts; when the water is poured off from the furface of the Tin, and the light wafte upon it is fkimmed off and laid by itfelf, to be buddled over again by the name of the Skimpings. The Tin is then fifted through a copper bottom fieve, into another keeve of water, by which the gravelly wafte, whole ponderofity funk it equally with the Tin Ore in packing, is feparated from the clean Tin ; the Tin that runs through the copper or brafs bottom fieve, if it does not require to be buddled again, may be made clean by repeatedly toffing and packing it as before. If it is neceffary to buddle the Tin over again, after it is fifted (which is the beft method for cleanfing most forts of Tin, for there may lie a rough wafte, that will not come off by toffing and packing) then buddle it over again, and fave it in three parts, viz. the crop, the creafe, and the tail. The crop is to be cleanfed by toffing, &c. and the creafe muft be buddled again, out of which must be faved as much as will cleanfe by toffing and packing.

The remainder muft be cleanfed by an operation called Dilleuing, from Dilleugh, to let go, let fly, fend away. A dilleugher is a large fine hair fieve, which the dreffer holds in a keeve one-third full of water, while an affiftant throws a fhovel full or two at a time into the dilleugher, which the dreffer fhakes to and fro, and, by his dexterity, turns round the water in the dilleugher, till all the Tin that is in it is in motion. He then dips one fide of the dilleugher under water and raifes it again,

again, letting the water run over the other fide, either flow or fast according to his judgment of the nature of the Tin and wafte : the latter will run or fly over, and is called dilleughing fmalls or pit-works, which muft be laid afide, to mix with the fkimpings, to make the famples of a low value, called the rough (or row) Tin. But there is another operation upon this rough Tin to gain as much out of it as poffible, to mix with the crop, which manœuvre they term "drawing the row Tin in the " buddle," viz. by putting the quantity of a fmall tub full in the bottom of the buddle, on one fide forth against its breast; then with a pretty ftrong rill of water, mostly turned the other fide of the buddle, they draw it with a fhovel by little and little from one fide to the other, where the water runs. By the force of the rill, the roughest and poorest of the row is carried back, while the best stands forth. This must be repeated, till it is cleanfed from the rough gravelly parts, which may be known by vanning of it on a fhovel : which done, they dilleugh it again, till it is fit to mix with the crop Tin.

The rough that is carried back with the fiream, by drawing it over again, may be rendered merchantable at a lower rate than the crop; and the rough of this rough, is thrown afide to make leavings. The pit-works and fkimpings must be feparately buddled, toffed, and packed again, till they are quite clean, and the refidue put by for leavings. Thus every part is kept feparate to make it clean; first the head, next the creafe, then the fkimpings and pit-works, when all are mixed together for the fmelting-houfe, there to be bartered for white Tin, excepting a finall proportion of row for an inferior fample, which if mixed with the crop would fpoil the whole.

A perfon that is ignorant of cleanfing Tin Ore, may fafely undertake to pronounce, whether a batch or parcel of black Tin is well purified or not, by plunging his wet hand into it; for if there is any wafte in the Tin it will flick to his hand; otherwife his hand may be drawn without any thing adhering to it, except fome few evident Tin grains in the lines of his palm: confequently, if a wafte is thus visible in fo few points of contact, then certainly must the wafte be very great and prejudicial in the whole batch.

From the defcription of dreffing clean work, we must proceed, in course, to give an account of dreffing Tin-stuff, that is corrupted with Copper, Lead, Mundick, Black-Jack, and other

other Semi-Metals; for fometimes we meet with all thefe forts of Minerals intimately blended in one and the fame ftone of Tin Ore; which being fpecifically heavier than the Tin, whatever Tin-ftuff is incorporated with thefe muft be burnt to evaporate the fulphur, arfenick, &c. after it is firft ftamped, dreffed, and cleanfed from its earthy fordes, in the manner before defcribed, in order to make it fit for calcination in the furnace, called a burning-houfe.

A burning-houfe much refembles a finelting-furnace, but not in every particular. The furnace is built without doors, at one end of the houfe, where the chimney is raifed to carry off the fmoke and fublimate of the calcined Minerals. The houfe ferves no other purpofe than that of a covering for the man who rakes the calcining Ores, and the prefervation of fome few tools that would be unfafe out of doors.

The foundation of the furnace is built of hewn moorftone about four feet and a half high, on which the bed or bottom of the furnace is laid. Under the bottom, a little towards the house where the man stands to rake the Tin, is left a hollow place for holding the Tin after it is burnt, which they call the Oven, that will contain about fixteen or twenty Winchefter bufhels, with an opening on that fide next the flamps plot, in fhape and fize much like a fmall chamber chimney, in order to come at and take out the calcined Tin, which is let down through an orifice in the bottom of the furnace adjoining to the houfe. Except at this orifice, the oven is arched over to lay part of the furnace bottom upon. The top, bottom, and hewns (fides) of the calciner were formerly made of moorftone wrought very fine; but brick is now moftly used, it being more durable for fire work than ftone. The length of the calciner is generally about nine feet, and the width five in the belly or middle, gradually decreasing towards the chimney or house to fixteen inches, and towards the grate or fire place to three feet, which is at the further end directly opposite to the house and chimney. The hewns, or fides, are about ten inches high; upon which is turned a flat arch or covering, which includes the fire place alfo. This grate or fire place is about ten inches wide, and three feet long; at the fide of which, between it and the furnace, is a brick thick partition or bridge three inches high, to prevent the Tin from mixing with the coal. Over this bridge the fire conftantly reverberates upon the matter in calcination, while the fmoke and fulphur afcend the chimney at the houfeend

end opposite the fire place. Upon the top of the arch or back of the calciner, is made a square hollow place called a Vate or Dry, sufficient to contain a serving or hand barrow full of Tin, which acquires heat enough to dry it ready for calcination in the furnace below, where it is conveyed through a small hole in the bottom of the vate.

A calciner of these dimensions, will confume three Winchester bushels of coal to every ferving, if the Tin is greatly corrupted with a flubborn brood, but most commonly half the quantity, or lefs, will do; alfo fome forts of Tin, that are very fulphurcous, will yield a flame for feveral hours, and greatly help their own ignition to the faving of fuel in the operation. As for the time of making a complete calcination of a ferving or laying of Tin, it cannot be limited till a trial is made; for if it is not very foul, it may be burnt in fix hours, and fo on the contrary from that to twenty-four hours, according as it is more or lefs corrupted; efpecially if there be Copper in it, when it will require a longer time to weaken and deaden the Copper as they pretend, otherwife it will not cleanfe fo well in the future dreffing; that is to fay, the ignition must be strong, uniform, and conftant, to render the Copper a light wafte to wafh off from the Tin, which by the strongest calcination used here, lofes very little of its first ponderofity.

When the fire is up, and the first ferving of Tin in the vate is dry, the dreffer lets it down into the furnace through the hole at bottom, where he levels it with his rake through an opening twelve inches fquare, made under the chimney in the houfe. After it is all down, he ftops the hole in the vate with clay, and carries another ferving into it in readinefs for the next layer. The Tin in the calciner must reft for some time before it is turned, that it may be quite hot; otherwife if it be ftirred before ignition it will effervesce and fly up the chimney; but when it is ignited, and ready for turning, the dreffer rakes it backwards and forwards alternately, moving that which is furtheft from the fire near to it, and that which is close by the grate further off. This must be repeated over again, at due intervals of perhaps every hour, or more frequently if the nature of the Tin requires it. But in either cafe, a ftrong heat fhould be kept up, and the fire not let to flacken, till the Tin is fully calcined; which may be known by the dead weight of the Tin against the rake, by its having exchanged its fiery red hot appearance for a black one, and its yielding little or no arfenical fmoke upon ftirring. Mmm The

٠

The Tin after it has been fufficiently burnt is let down into the oven before mentioned, and from thence is drawn out and fifted in a keeve, through the brafs or copper bottom fieve; whence it is removed to the buddle, and undergoes all the feveral lotions of buddling, tofling, packing, &c. till it is quite clean for fmelting.

Let us now advert to the dreffing of leavings of Tin. Leavings confift of flime and tails ; that is, of Tin mud and Tin gravel, which a Lappier, or dreffer upon tribute, will commonly undertake to bring about for the mafter Tinner, for one-third part of the produce to pay his charges; or, in other words, the former will account to the latter, for two-thirds of the produce in white Tin, free and clear of all trouble and expence. The tails I have fhewn before are in abfolute bulk, produced from the hinder or tail part of the buddles; from whence they derive their name of tails. The flime being compounded of the fmall and lighter parts of the Ore intimately mixed with a greater quantity of earth and ftones, bruifed to duft by the mill, is floated on to the flime pit H, which is emptied, as occasion requires, on one fide, into another flime pit called a Hutch, till it accumulates to a great heap, where the water leaks away and leaves it dry, exposed to the fun and air, which do not a little contribute to its better working when it comes to be dreffed ; for this we find every day by experience, that the longer the flime is left before it is dreffed, the more profit it yields, and the purer the Tin : from whence fome have concluded, that Tin in the flate of fludge or flime, by length of time, muft grow and increase. It must, however, be confessed, that the fun and air act as menftrua upon the flime, by confuming or rather diffolving the Poder, that is, the Mundick, particles of Copper, and other trafh, not fo denfe and compact as the Tin, which comes out the cleaner and with greater eafe by fuch infolation and exposure. Therefore, when the water is fufficiently foaked out of the flime hutch, it is removed further off to a large plot of ground near the veffels deftined for its future lavations, where it is fpread and exposed to the weather that it may moulder and decay the fafter. Then it is digged and broken to pieces with a bidax, or hedging tool, when it is trunked and framed, thus :

A trunk O, is a pit lined with boards ten feet long, three wide, and nine inches deep. At the higher end is a circular pit Q called the Strêk or Strep, large enough to contain four hand

hand barrows full of flime, where it mixes with a little rill of water that floats it down into the femi-circular pit P called the Head or Pednan, wherein a boy treloobs or flirs the flimy water round about with a fmall flowel, that the water may wafh away both the filth and Tin over a crofs board ten inches deep at the lower part of the pednan : the board is fomewhat lower in the middle than at each end, for admitting the watery mixture with more eafe into the body of the trunk O, R, R : that which refts in the fore part of the trunk at O o, is carried off to be framed, and the fettlement at R, R, is moved forwards to P, to be trunked over again before it is fit for the frame : the rough grains lie at the bottom of the ftrêk, whence it is removed for flamping, and the moft light and fmall flime paffes the bottom or lower end of the trunk into a pit, where it fettles and acquires the name of Loobs.

The frame or rack TW, confifts of two inclined planes of timber; the body W, the head T. The frame is an oblong fquare eight feet by five, with fides four inches high, all joined closely, that nothing may escape but at the extremity or lower end. At the middle of the two ends are fixed two round projecting irons called Melliers, by which the frame hangs and turns as it were on an axis, upon two upright pieces of timber one at each end, whereby the frame may be fwung up and down, perpendicular to the horizon. The head T, is two boards wide, and in length parallel to the breadth of the frame. To the bottom of this is joined a water head, or board, feven inches high; to which is hung, by hinges, a flight piece of board fix inches wide, and the length of the head, called the Lap, or Lippet, whofe use is to convey the water and Tin equally down upon the frame. Underneath the fore part of the frame, is fixed a little tray or cheft three feet long, called the Kôfer, and another at its lower end called the Hind-Kôfer.

The water falling in a gentle manner from S upon the head T, wafhes the Ore, which there offers itfelf (as at the buddle) in little ridges, downwards over the lippet, upon the body of the frame W. On this frame the water is fpread fo thin, and runs fo flowly, (the plane being very little inclined) that by moving the flimy Tin to and fro with a light hand, and expofing it cautioufly to the water by a fmall femi-circular toothlefs rake, all the fordes are wafhed away, and the Tin though ever fo fmall, remains on the frame near the head. When the Tin is found fufficiently clean, the body of the frame being hung on melliers,

melliers, as I have faid before (by flipping the ftake underneath, which fupports it) is turned eafily from horizontal to perpendicular; and the Tin which remains on the frame runs off, by the affiftance of a little fprinkling, in two degrees of purity, into the fore and hind kôfers. The frame is then righted into its horizontal politions, and the process repeated till the kôfers are full. The fmaller flime, which runs off the lower end of the frame, is yet preferved in a pit by the name of Catchers, and makes a part of the loobs or leavings of leavings, to be worked over again at a future time. The contents of the fore kôfer is then fifted through a fine hair fieve or copper bottom, into a keeve with water in it, to feparate the gravel, chips, or any other accidental mixture from it. Then it is buddled and faved in different portions, like crop Tin ; as well undergoing the feveral operations of toffing, packing, fkimping, dillhuing, &c. After all, if the Tin is very fmall, it is carried to the frame again, and reframed or cazed, as they term it; which is performed, by floping the lower end of the frame with mud and turf, that the water may be almost still, and the Tin more eafily fettle upon the frame, and defcend the more furely into the kôfer : the fore kôfer is then emptied the fecond time, the Tin carried to the keeve again, there toffed, packed, fkimmed, &c. and thus the flimes are finished, and brought to as great a degree of purity, as the fize of the Tin will permit, which being exceeding fmall, will neceffarily have fomewhat more of wafte, than what is larger and heavier.

The great pile of tails behind the buddles, are commonly washed down into the trunk below, by a pretty ftrong current of water, which may be rendered more or lefs forcible by an alteration of its fall, to divide the rough from the fmall, by treloobing them in the femi-circular kôfer of the trunk with a The fmall that flashes over into the trunk, is defigned fhovel. for framing, and fo divided into two parts, the fore, and the hind kôfer. The latter must be toffed and framed again; but if the fore kôfer is pretty good, it may be toffed and packed, the fkimpings of which must be cazed in the buddle, that is, one perfon buddles it as ufual, but with a very fmall flow ftream of water, while another with a few quils fixed on the end of a pole, lightly fweeps the buddle across from fide to fide, beginning at the bottom, and fo proceeding forward every ftroke, till he comes to the breaft of the buddle, when he returns in like manner progreffively to the end or tail. By this method it is made fit for cleanfing in the keeve, &c. and the hind part, that

that is not fit for tofling, &c. must be framed again, and proceeded with in the former manner.

Mean time, all tails that are taken from the bottom of the trunk head or pednan, together with the roughs (or rows) that come from the flime, or from the toffings of the hind and fore kôfers, that are not of a proper fize, must be stamped over again, and dreffed in the manner before mentioned for bringing about the crop Tin or bal work. But in the ftamping them, care must be taken to fuit them with a proper grate and fmall weight of tackle, or worn old ftamp-heads; otherwife they may be stamped under fize, and choak the grate, which they call being dumbed; to prevent which, they mix with them a fmall quantity of Goffan or poor Tin-ftuff, to cut and jagg them up, elfe the ftamp-heads would mudify them too much to pafs the grate holes as freely as they ought : nay I have known common Quartz used for this purpose, entirely deftitute of Tin. If there be a corrupt brood in the leavings Tin, fo as to damage its value two parts in twenty, it must be burned in the manner before directed, but with a lefs violent fire, and then dreffed again from its calcined impurities : the calcination of leavings Tin should, however, be always avoided if possible, becaufe it is fo fine, like floran Tin, that it will, by its fized levity, be elevated and carried off, together with the arfenick and fulphur.

The modes of dreffing Tin and its leavings, are too various to lay before the reader, without danger of prolixity : all of them depend upon the difference of the kinds of Tin in the stone, and must be dealt with, agreeable to the judgment of feveral manufacturers. So much depends upon the fkill of a dreffer, that one may fave one-twelfth part of a batch of Tin, which another for want of equal knowledge may caft away in wafte, or perhaps take up fo much wafte with it, as to depreciate the value of the whole by two parts in twenty. Neverthelefs, all dreffers fave the hinder ftuff from the frame end, as it washes off in a pit by the name of Catchers, which is expreffive enough; and likewife the mud at the trunk ends, by the other name of Loobs, both of which are denominated the Loobs, after leavings, or leavings of leavings. These are wrought over in the fame manner as the former, mostly upon tribute, by an aged workman and a few little boys in the fummer months, when they can ftand out in good weather, and do a long day's eafy labour. The tribute paid by the undertaker is one-third Nnn of

of the produce in white Tin; the other two-thirds he has for himfelf to pay his coft and charges.

Proceeding upon this fingle principle, that the force of water, properly applied and introduced among the particles of Tin Ore and the fordes mixed with it, will difperfe the latter and leave the former at reft for them to collect and treafure up, they vary their operations inconceivably, conducting them with great ingenuity, leffening, encreafing, diffufing, or contracting their water, the great inftrument of purity, as the fize, weight, and combinations of the Metal and its feeders require; and that with great eafe, cheapnefs, and regularity, throughout the feveral proceffes.

Hence, this bufinefs of dreffing is a particular trade, entirely different from that of the labouring Miner; and is best learned under a master workman, who makes it his fole occupation to follow the ftamping mill and the works belonging thereto. This mafter workman hires boys from feven years old to eighteen, gives the former about three shillings a month, and raifes their wages as they advance in years and workmanship, till they have man's wages, viz. at the leaft twenty-four fhillings, at the higheft thirty shillings & month. This is of double benefit to the poor parents; and the boys being taken in fo young, become healthy and hardy by using themselves to cold, and to work with naked wet feet all day; and they learn early to contribute to their own maintenance. Each ftamping mill which has conftant work and water, will employ one man and five boys; and one hundred facks are carried, flamped, and dreffed, in the fpace of a few days, at the average rate of about fourpence # fack, or one guinea and a half # hundred.

We fhall here obferve, that even burnt leavings of Tin are often confiderably valuable, efpecially if they are cupreous; and even the pooreft of thefe leavings bring ten or twenty fhillings raid even the pooreft of thefe leavings bring ten or twenty fhillingston; which is better than to throw them away, as was theeafe no further back than forty years. All burnt leavings takenfrom Tin-ftuff, till the year 1735, were efteemed good fornothing. But in that year there were feveral finall parcels lyingon fundry ftamps plots in this parifh, which induced Mr. MorganBevan, an old experienced affayer, to try whether he couldreduce them into Metal. For the first time he affayed a fampleof three tons; and, to his own great furprife, as well as that ofothers, he found that he could give feven pounds four fhillingsand

and fixpence & ton for them, which he actually did, and prefently after bought feveral parcels more of Meffrs. Carter, Reynolds, Penrofe, Cornifh, &c. the principal Tin dreffers of those days. From that time all burnt leavings were taken much care of, provided they were fufficiently impregnated with Copper; for fome of them are merely Mundick, with little or no Copper in them. When the Brass-wire Company carried on the great Tin Mine of Chacewater, before this discovery they cast away fome hundred tons of burnt leavings, to their great prejudice; but fince that time there have been large quantities fold from the fame Mine.

The very water in which burnt Tin is washed, may be converted to a uleful and profitable account, either by evaporation to a pellicle for cryftallization of Copper, commonly called Blue or Roman Vitriol; or for the precipitation of Copper by the medium of Iron, laid in veffels filled with this vitriolick water. The precipitation of Copper by Iron, is too generally underftood to make an explanation neceffary here; but we have observed among our Copper precipitate, where it has been effected by a very ftrong folution with the cleaneft Iron, feveral pieces of malleable Copper, fome of them retaining the form of the Iron, like incrustations fallen off from it. Hence it feems as if there was a degree of attraction between the Iron and the particles of Copper, floating in the water; as well as the more obvious attraction between the acid and the Iron. Muft not the particles of Copper thus attracted, cohere by their own magnetifm, or the attraction of cohefion ?

It may not be improper to add how far this quality has already tended or may tend to the advantage of the publick. Perhaps the hiftory of its rife and progrefs in this country, and in Ireland, may ferve to illustrate that matter. About fixty years ago, this phenomenon was first observed by Mr. Coster in Chacewater Mine near this town; for after he had drawn out the water, which had been in the Mine for feveral years, he found the poll of a pick-axe wholly encrufted with a cafe of malleable Copper between two and three pounds weight. This it was juffly fuppoled was observed by the workmen, fome of whom afterwards fettled at Cranbaun Mine in the county of Wicklow in Ireland. The water of Cranbaun having this vitriolick acid in a very high degree, Capt. Thomas Butler, who was one of Redruth, and manager of that Mine, perfuaded the proprietors to adopt the fcheme of precipitating Copper, of which

which they have made for many years paft and now continue to make very confiderable profit. They dig pits at proper diftances in the Adit, (or fo near as to admit the water) in which pit they place wooden rails, fomewhat like a bottle rack, fo as to fufpend the Iron thereon. They put in many tons at a time; and, in about fix weeks, the Iron is totally diffolved. The precipitated Copper is then taken out, fit for fale; the greateft part in the form of our Goffan pounded, with feveral grains of pure Copper interfperfed.

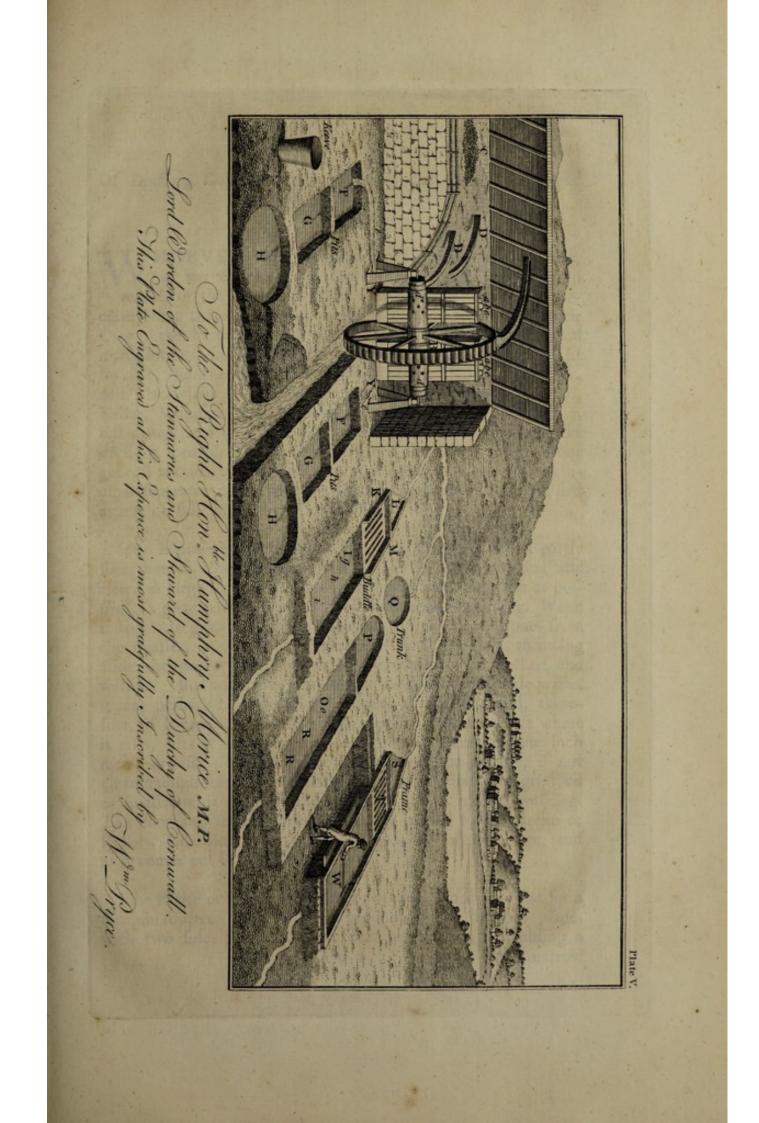
An attempt of this kind was fome years paft made in Huel-Crafty, but without fuccefs; for the water being in one part of the Mine only, and in no greater quantity than would run through a quill, was too much diluted by other water mixing with it in the hutch where the Iron was placed; befides, the Iron itfelf was very rufty which will always obftruct the fuccefs, unlefs the water is in the higheft degree impregnated with the acid. A fmall and ready experiment proves this; for take a bright piece of Iron, fuch as a key, or polifhed knife, and immerfe it in the water for half a minute, and it will be ftained of a Copper colour. Many Mines in this county have fome rills of this water, fo as to do confiderable mifchief, without having as yet (perhaps for want of proper attention) applied it to this ufe.

But though we may date the firft hints relating to this matter in England and Ireland from the foregoing difcovery in Chacewater, it is no new thing in other countries. Brown mentions it in his travels into Hungary, as a profitable appendage to the Mining of that country. Dr. Rutty, in his Natural Hiftory of Dublin, fays, "Our water at Cranbaun in the county of "Wicklow, may well vie with those of Herengrund and Ciment " in Hungary. Of ours I received the following account in the " year 1765 from a perfon conversant in thefe matters."

" It is faid to tranfmute Iron into Copper; but the fact is, that it precipitates its contained Copper upon Iron bars immerfed. It continues in its full ftrength; and, in feven years laft paft, yielded to its proprietors a fum no lefs than feventeen thousand two hundred and fifty-nine pounds eighteen fhillings and ninepence halfpenny, and all this without any expence of fuel and men. The precipitate thus formed being fluxed, yields above half of pure Copper: for an ounce gave twelve pennyweights and eighteen grains in one experiment, and thirteen pennyweights twelve grains in another."

CHAP.

which





CHAP. II.

Of Dreffing Copper and Lead Ores, and Sampling Copper Ores for Sale.

WHOEVER confiders the diffimilarity of Copper Lodes, in my chapter "on the different kinds of Lodes in "refpect of the earth and ftones they contain," will foon perceive, that there can be no uniform method for dreffing their Ores: the hard and poor Ores require much bruifing, and many lotions, before they can be feparated clean, and made fit for fale, fuch as the hard Peach, Quartz, Killas, Mundick, and Black-Jack; but the more tender Peach, Pryan, Cryftal, Killas, Mundick, and Flookan Lodes, admit of lefs handling, lefs water, and of courfe are attended with lefs expence in the dreffing, provided they are well given for Ore; for it is one general maxim, that a judicious application of water, the principal feparator of them from their fordes, conflitutes the firft article of fkill in dreffing Copper Ores.

The manner of dreffing and cleanfing Copper Ore, is partly like that of Tin; but as good Copper is commonly dug and raifed in large maffes, as little mixed with any thing elfe as poffible, a great part of it is folid Ore that needs no washing. When it comes to grafs they make a fortment of the larger ftones from the fmaller, and fpal or break them to a lefs fize, throwing afide the poorer part, which is afterwards to be ftrêked and washed. But when Ore rifes plentifully, and with little waste, it may perhaps be a lofs and detriment to wash it; and, therefore, if it comes moderately dry, a perfon near the Shaft where it rifes, fifts it in a Griddle, or iron wire fieve, of one inch meafh or lefs. The part that runs through the griddle, if not clean enough for fale, is washed; and it is feldom that griddled or fmall Ore is fo pure and clean as not to require washing. The poor and fmaller Ore is generally carried to the ftrêke or ftrakes, fometimes after being griddled, but oftner before, and as it comes out of the Mine.

The ftrêke or ftrakes is made of two deal boards laid flat for a bottom fourteen inches in the ground, on an inclined plane, with two fides formed of one deal board each, refembling a O o o narrow

234 OF DRESSING COPPER AND LEAD ORES,

narrow shallow cheft without a cover. In this runs a pretty quick ftream of water. One perfon throws the foul Ore into the ftrêke, while another moves and toffes it with a fhovel in the ftream, by which means the flimy earthy parts are carried by the water into a flime pit just below; and the ftony coarfe poorer part fettles in great measure on the tail or lower end of the boards, which at times is divided, and caft afide to be ftamped, as it contains fome Ore. The better Ore by its gravity, and a peculiar motion of the fhovel in ftirring it, refts at the head of the ftrêke. But if there be much pure Mundick in it, this alfo fettles mostly near to the head of the ftream, because it is more ponderous than most forts of Copper Ore; and it is feparated and laid by itfelf. Moreover, the largeft ftones, either of Ore or wafte, rife uppermoft by the motion of the shovel; these the dreffer throws on one fide of the streke, where women and children fit to pick out the good flones of Ore, and are from thence called Pickers. The remainder is laid by to be Bucked, or broke fmaller with flat iron hammers made for that purpofe, if the Ore be worth this trouble; otherwife it is carried to be ftamped.

The picked Ore, which is rich and folid, is put to a number of girls called Cobbers, who break it on large ftones with flat polled hammers to the fize of a chefnut and lefs, and it is then called Cobbed Ore, being the fame as Knocking or Bing Ore in the Lead Mines. This requires no water, nor further dreffing, being fit to mix for fale. The ftony Ore that is left by the pickers, which is called by fome Dredge Ore, from its being poor and fprinkled as it were in the ftone, and alfo the little refufe which is feparated by the cobbers, are carried to the bucking-mill, which is fomething like a wooden coal fcuttle placed on a low hedge with a hard ftone at its lower narrow end, whereon a ftrong wench with her flat hammer or bucking iron breaks thofe ftones, to the fize of fmall beans or peafe.

From thence it is carried to the kieve or vat, where it is further cleanfed by an operation called Jigging; which is by far the best method, not only for those Ores which have undergone a previous lavation, but also for all tender rich Ores, as they are immediately dug out of the Mine.

Preparatory to jigging, they fill the kieve half full of water, on the furface of which the jigger holds a coarfe wire fieve of two holes to the inch, while another perfon throws the unclean Ore

AND SAMPLING COPPER ORES FOR SALE. 235

Ore into the fieve, which the jigger dips into the water and fhakes twice or thrice until the fmaller part falls through to the bottom of the kieve. What remains in the fieve, he referves by itfelf, till there is a quantity. This coarfer fize made by the fieve, is jigged pure and clean, if it be well given for Ore; or elfe it is picked, and the refufe bucked over again, purfuant to its richnefs or poverty, and the dreffers direction and judgment. When the kieve is almost full, they pour off the water, and take out the fmall Ore, which perhaps they fort again after the fame manner in fieves with leffer holes. Being thus divided, they drefs each fort apart, in kieves half full of water with proper fieves, whofe holes are fmall enough to keep the Ore from running through.

The jigging fieve made of brafs wire four or five holes to each fquare inch, and fometimes for fmall Ores feven or eight holes, is held by the jigger in the kieve, while a girl throws two or three shovels full of the Ore into it. The jigger dips and fhakes it a few times in the water, by a peculiar indefcriptive motion and turning of the hand, which makes the light wafte, fuch as Quartz and Killas-gravel, &c. rife uppermoft in the fieve, the Ore lying under it, and the Mundick (if in any quantity) under the Ore, each according to its specifick gravity. Now to feparate thefe, the jigger takes a fmall femi-circular piece of wood called a Limp, being the fhape and fize of half the head of a quarter hundred powder barrel, with which he fcums or rakes off the light refufe or gravelly part, and throws it by, perhaps to be jigged over again. In like manner he fcums off the good Ore, and lays it afide for fale. Laftly he referves the remaining Mundick, until it comes to fome quantity, in order to jigg it over again; becaufe the first operation may not be fufficient entirely to take out all the Ore, either from that or the light wafte that lay uppermoft.

This refuse part of the Ore is commonly to light, being as I have juft faid, a Quartz and Killas-gravel, that it may fometimes be very properly put to the ftrêke, and washed in a pretty quick ftream of water, which will carry the waste to the tail or hinder part of the ftrêke, fo as to be divided from the good Ore, which lies at the head. But the flimy fine Ore, which falls through the fine fieves to the bottom of the kieve, is often cleanfed by the tye, which is the fame as the ftrêke, but with an exceeding flow and fmall ftream of water, or, which is much like

236 OF DRESSING COPPER AND LEAD ORES,

like it, by buddling or framing, the fame as Tin Ore; alfo by jigging it in a very fine clofe fieve like a dilluer.

All this is varied and modified according to the difcernment of the dreffer : and though Ore cannot be perfectly dreffed by water fo as to be entirely clean, yet all Ore, except Tin-ftuff, is beft cleanfed by jigging, though it is the floweft way, and of confequence the moft coftly ; alfo the flimy earthy part is apt to lie among the laft or fmalleft Ore, more than in the other methods of dreffing, and thereby depreciate its value : therefore I fuppofe the fine flimy part of it may be packed in kieves like black Tin ; but the dreffer's guide in this cafe, fhould be the tendernefs and value of the Ore. Here is not, however, that wafte of Ore, that is made by the ftrakes, which is the reafon why the method of jigging ought to have the preference.

As the foregoing is the moft general rule for dreffing of Copper Ore that I can form, it would render my differtation upon the fubject too prolix, minutely to defcribe the various methods of cleanfing different forts of Ore : I shall, therefore, content myself with just hinting the several diffinct operations each fort separately requires, and leave the regulation of them to those who are employed in the business.

Common yellow Ore fhould be feparated at the Shaft fide, the rough from the fmall, either by griddle or ftrêke. The folid Ore fhould be further difunited from the ftony part, by fpaling with fledges, or cobbing with hammers to a proper fize.

Dredge Ore, which may be left from the above, or which may rife fo poor and diffeminate in the ftone from the Mine, as to deferve that name, in the firft place, fhould be fpaled, cobbed, and then bucked to a proper fize to run through a fieve two holes to the inch, preparatory to its being jigged in a four or five hole fieve. The remainder fhould be wafhed, and then put on a table of loofe deal boards, that the pickers may chufe the good from the bad, that the good may be handled as the firft. The fmall, which runs through the four or five hole jigger, fhould be tyed in a fine fmall ftream of water; and thus by repetition be made fit for fale.

If Copper and Tin Ore are mixed together, which is often the cafe, the latter being moftly the heavieft body, may be wholly faved in the fore part of the tye, by repeated effays. But

AND SAMPLING COPPER ORES FOR SALE. 237

But if each Ore is of equal gravity, (and I apprehend fome poor Tin Ore, which they call dry for Metal, may be lefs ponderous than Copper Ore) if the tye will not feparate them, they fhould be first cleanfed from every other impurity, and then moderately calcined in a burning-houfe. The Copper Ore being thus rendered light, will eafily feparate from the Tin, and both will be made faleable by buddle, kieve, dilluer, &c. I am not certain whether all this may be too expensive or not, especially when I recollect that fome buyers of Copper Ore may prefer it with fome Tin for fmelting to pot and bell-metal.

Copper Ore that is charged with Mundick, may be difunited at the ftrêke or by jigging, provided the Mundick is hard and folid ; but if it is fmall and fine like fand, it must be separated by the tye, buddle, kieve, &c.

If the infection is Black-Jack, care must be taken in cobbing and picking to divide them, as they are nearly of one weight. Some have advifed calcination; but they are alike ponderous after calcination; and, therefore, water will equally float them away. Mock-Lead is not the worft brood in Copper Ore, especially for the use of the brass founders, it being a Zinc Ore.

Gray Ores are generally the heavieft of all, and are commonly infected with Iron. They must be dreffed like the common Ores, by forting and fizing them, &c.

In the dreffing of light pryany black Copper Ore, very little water is neceffary; for the fmall fhould be fifted, and put to pile from the Shaft fide; and the remainder muft be cobbed, bucked, and jigged : but if it is committed to a fmall ftream of water, the major and beft part of it will be carried away and loft by its fuperior levity and finenefs.

The prime Ore being feparated and dreffed by itfelf, the refule goes by the names of Halvans and Hennaways; and is generally dreffed over again and again by ftrêke, ftamps, &c. The halvans of halvans are mostly dreffed by an undertaker for fo much in the pound fterling of the money they produce, according to the richness or poverty of the Ore, and the price # ton it will bring when ultimately dreffed. No exact effimation can be made of the value of a pile of Ore halvans : the method of calculating, is by gueffing how many tons of Ore it will make for every hundred facks of the pile. As for those halvans, whofe

238 OF DRESSING COPPER AND LEAD ORES,

whofe contents are lefs than half a ton # hundred facks, it is fcarce worth the trouble of returning and dreffing it, except the Ore is rich in quality, and will bring a good price: much alfo depends in this cafe upon conveniencies, care, and expence more or lefs in carriage and water to drefs it.

Halvans ftamped fmall, and then washed in a ftrêke with an eafy ftream of water, is termed Stampt Ore. But a finer fort is still to be had from the flime pit, which proceeds from the minute particles that glide away with the mud and water; this fort will not bear a brifk ftream, therefore it ftill retains much dirt and mud, whence it is called Slime Ore. The rough part of ftampt Ore fhould be tyed in a ftream of water, and the hinder part of the tye jigged through a fix or feven hole fieve. If it is much adulterated with Tin, Lead, or Mundick, it must be cleanfed by frequently tying or buddling of it. In order to clear the earthy fordes from the flime or loobs, it may be trunked, and after purified by the buddle, kieve, dilluer, &c. the fame as flime Tin, if it is worth the expence. It must also be noted, that Copper Ore requires a coarfer plate or grate in ftamping, than Tin does, because it is of a lighter nature and more fleaky.

I have heard of a poor fandy Copper Ore fomewhere in Wales, of the appearance of verdigreafe, which is fo light, that the cupreous part of it will not bear even the leaft ftream of water : they drefs it by grinding, dry ftamping, or bucking ; then put it into tubs or kieves, and tofs and pack it the fame as I have obferved of Tin : now the real Ore in it being without any fulphur, or much Metal, is fpecifically lighter than the wafte or fand ; therefore the Ore fwims uppermoft, and is fkimmed off in the manner of Tin fkimpings. But I fuppofe thofe extreme light Ores are fo very poor, that none would be concerned with them, only in hopes of their improvement.

It is worth notice, that Copper Ore may be too curioufly or too remiffly dreffed, fo that either way the adventurers may incur a lofs; the ground of which is fometimes not fo well confidered as it deferves. If too much time and coft are expended in dreffing the Ore, every one will grant it infers a lofs; but on the other hand, if too much foul Ore is left in it, that will alfo be to the prejudice of the concerned. Every ton of wafte Ore cofts as much to be finelted as a ton of clean; at leaft, the buyer fubftracts as much for a ton of the one, as the other. Suppofe

AND SAMPLING COPPER ORES FOR SALE. 239

Suppose the buyer allows three pounds sterling for his charges of fmelting and working a ton of Ore, and confequently the fame fum for each ton of waste in the Ore, which in reality the fmelting costs the buyer or refiner; and therefore he must deduct fo much from the produce of the Ore \oplus ton. This is the case in Cornwall; but in other places, more distant from the furnaces, in Ireland for instance, the deduction must amount to more money, in proportion to the duty there on Ore, and also an overplus of freight, and if there be any other furplusage of cost, more than in Cornwall, as a longer carriage by land, and the like, all will operate to less than common, as a very short freight, or little charge in land carriage, then instead of a deduction, there is room to make a further advance of the price.

To illustrate this cafe, suppose one hundred tons of Copper Ore, to be worth ten pounds & ton, the amount of which will be one thousand pounds; suppose also it has so much earth or wafte in it, that it may be reduced to fifty tons, with a moderate charge in dreffing, and with an inconfiderable lofs of the Ore; then each ton will contain nearly the Copper which two tons did before : and whereas the buyer would have taken out fix pounds for the charges of carriage, freight, and fmelting of two tons, he will now deduct but three pounds for those charges upon the fame Ore in one ton : fo that inftead of deducting three hundred pounds on the one hundred tons of Ore, he will now deduct but one hundred and fifty pounds on fifty tons, whereby the adventurers will fave fo much of the other one hundred and fifty pounds, by how much the parcel of Ore will coft lefs for dreffing and taking out the wafte; for the fifty tons of Ore will now be worth twenty-three pounds & ton, which will amount to eleven hundred and fifty pounds inftead of one thousand. Yet if the Ore be light or rich, there may be more of it loft, than the ufelefs wafte carried off may compenfate.

Again, if one hundred tons of wafte were mixed with the one hundred tons of Ore worth ten pounds # ton, then the buyer would make an additional abatement of three hundred pounds more for his charges upon the one hundred tons of wafte; fo that the whole amount of the Ore, would be but feven hundred pounds, inftead of one thousand pounds; for the Ore would be only worth three pounds ten so fullings # ton; according to which, it is plain, that Ore may be too curiously or too careless drefted. For Ore rich in nature, may be brought to a great

240 OF DRESSING COPPER AND LEAD ORES,

a great rate, and produce a large profit to the adventurers; otherwife it may be fold to a great difadvantage, and without any gain, for want of being well handled : there are, however, feveral poor Ores, fo dry and barren by nature, that they are not capable of being fo well conditioned, as to bring a good price.

The conclusion I would draw from hence, is, that if a ton of wafte can be taken out of the Ore, for lefs than the charge of fmelting a ton (which I call three pounds here) and without any confiderable lofs of Ore, the adventurers fave money by dreffing it thus: but if the charges of taking out a ton of wafte arife to more than three pounds, then they lofe as much as the excefs of coft amounts to, together with the Ore wafhed away; hence, mediocrity fhould always be obferved.

The dreffers of Copper Ore often work for monthly wages, but then they do not always make the difpatch they ought; therefore they more commonly agree with the adventurers at a certain or fixed price for every ton of dreffed Ore; but this makes it the dreffers intereft, to make the greateft number of tons that he can, fo that the adventurers may fuffer a lofs, for want of a true cleanfing the Ore. To prevent this inconvenience, the beft method is to fet the Ore to drefs in proportion to the price it brings Ψ ton; or in other words, to allow the dreffer fo much in the pound fterling, according to the price the Ore will bring; for this makes it his intereft, as well as the adventurers, to make the Ore as merchantable as he poffibly can : however, he fhould be ftinted from throwing away too much Ore in the halvans, or be obliged to ftamp the halvans, and return their contents in Ore.

There can be no flated rule given for fetting Ores to drefs at a price, becaufe the Ore is incompact, or lefs, as well as poorer in value, in fome Mines, more than in others; but where Ore rifes with little wafte, it may be dreffed at a much cheaper rate, efpecially if it be rich in quality. I have known Copper Ore in feveral Mines, where it might be fifted out at the Shaft fide, without any other trouble, to be dreffed for one penny in the pound fterling; on the other hand, five fhillings may not be a fufficient price for Ore that is hard and barren.

It may be worth enquiry, whether very fulphureous Ores which abound with Mundick, may not be advanced in value

by

AND SAMPLING COPPER ORES FOR SALE. 241

by a previous uftion. It is evident from the foregoing observations, that if Ores be made confiderably lighter by being burnt and deprived of their fulphureous heavy wafte, with a fmall charge and no lofs of Metal, that then it must be an advantage to the owners, by putting the charges of fmelting the evaporated Mundick into their own pockets. Supposing this should answer the end proposed, the most proper time of burning must be after the Ore is dreffed and fully cleanfed by water; for if it were done before, the Ore would acquire fo great a levity and tendernefs that it must unavoidably float away, in a great meafure, with the water, though but a very fmall ftream, and be inevitably loft and confumed : it would likewife be fo much fmoked and difcoloured, that it might deceive the dreffer in judging when it may be right clean. Neverthelefs, if a parcel of Ore be dreffed clean and then burned, a great part of the Mundick muft evaporate, and the Metal or Ore will remain in the pile; therefore, for every ton of Mundick, that would fublime from it, the parcel would be worth three pounds more on the entire quantity. For inftance; if one hundred tons of very pyritous Ore were decreafed to eighty by this method, the adventurers would fave fixty pounds, from the diminution of its weight or loss of Mundick; as well as gain, by its improved value, as much at leaft as would pay the charges of burning, which I prefume would be fmall, for the Ore may be burned in furnaces fimilar to those commonly used for the calcination of limeftone; or by kindling piles, confifting of ftrata of fuel and of Ore placed alternately upon one another, and by other pieces of useless timber, which should reach from top to bottom of the Thefe being burnt out, and the Ore fettling fleady, the piles. vacancies of the burnt timber would ferve as flues or chimneys to carry off the vapours, and keep the fire from being extinguifhed too foon, efpecially if the fmall Ore was thrown on after the other Ore was well kindled and throughly burning.

Otherwife, a fmall arch or channel of loofe bricks may be placed on the ground, where part of the round Ore may first be eafily kindled by a fire of charcoal or wood; and as the fire increases, the place may be fed and supplied with more Ore, till the whole pile be set on fire; for Ores that are very sulphureous, are so combustible, that they soon take fire, if well ordered, and will burn a long time, or till they are mostly deprived of their superfluous sulphur, when the fire extinguishes of itself, for want of a Pabulum or feeder. Fig. 11, plate VI, represents a quantity of Ore piled up to be burned: 1. two fides Q q q or

242 OF DRESSING COPPER AND LEAD ORES,

or faces of the pile: all the fides of it are covered with fmall Ore: 2. the upper part of the pile where holes are feen, which ferve as flues both to help burn and evaporate the Mundick and fulphur: 3. an opening to fet fire to the pile, and in which the fulphur may drop pure when melted: 4. a plank to keep off too much wind. Fig. 12, is a fection of the above pile: 1. the wood to make the fire: 2. fome charcoal for kindling the fire: 3. a channel formed by a wooden tube or pipe to begin a draught of air: 4. large lumps of Ore: 5. fmall Ore: 6,7. finer Ore, or duft of Ore.

When the Ore grows cold, it is fit for finelting, but muft by no means be any more cleanfed in a ftream of water. By this management it will run much freer in the great furnaces for fuch a gentle deprivation of its flubborn brood of fulphur and arfenick ; and I am pretty clear will also yield more Metal, than when it is melted crude in the furnaces, where the fulphur and arfenick being excited by a violent fire, may elevate or carry off fome part of the Metal in their passage. The worst inconvenience that feems to attend this matter, is, that it requires to be done near the Mine, to prevent the charge of removing the Ore; in which cafe, the fmoke being blown by the wind, would be offenfive to the workmen, without a due precaution to prevent it. To my aftonifhment, neither this method nor any thing fimilar to it, takes in Cornwall, though it has been used with fuccefs in Germany, it feems even before the Ore is wafhed clean; and therefore it may much more reafonably be thought to turn to account, after the Ore is cleanfed.

Indeed, the adventurers of Bullen-Garden Mine, fome few years paft, not only calcined their poor Copper Ore, but fmelted it likewife into a regulus, and that at an expence which was very easy to be borne for the improvement of the Ore in its value: but this attempt was of no long duration, the Copper Ore buyers very honeftly confirming the fufpicions of the adventurers, that they did not, neither would they offer at fo high a ftandard for Copper Regule as they would for Copper Ore, becaufe an encouragement of this kind, would neceffarily deprive the trade of fome part of the labour, which was very profitable to them. That argument, backed by a more powerful one, viz. not giving half value for Regule, obliged the adventurers to decline a very ufeful and profitable bufinefs and employ for this country. For my part, I think the gentlemen concerned, fhould have advanced their undertaking, in proportion to the backwardnefs

AND SAMPLING COPPER ORES FOR SALE. 243

backwardnefs of the Copper companies, by erecting more furnaces, and running the fame Regule into fine Copper; a circumftance of great notoriety, which might be followed by many good confequences for them and their neighbourhood.

Lead Ore, like that of Copper, as it comes out of the Mine, is very little of it merchantable, or fit for fale or fmelting; the foffils and foil mixed with it, must first be separated by breaking and washing, according to the nature, richness, or poverty of the Ore.

As for Lead Ore that does not rife very folid, it ought to be bucked and jigged, and very feldom carried to the ftreke, or ftamps, except it be very fcarce and thin in the ftone; but when it is fo poor as to make bucking and jigging improper and coftly, then it is fcarce worth the trouble of ftamping and dreffing : however, when it is fo treated, the grate of the ftamping-mill should be yet coarfer than for Copper Ore; becaufe Lead Ore breaks into Facets or flakes, and is thence liable to float away and be loft, even with a very easy ftream of water. The method of jigging has been used a long time in the Lead Mines in Cornwall, though but very lately in the Copper Mines, and they find it to turn to good account both in the one and the other. There can be no doubt, that the Cornish were almost entirely obliged to the Derbyshire and other Lead Miners, for the beft method of dreffing Copper Ores in the first place; which I fuggest from the antiquiry of Lead Mines in the northern counties, and the much later difcovery of Copper Ore in Cornwall : to which we must add, that the great fimilarity in the nature and gravity of Copper and Lead Ores, would naturally incline us to use one and the fame method for their purification. Neverthelefs, it must be allowed, that the great varieties of Copper Ores in Cornwall, fome of which require a very nice management in dreffing, have given her Miners a preeminent judgment in that matter, which is warranted by continual observation and experience. When the Ores of Copper or Lead are dreffed and ma

But when Lead Ore rifes rich, in large folid pieces, it is broke with a hammer into cubes, from half an inch to one inch of a fide; and this is called Bing in Derbyfhire, but in Cornwall it is ftiled Cobbed Ore. Such part of the Ore which is too impure for bing, is further beaten down with a broad headed hammer called a Bucker, according to its degree of mixture with foffils, &c. which this beating is intended to break off, and

244 OF DRESSING COPPER AND LEAD ORES,

and prepare for feparation in water. This, with what was neceffarily broken to an under-fize in making bing, they term Knock-bark, i. e. Bucked Ore; which being put into a wire fieve, and washed in a kieve or vat filled with water, the Ore preponderates in the fieve according to its fpecifick gravity. Thus the fmaller parts of the Ore go through the mefhes of the fieve into the vat, the larger parts reft on the bottom of the fieve, and the foffil part forms a ftratum above the Ore, which is taken off with a femi-circular flat board or hand shovel called a Limp, and is thrown away; and the Ore remaining in the fieve, thus feparated, is called Peafy. Those particles which paffed through the methes of the fieve, in feparating the peafy from the foffils, with all fuch fmall particles of Ore as have been pulverized in getting or dreffing, together with those in the wafte hillocks, (halvans and henaways) is again washed over in the fieve and vat, once, twice, or three times, in order to feparate and cleanfe the Ore, which they call Smitham. In this manner are formed the three affortments of Lead Ore, viz. Bing, Peafy, and Smitham. Now in Cornwall thefe three forts are generally mixed together for fale; before which, we call the Bing, Cobbed Ore; and the Peafy and Smitham, Jigged Ore, the Peafy being first Bucked. So much in general do the methods of dreffing Copper and Lead Ores agree, that in the foregoing account they differ in nothing but terms of art.

There is another method of dreffing very tender Copper and Lead Ores, fpeedier than bucking, viz. in dry ftamps, where the Ore has no water to carry it through a grate, but it is ftamped dry or a little moiftened. In dry ftamping, it falls out of the mill, partly in grofs lumps; and one attends who with a fhovel throws it on a proper fized hurdle, through which the fmaller pieces fall; and the larger that run down to the foot of the hurdle, being pounded fmall enough to pafs through the hurdle likewife, the whole is dreffed and cleanfed by jigging as before.

When the Ores of Copper or Lead are dreffed and made faleable in Cornwall (for Lead Ore is difpofed of in a different manner in Derbyshire, and the northern counties) the piles or heaps are either kept feparate for a market, if the quantities are large; or elfe the different forts are well mixed together in one pile, very rarely exceeding one hundred and eighty or two hundred tons in one parcel, and from thence, down to one hundred, eighty, fixty, fifty, forty, twenty, ten, five, or even one

AND SAMPLING COPPER ORES FOR SALE. 245

one ton, if the feller pleafes, which is feldom the cafe, and never for his advantage. If a Mine has four hundred tons of Copper Ore dreffed ready for fampling, the managers may divide one half of the quantity, for inftance, in two parcels of one hundred tons each, and the other two hundred tons thus; one parcel of eighty, another of fifty, another of forty-two, another of twenty-one, and the laft may be a fmall parcel of poor ftamped Ore computed feven tons, in all, four hundred. But the reader is not to underftand, that these different parcels were ever mixed with each other : they may belong to feparate takers upon tribute each parcel, they may lie at feveral diffances from each other, and be of very unequal value; for the first hundred tons may fell for four pounds & ton, the next for five pounds ten shillings, the eighty for fifteen pounds # ton, the fifty for eight pounds five fhillings, and fo on of all the reft. It is very common, however, for tributors to mix their Ores with the owners, or with each other of their fellow tributors, fo that the Ores of four or five different fets of people may be all mixed together to make one fample for conveniency of fale, purfuant to the directions of the managers or captains of the Mine, previous to which, their feparate parcels muft be nicely weighed and private famples taken : but I have illustrated this matter in book iii. chap. iv.

A dreffed parcel of Ore, before the day of fampling, is very well mixed by feveral men, who turn it over again and again, a perfon ftanding on the top of the pile or parcel, who fpreads every fhovelful circularly, and as equally as he poffibly can, fo that in fact, it is mixed with great exactnefs. This parcel, if lefs than ten tons, is divided into three Doles or piles; if above ten, into four Doles; and if ever fo many more than nineteen tons, it is divided into fix Doles; and then it is ultimately ready to be fampled.

Now when the famplers meet upon the fpot according to appointment, either of them, indifferently, fixes upon the one-fixth, one-fourth, or one-third Dole of a parcel according as it is great or fmall, to take their famples from. The Miners then cut or part that Dole athwart and acrofs down to the ground, fo that is divided nearly into quarters, by thefe tranfverfe channels which are cut through it. Then a fampler with a fhovel pares down a little of the Ore from all parts of the channels, to take as equal and regular a fample throughout the whole, as he can, to the amount of two or three hundred Rrr weight,

246 OF THE DRESSING OF GOLD, SILVER,

weight, which is carried to a clean floor or laid on boards, and there well and regularly mixed in a fmall heap by itfelf. Next, a fampler cuts this also into quarters, ordering any two of the opposite or adverse quarters, to be returned to the great Dole from whence they were brought. The remaining half he ftill mixes and quarters, until it is brought to a fmall compass or quantity, when it is fifted through a fmall coarfe wire fieve; and the larger flones which cannot pass through the fieve are broken with a fledge or flat polled hammer till all will pafs through the methes. After this, he mixes it very curioufly three or four times over; and fo quarters and remixes it as before, until it is reduced to a small quantity. Lastly, he puts about a pound or two of it in a fmall bag, which is a fample of the whole parcel. Each of his brother famplers fills his bag likewife, in order to affay or prove its value by fire, as shall be hereafter fhewn.

CHAP. III.

A Summary of the Dreffing of Gold, Silver, Quickfilver, and Semi-Metals.

THE inhabitants of Africa, and of Brazil, drefs their Gold-duft in fmall bowls, after the manner that Goldfmiths wafh their fweeps; and I fufpect, that the Spaniards in Mexico, and on the continent, drefs their Ore in the fame way: but the inhabitants of Brazil will fometimes find a kind of Goldduft, fo very weak and minute, that they cannot fave it well in bowls. This has obliged them to have recourfe to another method of making the moft of this very fmall Gold-duft, by laying an ox-hide on the ground, with the grain of the hair againft the water, which paffes gently over it. On this they ftir and mix the fand and Gold-duft; by which means, the fmall particles fink, and are intercepted in the hair of the hide; while the fand wafhes off. This method feems very rational and well contrived; and Sir John Pettus, in his Fleta Minor, fays, "The Gold-wafhers ufe ftrong black and ruffet woollen " cloth for the fame purpofe, in like manner."

From the feveral methods prefcribed for cleanfing Ores by water, it is eafy for one who has a tolerable notion of dreffing Tin

Tin and Copper Ore, thence to conceive, what may be the beft way of drefling Gold, or Silver Ore, conformable to the wafte or mixture which abounds in either. Yet there can be no certain rules prefcribed without feeing the matter to be dreffed, becaufe its plenty or fcarcity of Metal, the different fizes, the various quantities of its brood or wafte, may probably caufe great variety in the methods of dreffing it; but as rich Ores, on account of their great ponderofity, are eafier cleanfed than any others; fo alfo, in respect to their intrinsick value, they require a more curious and artificial management and operation. I have feen fome forts of pure Silver Ore, which contained near one half pure filver, the wafte being a light Quartz, fomewhat transparent : now to drefs a quantity of this, I should advise its being bucked fmall, and then I fhould prefer jigging before any other way of washing it. I should chuse this method of dreffing a quantity of Gold and Silver Ores, provided they were rich in quality, or contained much Gold and Silver in proportion to the wafte in them ; but if there were little Metal in the Ore, fo that it would not well answer the charge of jigging, in that cafe I should rather wash it in a streke, on which I would try an experiment of fixing an ox-hide as above, or rather of covering the ftreke with a flannel cloth, or the like, to intercept and retain the fine particles of Metal : but this is not to be underftood of fuch Gold or Silver as is intermixed with bafe Metals or Minerals; for then the methods of cleanfing Tin, Lead, and Copper Ore must be purfued, and afterwards the Gold or Silver may be extracted by fire, S. A.

As for the Ore of Quickfilver, it is generally ponderous, and therefore may be dreffed like other Ores. Iron Ore, I doubt, will fcarce defray the charge of cleanfing, and perhaps it needs washing but feldom, because it often rifes rich with very little mixture.

Thus, according to one or other of the foregoing methods for dreffing of Ores, may the Semi-metals of Bifmuth, Cobalt, and Antimony, be cleanfed by water, and by comminuting them more or lefs in proportion to their richnefs and ponderofity. As for those Minerals which are foluble in water, as Alum, Copperas, and all Mineral Salts, they must be extracted from their impure mixtures by means of water only, in which they must be further purified.

BOOK

BOOK V.

CHAP. I.

On the Art of Affaying Ores and Minerals; defcribing the Utenfils and Fluxes for Affaying.

T is not here proposed, to teach the art of affaying Ores, fo as to determine the quantities of Metal they contain with fuch accuracy, as is neceffary for those who buy Copper or Tin Ores, that being a peculiar trade : nothing but inftruction by a good affayer, and much practice in the bufinefs, can make a man a perfect adept in the art. What is intended here, is, only to give the principles of affaying, with fuch an idea of the practice as may help a perfon to attain that degree of proficience which will enable him to form a pretty good judgment of Mineral fubjects in regard to their contents. And if a man hath a genius for fuch fort of enquiries, with that degree of diligence and attention which ufually accompanies it, it is poffible that what is here faid, may open the way for a more fcientifick and extensive knowledge and practice of affaying, than is at prefent known or used in the county of Cornwall; for whole use this little effay is chiefly calculated and recommended.

To the forming a comprehenfive idea of Ores, &c. a man ought to know the natural hiftory of those things which enter into their composition, which are the Metals, as Gold, Silver, &c. and the Semi-metals, Bifmuth, Cobalt, Antimony, &c. Brimstone is also a very common and almost a constant concomitant of the Metals and Semi-metals in Ores, as well as stones or earths, which in Cornwall are almost always of the vitrifiable kind, that is, such as run into glass with fluxing materials; as the fixed falt of vegetables, pearl as and falt of tartar; nitre, divessed of its acid by means of any inflammable matter; borax, and the calxes of Lead; fluors, or the fusile stores; clays, and stones, of the vitrifiable or flinty kind. By reference to book i. chap. iii. of this work, the reader will there find the natural history of

OF ASSAYING ORES AND MINERALS, &c. 249

of Ores and Minerals, with that of the fluxes neceffary for their fusion and the feparation of the Metals and Semi-metals they contain. I fhall only beg leave, in this place, to add a method of making the white flux for refining of impure Metals; and another method for making the Fluxus Niger, or black reducing flux.

Black Flux or Reducing Flux. Take ten ounces of white tartar, three ounces and fix drams of nitre, and three ounces and one dram of borax. Powder and fift them through a hair fieve. When equally mixed, put this powder into a wide mouthed bottle, well corked for ufe. Though the colour of this is not black, yet it is a most excellent reducing flux.

The White or Refining Flux. Take two parts of nitre, white tartar one part. Powder them, and throw them by a large fpoonful at a time into a red hot crucible. As foon as a portion of the mixture is thrown in, there will be a violent deflagration : when that is over throw in another quantity, and fo proceed till the whole is deflagrated. The operator muft be careful to prevent fire or fparks falling among the powder, as it will take fire. The matter muft be taken out of the crucible, powdered, and put up as the former. It ought to be well corked, as it is apt to run foon from the moifture of the air. There is yet an eafier way of doing this, which is, to put the whole quantity of the powder into an iron mortar ; then to fet fire to it with a red hot poker, continually flirring it till the deflagration is over. When cold, powder and fift it, &c.

The common wind furnace used in Cornwall, is a very good one in general for the purpose of affaying Metals; and it might be made convenient for cuppelling, if it was contrived fo as to have a fmall reverberatory built on one fide, to take the flame just as it arifes from the furnace. I have given a fection of the furnace for melting, and the reverberatory for cuppelling, in plate VI, fig. 1, viz. A, the melting furnace for trying Copper and Tin Ores; B, the reverberatory; C, a hole in its fide for introducing the cuppels. The place or opening at C, muft have a door of brick clay exactly to fit it, with a fmall hole in the middle to infpect the flate of the affay, which hole must be ftopped with a bit of clay. D, the chimney into which the flame paffes from A over the cuppel in the reverberatory B. E, iron bars or grate of the furnace. F, the afhes pit, the whole length of the building from G to H. A furnace thus Sff constructed,

conftructed, is, I think, fufficient for most if not all asfays in Metal.

contain.

I fhall fpeak of fuel, and the conduct of the fire, when I come to the proceffes; and fhall likewife treat of the veffels ufed in affaying, and the materials of which they are made: mean while I fhall first give the artist a process for discovering the contents of a Mineral in the liquid way, or by a menstruum.

Procefs I. Calcine the powdered Mineral, or keep it red hot till it ceafes to yield any fulphureous flame; and if the white arfenical fumes are difcharged, it may be the better. The Ore must be stirred during the calcination, to prevent its running into clots, in which cafe, it must be powdered anew. Put this calcined Ore into a phial, and pour on it pure double aqua fortis, or spirit of nitre, fufficient just to cover it. Let the phial fland on warm fand, or in hot water, for two hours : if there fhould be a violent ebullition, and plenty of red fumes, remove and put the phial into cold water, in which it muft ftand till cold. Drop fome of this spirit of nitre into water, and if it lets fall a very white fettlement, the Mineral contains Bifmuth. Pour about as much water into the phial, as shall be equal to the quantity of aqua fortis or fpirit of nitre that was ufed. Set it on the hot fand or water for an hour; let the phial ftand till the folution is quite clear; then pour it off from the Ore, and drop a fmall quantity of ftrong brine into it; if a white matter precipitates, the Ore contains Silver, or Lead, or both : continue to add brine till no more precipitates. Pour the liquor from this precipitate, and wash it with clean water, letting the water fettle clear before it is decanted off; add fresh water, and repeat the washings till it is fweet. Melt the precipitate with treble its weight of black flux; and, if there is Lead in it, evaporate the Lead in a cuppel, when the Silver, if any, will be left behind. The Bilmuth that falls, will be carried off with the Lead; but in order to free the folution as much as poffible from Bifmuth, it may be proper to dilute it with more water before the brine is added ; and if there is any precipitate, to feparate it. Try the folution for Copper, by dropping a little of it on a bright piece of Iron ; if it leaves a ftrong full stain of Copper, this Metal may be separated from it by powdered chalk; for by gradually adding the powder, in fome time, on the ceafing of the violence of effervescence, the Copper will precipitate in a green powder, called Verditel. Continue to add the powdered chalk, till no more precipitate constructed. falls ;

falls; wash this as the former precipitate, melt it with black flux, and it will be revived into Copper. The folution should be kept in hot fand, or water, during the whole time of the precipitation.

In the above procefs, the fpirit of nitre being the proper folvent of Silver, Copper, Lead, and Bifmuth, if any of thefe matters are in the Ore they are diffolved; that is, after the fulphur is burnt off, which would otherwife guard them from being attacked by the fpirit. It is expedient, that there fhould be a larger quantity of fpirit than is juft neceffary to diffolve the Metals, otherwife they might precipitate one another; it is therefore right, to tafte the folution; and if it taftes very fharp and acrid, the quantity of fpirit hath been fufficient. To make this experiment as accurate as poffible, in regard to quantity, the calx ought to be finely levigated in a glafs mortar; and the affufion of fpirit of nitre, and the digeftion, &c. continued as often, and as long, as any thing metallick can be gotten from the calx.

Procefs II. To affay Pyrites, Marcafites, or Mundicks, for Gold or Silver.

Light a fire in the wind furnace, with common coal; and when it is got up to a good white heat, place a crucible in it, which fhould be firft dipped in water to prevent its cracking; furround it with coal almost to the brim, and as foon as it is of a good ftrong heat inclining to whitenels, put into it the Mundick defigned to be affayed, which ought to be previoufly weighed. Shut the opening of the furnace with the bricks ufed for that purpofe. Let it remain till it is perfectly fufed; then pour it into a cone, greafed, or rather fmoked by the flame of a candle; when it is cold, knock it out of the cone, and feparate the reguline or metallick part from the fcoria, if any on the furface of it. A cone is a hollow veffel made of caft Iron. See fig. 2, plate VI.

Procefs III. The method of fcorifying this Mundick, or converting all the parts which compose it (except the noble Metals) into Glafs.

Place a crucible of the largeft fize, on a piece of brick fuitable to it, in the middle of the wind furnace. Make a fire round it with charcoal till it is red hot, when common pit-coal may

may be used. Then put in the Regulus of the Pyrites or Mundick, with one half its weight of Lead revived from litharge, and as much Glafs of any kind, with as much litharge as Glafs, previoufly mixed together. Raife the fire till all is melted, and the fulphur and arfenick appear to rife through the Glafs a-top, and fly off in a flame. Continue the fire for fome hours, till this appearance ceafes, and the Glafs melts fmooth like oil, when it may be fuppofed the fulphur and arfenick are confumed and the fcorification pretty far advanced. In this part of the operation, it will be neceffary, from time to time, to make fresh additions of litharge to thin the Glass, which is apt to grow thick and tenacious by the Iron (which is continually fcorifying) mixing with it. When the litharge is thrown in, it ought to be mixed up with the Glafs a-top, by means of an Iron rod. The Glafs ought to be very thin before the whole is poured out; when this is the cafe, pour it out into the greafed or fmoked cone; and when cool, knock it out, and feparate the fcoria from the Lead at bottom. If the Lead is quite foft and malleable, and the fcoria very thin, fo that if a wire was dipped in them, they would have dropped off it like oil, leaving only a varnished like appearance on the wire; the operation is well done : but if the Metal is brittle and hard, the operation muft be continued till it is rendered quite foft and malleable. Sometimes it is neceffary to make an addition of fresh Glass, in order to a complete vitrification of the Iron, but then litharge must be added at the fame time.

When the Lead is reduced to perfect foftnefs, it is fit for cuppellation. To carry this procefs to perfection, it is neceffary to bring the fcoria to a complete vitrification, when they will be very thin and fhining. They are then to be powdered, and mixed with their weight of black flux, a little powdered charcoal, and one quarter their weight of fea falt decriptated : the whole is to be perfectly fufed, till it flows like oil, when it is to be poured into the cone; and, when cold, the Lead in the bottom, which is like to be in confiderable quantity, muft be alfo cuppellated, but feparately from the other, in order to determine if the firft affay was perfect or not.

The intention of the above procefs, is to feparate the fulphur and the arfenick from the Mundick; and to convert the Iron, which makes up a great part of this compound, into fcoria; and finally to vitrify it fo, that the Gold and Silver it may contain fhall be abforbed by and left in the Lead; which I think is perfectly

perfectly well done by this procefs. The fulphur and arfenick, are continually flying off through the Glafs, which is likely to detain any of the nobler Metals, which the arfenick might otherwife volatilize; at the fame time, the Iron which was mineralized by them, burns to fcoria, and rifing a-top of the metallick part mixes with the Glafs, and is vitrified with it; the Mundick at bottom grows more and more metallick, and, as I apprehend, the Lead, if not entirely, is at leaft greatly mineralized by the fulphur and arfenick. The Iron and Lead, in this Mineral ftate, are mixed; but the Iron parting from thefe matters eafier, as well as attracting them ftronger, than the Lead, difcharges them up through the Glafs, and is gradually turned into fcoria, till the whole of it is feparated from the Lead, leaving with it the nobler Metals it contained.

The only hazard of miffing in this procefs, is from the veffels being corroded by the Glafs of Lead, which is very penetrating, when brought to that thinnefs by the litharge which is neceffary; but this may be effectually prevented by the ufe of a porcelain or china-ware crucible, which as it is a new invention, and may be of great ufe to the curious in Metallurgy, without remarking on what others have done, I fhall here give it to the publick in few words.

Procefs IV. Whoever hath been converfant in Mineral chymiftry, must know, that vessels which will hold Glass of Lead, prove a great defideratum. Now the micofe clay, which is one part of china ware, is known to be abfolutely unvitriable; for though mixed with an equal part of vitriable ftone, it ftands the greateft heat that art knows, without being vitrified.* I believe all the grouan clays would answer to make the veffels in queftion; and, I know that the porcelain clay at St. Stephen's will. The composition I would recommend, is two parts of the washed clay, and one part of the gravel it contains, ground to a very fine powder, mixed and made into a paste. Let a potter form them into the fhape of coffee diffees of a moderate thicknefs, and of different fizes, according to the purpofes they are defigned for. They must be burned in a crucible, or with crucibles, or porcelain, if you are in the neighbourhood of a factory of either kind. The fire must be full as strong as is neceffary to burn china ware or crucibles; but if one hath not the advantage of a neighbouring pottery, the highest heat that

* See book i. chap. iii. upon Steatitæ, or Soap-rock.

Ttt

can be given in a fmart wind furnace, is fufficient. When burned, they are a true unglazed porcelain as it is poffible; the St. Stephen's clay without mixture, may make the ftrongeft veffels; it might be tried: but I know common porcelains anfwer extremely well.

As thefe veffels will by no means bear an open fire, they muft be guarded: the beft way of doing which, is to place them in crucibles made round, and about two-thirds of an inch, or an inch wider. Lay in the bottom of the large crucible the thicknefs of half an inch of flint fand; if this cannot be had, Quartz, or (as it is improperly called in Cornwall) Spar, may be powdered and fifted through a hair fieve: fill up the vacancy between the two crucibles with the fand or powder, and let the outfide crucible have a cover made to it exactly like that of a teapot, and the apparatus is finished. See plate VI, fig. 3. This apparatus muft be fixed on a conical bafe made of two parts pipe clay, and one part fand; the fhape of it is to be feen plate VI, fig. 4, a little excavated at top, to let in the crucible that it may ftand fteady.

I have thought proper to give this process on Pyrites, as there has been much contention about the matter; people will now have it in their power to know whether or not they are of any value.

Any Ore that is fuppofed to contain Silver, or Gold, mixed with a proper quantity of litharge, with revived Lead at bottom, and a mixture of Glass, if the Ore has no vitrifiable ftone in it, may be tried the fame way. The want of vitrifiable ftone or earth, may be known by the fcoria, which will be tough and metallick, not glassy.

Litharge is eafily revived, by mixing it with a proper quantity of black flux, and a little charcoal duft, and melting the whole in a ftrong fire, till the furface melts fmooth and equal, without bubbling.

Procefs V. Cuppellation; and the feparation of Silver and Gold by Aqua Fortis.

The veffels used in this process, are called Cuppels, and are formed ordinarily of bones burned white and powdered, or of the ashes of vegetables from which the falts have been thoroughly feparated

feparated by water. But for the formation of cuppels, I refer to Cramer's Art of Affaying, or Maquer's Chymiftry, where the manner of doing it is very rightly directed. Some of thefe cuppels are made in moulds, and others in Iron rings. The former are inverted frustums of a cone, much about the fize of fig. 5, plate VI, which is a fection of a cuppel. The others are formed in Iron rings, larger or lefs at pleafure. The method of forming them, is to fill the ring with the bone or other affres, or a mixture of both. The affres are brought much to the fame temper of moifture with water, as fand is for caffing Metals : the fand is then beat down as clofe as poffible, and a hollow place is formed in the cuppel, for holding the Metal. Thefe cuppels are made either round or oblong. The kind of fig. 6, plate VI, may be used, four or five inches wide; which will work off four or five pounds of lead.

As the cuppelling furnace will hold feveral tefts, when one wants to cuppel, it is right to put three or four dry cuppels into the reverberatory with their bottoms upward. Light a fire in the wind furnace, and raife it gradually till the cuppels are red hot; then fet one or more of them with their hollows upward, and with a fmall Iron ladle put the Lead to be tried into one of the cuppels : the Lead is usually beat flat, and cut into pieces, which will melt immediately and contract a fcum, and if the fire is fufficiently ftrong, in fome little time the fcum will feparate, and difcover the melted furface of the Metal, as bright as Quickfilver. If the process goes on well and right, there will be little particles or drops refembling oil, continually rifing on the furface of the Metal, which will be thrown off to the fides, and abforbed by the cuppel. The fire is to be conftantly and uniformly kept up, fo as to keep the affay in this way of working, till the Lead is all converted into litharge, and the Silver or Gold fets on the cuppel. Expertness in this process is only attained by practice. Cramer's defcription of it, is very exact; but as the furnace here directed, is different from his, it is neceffary to observe, that if the fire wants to be fuddenly quickened, fresh lumps of coal, or small pieces of dry wood, are to be thrown into the wind furnace, by just opening one of the bricks that cover it. When the affay is too hot, a covering brick or two may be taken off, or even the ftopper in the reverberatory left open, till the heat is funk to a proper temper. The marks of too great or too fmall a degree of heat, are accurately defcribed by Cramer.

Weigh

Weigh the grain left on the cuppel, and fee what proportion it bears to the Mundick affayed; from whence it is eafy to calculate the quantity of noble Metals, in any given quantity of the Mundick. Lead reduced from litharge is used in this operation, as it contains no Silver, at least fo inconfiderable a quantity, as is not worth attending to.

Procefs VI. To difcover, whether the product of the affay contains Gold, and the quantity it contains.

Pour on the grain, four or five times its weight of proof aqua fortis; place the phial on warm fand, and if the Silver entirely diffolves without any black fediment, it contains no Gold; but if there is any black fediment, this is Gold. Pour the folution of Silver from it, and pour water on it, fhaking the whole; let this water fettle, and then decant it off into the folution of Silver; repeat this till the water has no bitter tafte. Wafh out the black powder into a fmall tea difh; and when it is fettled, pour off the water from it, and dry this powder of Gold by placing the difh on hot fand. Weigh the powder, and make the calculation. If the Gold is in fo fmall a quantity, that you have no fcales or weights nice enough to weigh it, the Lead muft be enriched by the operation of fcorification, being repeated with the fame Lead, on three or four more parcels of frefh Mundick.

If the grain or bead of Metal contains much Gold, fay as much, or more, or even one-third of Gold, the aqua fortis will not diffolve it; in which cafe, three or four times its weight of Silver (which contains no Gold) may be melted with it, or fo much as will render it diffolvable in the aqua fortis. The Silver may be precipitated from the folution, by evaporating the water from it in a fuitable china-ware veffel fet in hot fand, till the quantity is properly reduced; that is, till the water ufed in washing the Gold is mostly evaporated from it; when by putting clean bits of Copper into it, the attraction between the aqua fortis and the Copper, being ftronger than with the Silver, this latter will be precipitated in the form of a white fhining powder, to be feparated from the bits of Copper. If clean bright pieces of Iron are put into the folution, the Copper will be precipitated; and alkali falt will precipitate the Iron. Wafh this precipitate till the water is no longer faline; evaporate the whole, and what is left will be a true good nitre, formed by the

256

the fpirit of nitre, and the pot-ash; the vegetable alkali being the basis of nitre.

Procefs VII. Proof Aqua Fortis.

Take any quantity of good aqua fortis, which will diffolve Silver; drop into it a few drops of a faturated folution of Silver: if there appears to be any precipitate or cloud of a white colour, as there will if the aqua fortis has fpirit of falt in it, which I believe is always the cafe; if this precipitate falls foon to the bottom, it is proof the aqua fortis contains much fpirit of falt, and one may be bolder in dropping in the folution of Silver; but if it is thin and light, it is neceffary to proceed with more caution. Let this milkinefs fettle; and to a fmall quantity of the aqua fortis in a phial, add a drop of the folution of Silver; and if there ftill appears a milkinefs, more of the folution may dropped in, always aiming to add no more of the Silver folution, than is neceffary to feparate the whole of the fpirit of falt from the aqua fortis, which may be known by adding a drop of the folution to a little of the aqua fortis in a phial; for if the aqua fortis is proof, it will continue quite clear without the least milkinefs.

There is an eafier way of preparing proof aqua fortis, which is by putting a bit of Silver into it, and fhaking it feveral times in a few hours; and if, the next morning, it is fettled quite clear, and any of the Silver is left, it is proof. The only queftion is, whether it doth not contain Silver; to determine this, drop a few drops of it into filtered brine, and if there arifes no cloudinefs in the mixture, the aqua fortis contains no Silver.

Spirit of falt will not diffolve Silver; but being diffolved in aqua fortis, there is a ftronger attraction between the fpirit of falt and the diffolved Silver, than between it and the aqua fortis, as it diflodges the fpiritus nitri, and unites with the Silver into a falt that is not diffolvable in water, and fo finks to the bottom in a white curd called Luna Cornea, which may be reduced into Silver with pot-afh, by being melted with it; and if the pot-afh is not in too great a quantity, it will be converted into a fea falt, with a vegetable alkali bafis; by which it appears, that the fea falt was decomposed, or feparated from its mineral alkaline bafis, in the operation of precipitating the Silver. What is called the Mineral Alkali, or Bafis of Sea Salt, is of the U u u

fame nature with the Barilla or Soda, used in the preparation of French and Spanish foaps.

I have been thus particular in defcribing the process of preparing proof aqua fortis, as it is a very necessary menstruum in metallurgical experiments.

As it is poffible the Mundick tried, may contain Copper in fo large a quantity as not to be entirely fcorified by the above operation, but may poffibly remain on the cuppel in a confiderable quantity; in this cafe, the bead muft be diffolved in proof aqua fortis containing no Silver, or that yields no cloud dropt into clean brine. If this bead contains Gold, it will remain undiffolved in a black powder as is faid above; wafh it, and add the water to the folution, into which, drop brine as long as any white precipitates : this is the Silver in the fhape of the Luna Cornea, and when wafhed and dried may be weighed. I think four parts of it contain three of Silver, or thereabout.

Procefs VIII. To affay Tin for Gold.

To eight ounces of melted Antimony, put two ounces of the Tin to be tried; keep them together in a moderate fire, till they melt together and flow like oil, without the leaft bubbling or effervescence, which operation may take an hour. If the mixture grows thick, fresh Antimony is to be added, till it melts perfectly thin or fluid; then pour it out into the Iron cone, and when cold feparate the bright antimonial regulus at bottom, from the fcoria at top : fet by these scoria. Heat a cuppel made of crucible clay, or the bottom of a crucible, reduced to the fhape of a cuppel (thefe veffels are called Teffs) in the reverberatory, till it is of a ftrong red heat inclining to white; place the regulus of Antimony in it, which will infantly melt. Direct the nofe of a kitchen bellows on this teft, and keep up a continual blaft on the regulus (which will evaporate in thick white fumes) till it is reduced to one quarter or lefs of its original weight. Take out the teft and let it cool; feparate the remaining regulus from it, and melt it in a crucible. Throw on it twice its quantity of nitre; and when the deflagration and fumentation are over, pour it out into the cone. If there is any Gold left, and this Gold is fine, the operation is complete; but if there is nothing left at the bottom of the yellow glaffy fcoria, the Tin contains no Gold. If there is a imall button of brittle Metal, or Metal not fufficiently malleable, add

add equal parts of nitre and borax, and repeat the operation, till the Gold is quite fine; when it is to be weighed, and the proportion it bears to the Tin affayed, determined.

In this operation, the fulphur which mineralizes the Antimony, having a greater attraction with the Tin, than with the regulus of Antimony, deferts the regulus, and lays hold of, and mineralizes the Tin, with which it afcends among the melted Antimony; whilft the regulus feparated from the Antimony, defcends, and mixes with the Tin at bottom. This process goes on till the whole of the Tin is mineralized by the fulphur, and fomewhat a greater quantity of the regulus feparated and precipitated ; if the Tin contains any Gold, it will be mixt with this regulus, as fulphur cannot mineralize it. If there is any Silver, this will be mineralized, and raifed among the fcoria, which confift of the Antimony in its Mineral state, and the Tin reduced to this state; the regulus containing the Gold, being volatile, is evaporated in white fumes, by the fecond operation, whilft the Gold is left : but as it is difficult to bring it to perfect finenels this way, nitre is used in the finishing operation, which immediately calcines the regulus. In this operation, the fpirit of nitre evaporates along with the phlogifton of the regulus, and the alkaline part of this, together with the reguline calx, melts into glaffy fcoria of an amber colour, leaving the Gold untouched by the nitre, which cannot diffolve it.

Procefs IX. To try the first fcoria for Silver.

Melt the first scoria, confisting of the mineralized Tin and Antimony, in a crucible; throw powder of nitre on them, and there will then be a confiderable deflagration; continue to throw in more nitre till the deflagration ceases, and when the matter in the crucible melts like oil, pour it into the cone, knocking it gently that it may fettle. When it is cold and ftruck out of the cone, carefully examine the apex of the melted scoria, where the Silver will be found if the Tin contained any.

In this procefs, the phlogiston of the fulphur is carried off by the spirit of nitre; and the other part of it, viz. the vitriolick acid, is attracted by, and united with, the alkaline basis of the nitre, forming with it a true sal polycreston, that swims at the top of the melted scoria, which by this process, are converted into

into a compound crocus metallorum, confifting of the calcined Antimony and Tin. The Silver not being calcinable, when the fulphur which mineralized it is feparated by the nitre, it regains its metallick form, and falls to the bottom of the cone.

The compound crocus metallorum, and the amber fcoria, may be reduced into a metallick form, by being mixed with a proper quantity of black flux, and melted in a crucible; but not without great lofs of the regule. This procefs for the feparating Gold from Tin by Antimony, may be applied to Copper, or any other Metal.

Procefs X. To affay Copper Ore.

Powder the Ore and fift it through a hair fieve; fhake and mix it together, that every part of the powder may be alike, in regard to its metallick contents: form this powder on a piece of paper into a bed of half an inch thick; then weigh off a troy ounce, or ounce and quarter of it, from different parts of the bed or heap: and in order to affay it, the Ore is first to be calcined, in the following manner:

The wind furnace having been before well heated, is to be filled with fea coal, reduced to the flate of charcoal, or as it is ufually called, coakt or charkt. A crucible of the largeft fize for affaying, is then placed in the furnace, fo that the top of it fhall be a little beneath the top of the furnace. It is very proper to place one layer, or a few pieces of raw coal, round the top of the crucible, to keep down the flame and heat, which would otherwife incommode the operator in the calcination. The Ore may now be put into the crucible, and fome of the covering bricks put on the mouth of the furnace to raife the fire; but this must be done gently. As foon as the Ore is observed to be of a dufky red, it is time to begin to ftir it, to prevent its melting and running into lumps, which muft by all means be prevented, both by ftirring, and a proper regulation of the fire. The Iron rod used in ftirring, should be about two feet and a half long, and as thick as the end of the little finger, the one extremity of it flattened and formed like the toes of a pair of tongs, fo as to fuit the bottom of the crucible. With this rod the Ore is to be ftirred brifkly from time to time, fo as to prevent its melting, or running into lumps; and if it fhould appear disposed to do this, it must be stirred very briskly, till the appearance ceafes, and the Ore is again reduced into a powdery form.

form. It will not be necefiary to ftir the Ore continually; but when you ceafe to ftir, the rod must not be taken out of the crucible but left in it, the upper end refting on the bricks of the chimney.

In the above process, the nitre and fartar are converted into

In the beginning of the calcination, a large quantity of fulphureous and arienical fumes will be difcharged from the Ore; and moft Ores, at this time, emit alfo more or lefs of a fulphureous flame. As the Ore parts with thefe volatile matters, it grows lefs fufible, fo that the fire may be fuffered to encreafe a little, in proportion as the Ore is lefs liable to melt. The operation muft be thus continued, till the Ore emits no longer any vifible fumes. When the crucible is taken out of the fire and fmelt at, if it yields no fmell of fulphur, even when it hath been exposed to a ftrong red heat, a little inclining to white, then it is fufficiently calcined. This process generally takes three quarters of an hour, and the fire muft be often renewed by adding fresh charks, and raw coal.

In this procefs, the Ore is freed from the fulphur and arfenick which mineralized it, and is now reduced to the Metals and ftony fubftances; but as the Metals cannot be collected by fufion into a body, as the ftony parts are infufible, this makes it neceffary to use fuch things as will turn these ftony matters into Glass, by the following process of Scorification.

enable a perion to fix the quantity of flux requilite

Procefs XI. Supposing the quantity of Copper Ore made ufe of, to be one ounce, mix with it one ounce and a quarter, good weight, of black flux, and half a thimble full of powdered culm; put thefe into the crucible the Ore was calcined in, and cover them with nearly half an ounce of fea falt. Fill the furnace with charks, and place the crucible in the furnace, furrounding it with charks to the brim. After you have covered it with a cover, made of the fame composition with the crucible, put on the covering bricks on the mouth of the furnace, when the fire will rife, and the matters in the crucible will be heard to melt and boil. When these appearances have ceased for some time, remove the bricks, and infpect the matters in the crucible; if the furface is agitated, and the boiling and fermentation continue, the fcorification is not complete. If the fire wants mending, mend it; place the crucible fecurely, close the furnace, and continue the fire, till the contents of the crucible flow like oil. Take it out of the furnace, and fuffer it to cool; when cold, break the crucible, and feparate the Metal at bottom, Xxx from

from the fcoria. If these appear to be quite glassy, lucid, and black, and if they contain no grains of Copper, the fcorification is well done.

In the above process, the nitre and tartar are converted into an alkaline falt, which being rendered still more vitrescent by the borax, convert the ftony matters contained in the calcined Ore, together with a part of the Iron in it, into a true glafs, to which the blacknefs is given by the Iron. As this glafs is very fufible and fluid, the grains of Copper now reduced to Metal, eafily find their way through it, and unite at the bottom into one piece of Metal. The falt is added as it contributes to vitrification, and prevents the matter from rifing in the pot, and leaving grains of Metal on its fides, which would falfify the affay. The powder of culm is put in, to fupply phlogifton, after what the tartar contained is burned off; and if the operation is continued after this, there is danger of the Coppers being burned, and deprived of its phlogiston; in which case, the affay will be covered with a red fhining heavy friable fubftance, which is the calcined Copper melted : to guard against this, the powdered culm is added. won as has it boxileronine doinw frony (abftances; but as the Metals cann

The quantity of flux may be varied, according to the richnefs of the Ore. Very rich ones will require much lefs than what is ordered; nothing, however, but practice and experience, can enable a perfon to fix the quantity of flux requifite. The furnace for fcorification ought to have a fmart draught; for if the operation takes up much time, the affay is apt to burn; about fifteen or twenty minutes is fufficient for the most part, if the furnace is a good one.

The lump of Metal from the first melting is fearcely ever fine, being mixed with Iron, Lead, Tin, or possibly with all these Metals; therefore to separate them, it must be refined, for which the following is the process:

Procefs XII. Refining the impure Copper.

Fill the furnace with charks, and place a crucible of the fecond fize in it. Let the fire rife till the bottom of the crucible is white hot, when the button of Copper is to be put into it, by means of a fmall pair of forceps or tongs purpofely contrived for it. As foon as the Copper is feen to melt, throw on it, by means of a fmall Copper fcoop, about as much white flux as will

trone.

will lie on a half crown; there then will be a great boiling and fermentation in the crucible: when this ceafes, pour it into the ingot first fmoked or greafed; and when the whole is fet, plunge it in water to cool it; feparate the fcoria, and fet them by in a ladle. If the button of Copper is not fine, this operation must be repeated until it is, which is known by the brightness of the colour, its malleability, and breaking with a fine grain. This operation is generally repeated three or four times, or more, before the Copper is quite fine.

As the white flux contains a large quantity of nitre, and the aqua fortis in it corrodes Iron and Tin more readily than it does Copper, those Metals are turned into calx by it, and separate in the form of scoria along with the flux : some of the Copper, however, is always corroded, and turned into scoria; therefore, to render the assay perfect, this must be recovered and brought to Copper. In order to this, the next operation or process is neceffary, which is

Process XIII. The reduction of the scoria; and also the refining the prill.

together in the erucible, covered with one quarter of an inch

Dry all the fcoria of the former process which were fet by in the ladle; beat them to a powder in the fmall Iron mortar, and mix with them about their own weight of tartar powdered, and a little powdered culm : cover them with a layer of falt, and melt them as in the process of fcorification. When the whole is melted perfectly, and flows like oil, pour it into the fmoked ingot. The reduced Copper, or as it is more usually called by the Cornish affayers, the Prill, will be found beneath the flagg. This, too, is always impure Metal, fome part of the other Metals being reduced along with the Copper; the prill muft therefore be carefully refined as above, with the white flux, adding fome falt immediately after the flux is thrown in. The refined prill is then to be added to the button of Copper, and both weighed, to determine the quantity of fine Copper, which the Ore contained; from whence a calculation may be made, of the contents and value of a ton of Copper Ore.

The refining the prill is a very nice operation, which the Cornish assures perform with fingular expertness. They judge the effect of their fluxes very nicely, and help them by keeping the assure for fome time before they pour it; for fire has the same effects with nitre in reducing the imperfect Metals

to a calx, only it does it flower: the Iron, Tin, and Lead, calcining quicker than Copper, the effect of fire in refining is very evident. Neverthelefs, the fuccefsful management of it, can only be attained by attention and experience.

In Copper affays, the cone is not ufed, but an ingot of a peculiar kind. Hollows of a fpheroidal form, are made in a piece of Iron or Steel about an inch thick. Thefe excavations are polifhed very fmooth, and the utenfil hath a handle formed out of it, fee fig. 7, plate VI. The hollows contain about half an ounce of water, and are nearly an inch and quarter diameter. Some fmoke thefe hollows with the flame of a candle, and others rub them with greafe, or a rag inclofing fome tallow, rofin, or wax.

Procefs XIV. To affay Copper Ore the regule way.

Pulverize, fift, and mix the Copper Ore, as in the tenth procefs; then take the the fame quantity of Ore, with an equal part of common powdered black glafs, about a fourth or a fifth part of nitre, and half as much borax : mix and put them all together in the crucible, covered with one quarter of an inch thick of common falt. Melt thefe in the ftrongeft fire you can raife in the wind furnace till they flow freely, which will take fome time longer than a fample of calcined Ore. When cool, break the crucible, feparate the regulus from the fcoria, pulverize it, and then proceed exactly in the fame manner as with a calcinable Ore, ut fupra.

ingot. The reduced Copper, or as it is more ufually called by

Now, in order to calculate the value of a ton of Copper Ore by the produce of an affayed troy ounce, you are to remember, that if one ounce of Ore makes one pennyweight of fine Copper, it will be one part in twenty, five pennyweights will be five parts in twenty, and fo on : therefore, a perfon who is familiar in the bufinefs, may know the value of a ton of Copper Ore off hand, by only afking, how many parts in twenty fuch a fample has produced. But this valuation of an affay depends entirely upon a given ftandard price for the ton of fine Copper, be it either ninety, ninety-fix, one hundred, or one hundred and five pounds sterling. Of course, every pound or twenty shillings that the ftandard rifes or falls, will make a difference in the affay of one shilling or a twentieth in every pennyweight, and a halfpenny in every grain : as for inftance, one pennyweight, one grain, at ninety-five the ftandard, will make the produce equal 03

equal to four pounds fifteen shillings the pennyweight, and three shillings and eleven pence halfpenny the grain; but if the standard is ninety-fix, the produce must be valued at four pounds fixteen fhillings the pennyweight, and four fhillings the grain. Three pennyweights and three grains at ninety-five the standard, will amount to fixteen pounds fixteen shillings and tenpence halfpenny, and at ninety-fix will rife to feventeen pounds.

This mode of calculation being apprehended by the reader, I will proceed to a few examples by the rule of practice, which will fet the matter in fo clear and eafy a light, that any perfon may calculate an affay of Copper Ore without the leaft difficulty.

Suppose one troy ounce of Copper Ore pro- Dwts. duces an affay of fine Copper that weighs at ninety pounds the ftandard value of one ton of fine Copper, I first multiply the three pennyweights by four pounds ten shillings the standard; for ten times three shillings are thirty shillings, and four times three pounds are twelve pounds, and with the twenty shillings from the place of fhillings make one pound more, equal to thirteen pounds ten fhillings : fo that three pennyweights of fine Copper at ninety, is worth thirteen pounds ten shillings the ton : but here are nineteen grains unaccounted for in that price; therefore, I fay, twelve grains are one half of

a pennyweight, equal to two pounds five shillings; fix grains, the half of that, are equal to one pound two fhillings and fixpence : and the one grain remaining, is equal to ninety halfpennies; for, as I have faid before, one grain is valued at fo many halfpennies, as the ftandard is pounds; therefore one grain is equal to three fhillings and ninepence. By adding the whole together ; I find the affay of three pennyweights nineteen grains, at ninety, is worth feventeen pounds one fhilling and threepence & ton of Copper Ore. Thefe are the grofs proceeds; but as there is an expence upon the bringing this ton of Ore into fine Copper, fuch as carriage of the Ore to the coal by land or fea, or both, furnaces, labour, coal to fmelt it, &c. it must be deducted before we can fix the nett value thereof. These returning charges are commonly rated at three pounds & ton one with another; fo that, of confequence,

Yyy

| 3 £4 | 10 | 19 |
|------------|--------------|----|
| | 10 5 2 | |
| 12 20 - 27 | 3 | 9 |
| £17 3 | I | 3 |
| £14 | ill I | 3 |

one

one hundred tons of Copper Ore will require three hundred pounds expence to bring them into fine Copper; and the above feventeen pounds one fhilling and threepence will be reduced to a nett value of fourteen pounds one fhilling and fixpence; it being cuftomary to reckon no pence below fix.

Neverthelefs, in fome Ores, thefe returning charges at three pounds are over much; for if it requires but that money to fmelt Ore of fifty fhillings nett value & ton, it certainly cannot take the fame to fmelt Ore of thirty or forty pounds; as many of our rich gray Ores (which are naturally regulized) and native Copper demand but two or three flowings to be thoroughly refined. All these things are properly judged and confidered by the purchafers, who may add or diminish their estimates of returning charges as they chufe, the feller being generally as ignorant of the whole as any perfon unconcerned in the affair. I shall subjoin two or three assays at different standards, which may be calculated by the foregoing rule; premifing, that if the reader would know the quantity of Copper Metal in one ton, or any given number of tons of Copper Ore, he must divide four hundred and eighty by the produce of the affay, and the remainder by twenty, and that will fhew what quantity of Ore will make a ton of fine Copper.

| An affay of fine Copper weigh | | . Gr. 19 | at 95 the ftandard. |
|--|---|-------------------|--|
| pounds five fhillings; fix I royone pound two rhillings ain rem ining, is count to we thid hefore, one grain is as the thendard is pounds; | | 15 7 3 3 | 6 9 11 ¹ / ₂ |
| Deduct for returning charges | | TO | 2½ fuch as fmelting, &c. |
| an expense upon the bring- r, dech as carriage of the Ore | - | 17 200 7 | the first froceous than |

An

Dwts. Gr. An affay of fine Copper weighs 4 13 at 96 the ftandard. f_{4} 16 f_{16} 2 1 4 2 8 4 f_{21} 16 Deduct for returning charges f_{3}

Nett value £18 16 \$ ton.

Dwts. Gr.

£5

from running into lungov, which it is very a

LII 9 2 Deduct 3

Nett value £8 9 6 \vot ton.

An affay of fine Copper weighs 2 7 at 100 the flandard.

£10

Procefs XV. To affay Lead.

If this Ore is pure, that is, free from Mundick or the like, the procefs is very eafy. With an ounce of the powdered Ore mix about eight or nine pennyweights of frefh Iron filings. Melt the whole together in a pretty ftrong fire till it flows perfectly thin; then pour it into a greafed cone or ingot; and, when cold, feparate it from the fcoria at top. If the feparation fhould be difficult, put the whole into an Iron ladle, and when the ladle is red hot, the Lead will melt, and run from the fcoria, and will pour out perfectly fine Metal.

As through the violence of the heat in the first melting, the Lead will take into it fome of the Iron used in fluxing it; it is therefore

therefore neceffary to remelt it in an Iron ladle, when the Iron will immediately rife at top, in form of fcoria, when the Lead may be eafily poured off, and the fcoria will be left in the ladle. A little tallow may be added before the Lead is poured off, which will reduce fome of the Lead that was burned, and increafe the produce.

In this operation, the Iron having a ftronger attraction to fulphur than Lead, frees the Lead from it, which by this means is reduced to its metallick form. The Iron is alfo mineralized by the Lead, which is evident, by its melting the Mundick fhine, which those fcoria exhibit when broke; but especially by falling abroad when exposed to the air, and being convertible into copperas, just in the fame manner as the fulphurcous Marcafites are.

If Lead Ores have arfenical pyrites mixed with them, the affay is more difficult; for in this cafe, they muft be calcined like Copper Ores, and all the arfenick muft be evaporated. By adding powdered charcoal in proportion to one quarter the weight of the Ore, it will expedite the calcination, and prevent it from running into lumps, which it is very apt to do.

When it is calcined, it must be mixed with its own weight, or more, of black flux, and about a quarter or fifth part of Iron filings; put on them a layer of falt, and melt down, till it flows thin; then pour it out, and treat the Lead as was done in the former process, to free it from the Iron.

The use of the calcination in this last process, is to discharge the arfenick, which renders the Iron easily fusible; and if the Ore was not calcined, would fall down, in a reguline form, together with the Lead, and render it impure. Besides, it would cause an imperfect separation of the scoria, and keep up a great deal of the Lead amongst them; for, as this arfenical regulus would incorporate with the Lead, the mixture would be much lighter than Lead. The Iron filings are added, to absorb the vitriolick acid that may be left in the Ore after calcination.

Lead is affayed for Silver or Gold on the cuppel, as directed before; and all the Silver it contains above twelve troy ounces in the ton, is profit.

Procefs XVI. To affay Tin Ore, called Black-Tin.

The method of affaying Tin Ore is very eafy; for in its form and fize of Black-Tin (which is the Ore dreffed by flamping, feveral wafhings, and calcination, if mineralized with vitriolick, arfenical, or fulphureous pyrites) great part of the work is done to the affayer's hand; fo that little more remains, than to proceed to immediate fufion, which is prefently accomplifhed by a red heat, in the following procefs.

Take four or five ounces of Black-Tin as emptied from the facks; mix it well with about one-fifth part of its weight of powdered culm; put the mixture in a Black-Lead crucible on the wind furnace, and in twenty minutes (more or lefs, according to the ftrength of the fire, and the greater or lefs fufibility of the Ore) you will find the Metal precipitated as far as may be to the bottom of the crucible, the culm and fcoria floating on the Tin, not in a vitrified, but loofe unconnected flate. You will generally fee globules of Tin lying on the furface of this matter; you should therefore with an Iron rod ftir the mixture, by which means most of those globules will fall through it into the Tin at the bottom. Close the furnace, and let the whole remain in fufion from three to five minutes. Keep by you an Iron or Brafs mortar, and an ingot mould of about fix inches in length, fig. R, plate VI. Pour the Tin into the ingot, and empty the culm and fcoria into the mortar, fcraping off what remains in and about the crucible (which should always be of the Black-Lead kind) with a sharp iron. As foon as cold, put them into another mortar and pulverize them, first in a small degree, so as to separate the scoria from the largeft of the globules of Tin, fome of which will always remain therein after pouring out the ingot as before directed. Select the larger globules, and pulverize the remainder a fecond time; then put this stuff fo twice powdered on a shovel, and paffing it often through water, in the fame manner as the lighter parts are washed from Ore in vanning, you will have the smaller globules remaining on the fhovel; and thefe with the larger (both together generally called Pillion-Tin) being added to, and weighed with the ingot, fhew the produce in Metal of the four or five ounces affayed.

Procefs XVII. To affay Cobalt.

ZZZ

Take

Take a bit of the Mineral fuppofed to be Cobalt, with its weight of borax; put both into a broken china cup, and blow on them with a blow-pipe till they are perfectly melted and vitrified. If the china-ware is tinged blue in the fpot where the Ore was placed, it contains Cobalt. But as fome Ores contain Cobalt and Mundick together, in which cafe the Iron would render the Glafs black, the beft way is regularly to affay the Ore which is fuppofed to contain Cobalt, as follows:

Calcine an ounce of the Ore in the fame manner as Copper Ore is directed to be calcined, only the calcination need not be carried fo far; for as foon as the fulphureous flame evidently difappears, it is fufficiently calcined. Melt the calx with black flux, as directed in the fcorification of Copper Ore. Pour it out in the ingot, and melt a little of the regule with five or fix times its weight of flint glafs, and a little borax, for half an hour in a fmall crucible. If the glass is of a fine blue colour, the regulus is pure; but if the glafs is black, it contains Iron, and must be refined with the white flux, in the fame way as is directed in refining the Copper affay. As long as the fcoria are black or brown, the regule contains Iron; but as foon as the fcoria, and fides of the crucible, are tinged blue, it is fine : and if this does not happen, when the whole of the regule is confumed, the Mineral contained no Cobalt. The goodnefs and value of the Mineral is effimated by the quantity of pure regulus it contained. If there is any Silver or Bifmuth mixed with the Cobalt, they will neither of them mix with the cobaltine regulus; but, on breaking the pot, will be found quite diffinct from it : and it is the fame if the matter is poured into an ingot.

This regulus is not to be made malleable, but from this procefs is evidently that which ftrikes the colour : for a further proof, take two ounces of fmalt or powder blue, mix it with its weight of argol or tartar, and it will deposit in fusion the regulus that gave the colour. May it not be fairly concluded from hence, that all the Semi-metals which ftrike any colour, will deposit a regulus which is the efficient caufe of it ? But the knowledge of this valuable branch of Mineralogy is yet in its infancy with us.

Procefs XVIII. To affay Bifmuth.

Bifmuth

Bifmuth is eafily feparable from its Ore, and may be procured pure by melting the Ore in a crucible in a moderate fire, without any flux; but if it is very impure, an addition of the black flux will foon fufe it : however, the fire must not be too fierce, for if it be, the Bifmuth will be lost.

To difcover Silver in Goffans or very poor Ores.

Any Goffans or very poor Ores which are fuppofed to contain Silver, being calcined and mixed with three times their weight of litharge, may be affayed as directed in the process for affaying Mundick; only there will be no need of Glass, as the Ores are fupposed to be story. Care must be taken, that the scoria are thin at the last, either by the continuance of the fire (by which litharge will be formed from the Lead at bottom) or by the addition of litharge, as directed in the aforesaid process. The china-ware crucible is also best here.

channel is to which that fluid is confined, and confequently that the velocity of a fluid will be increased by maxing it run from a wider through a narrower passage. There principles

Of Smelting of Copper Ores in the great Furnaces called Copper Works.

TO form a just and general idea of the construction of furnaces, and of the disposition of the several apertures in them, with a view to increase or diminish the activity of the fire, it will be proper to lay down, as our ground-work, certain principles of natural philosophy founded on experience.

First, Every one knows that combustible matters will not burn or confume unless they have a free communication with the air, infomuch that if they be deprived thereof, even when burning most rapidly, they will be extinguished at once; that, confequently, combustion is greatly promoted by the frequent accession of fresh air; and that a stream of air, directed so as to pass with impetuosity through burning fuel, excites the fire to the greatest possible activity.

Secondly, It is certain that the air which touches or comes near ignited bodies, is heated, rarefied, and rendered lighter than

272 OF SMELTING OF COPPER ORES

than the air about it, that is further diftant from the center of the heat, and confequently that this air fo heated and become lighter, is neceffarily determined thereby to afcend in order to make room for that which is lefs heated and not fo light, which by its weight and elafticity tends to occupy the place quitted by the other : another confequence hereof is, that if fire be kindled in a place enclofed every where but above and below, a current of air will be formed in that place, running in a direction from the bottom to the top ; fo that if any light bodies be applied to the opening below, they will be carried up towards the fire ; but, on the contrary, if they be held at the opening above, they will be impelled by a force which will drive them up, and carry them away from the fire.

Laftly, It is a demonstrated truth in hydraulicks, that the velocity of a given quantity of any fluid determined to flow in any direction whatever, is fo much the greater the narrower the channel is to which that fluid is confined, and confequently that the velocity of a fluid will be increased by making it run from a wider through a narrower passage. These principles being established, it is easy to apply them to the construction of furnaces.

The materials fitteft for building furnaces are, bricks joined together with potter's clay mixed with fand, and moiftened with water; potter's clay mixed with potfherds, moiftened with water, and baked in a violent fire : alfo Stourbridge clay, and many of our talcy clays to be had in great plenty in the Cornish foft grouan ftrata, mixed and baked in the same manner.

The only kind of furnace for fmelting Ores where bellows are not employed, is what is called a Reverberatory Furnace. The Germans call it a Wind Furnace. It is alfo diffinguished by the name of English Furnace, because the invention of it is attributed to an English physician. The Copper furnaces bear four names, viz. the Calciner, which is the largest; the Operation, Roafter, and Refiner, which are all of one gauge or nearly so both in state.

The hearth or bed of the calciner fhould be eighteen feet long and thirteen feet wide within, by two feet ten inches at a medium from its concave back to the bottom, which muft be flat. The fire place three feet four inches long, by two feet wide and two feet deep, fo as to have two feet of flame to pafs over

IN THE GREAT FURNACES. 273

over the Ore in calcination. The length and breadth of the mafonry of this furnace should be in proportion from out to out as they express it, viz. twenty-four feet long, by eighteen wide.

Fig. 14, plate VI, reprefents a longitudinal fection of a reverberatory furnace used in the fmelting of Copper Ores : 1. the mafonry; 2. the afh-hole; 3. a channel for the evaporation of the moifture; 4. the grate; 5. the fire place; 6. the inner part of the furnace; 7. a bason formed of fand; 8. the cavity where the melted Metal is; (that is, in the refinery, becaufe the Metal there is not tapped but laded out by an Iron ladle, therefore the bottom is concave, but those of the operation and roafter are flat) 9. a hole through which the fcoria are to be raked or removed; 10. the paffage for the flame and fmoke, or the lower part of the chimney which is to be carried up to a height of about thirty feet; 11. a hole in the roof, arch, or crown of the furnace, where the Ore is put in-This furnace is eighteen feet long, comprehending all the mafonry; twelve feet broad, and nine and a half feet high-The hearth or bottom is raifed three feet above the level of the foundery : on one fide is the fire place, under which is an afh-hole hollowed in the earth; on the other fide is a bafon made, which is kept covered with fire when there is occasion : on the anterior fide of this furnace there is a chimney, which receives the flame after it has paffed over the Ore that is laid upon the hearth. This hearth, which is in the interior part of the furnace, is made of a clay capable of fuftaining the fire. This furnace has a hole in its front through which the fcoria are drawn out; and a bafon, as we have faid, on one fide, made with fand, in which are oblong traces for the reception of the regulus, matt, or black Copper, when the furnace is tapped.

The infide of this furnace is commonly an elliptick curve; becaufe it is demonstrated by mathematicians, that furfaces having that curvature reflect the rays of the fun, or of fire, in fuch a manner, that, meeting in a point or line, they produce there a violent heat. The most advantageous fize of the melting area of this furnace is feven feet ten inches long, four feet eight inches broad, and two feet high at a medium. The fire place two feet eight inches long, by two feet wide, fo as to form one foot nine inches fire : the refining furnace has alfo two fide doors, one for raking or fkimming, the other for lading.

iron wheel barrows are conv

274 OF SMELTING OF COPPER ORES

Fig. 15, plate VI. reprefents the upper plan of the furnace of which fig. 14 is a fection: 1. the outer wall; 2. the draughthole communicating with the afh-hole; 3. the door through which foffil coal is thrown into the fire place; 4. the place where an opening is made to let the melted Metal flow out of the furnace; 5. an opening through which the fcoria are raked and drawn off; 6. the bafon made of fand where the Metal lies; 7. the fire place with an Iron grate; 8. a fmall partition one brick thick between the fire place and the area of the furnace, over which the flame paffes—This is called the Bridge.

Copper is generally mineralized, not only by fulphur and arfenick, but alfo by Semi-metals and pyritous matters, and is frequently mixed with other Metals. As this Metal has great affinity with fulphur and arfenick, it is almost impossible to difengage it from them entirely by roafting : hence in the fmelting in great, nothing is obtained by the first operation but an impure Copper, which contains all the principles of the Ore, excepting the earthy and story parts, particularly when the Ore is fmelted crude and unroafted. However, the Copper Ore when brought to the works in fome few places is refined by repeated fmeltings and roaftings without calcination : but as I propose to deferibe all the process for its ultimate refinery, I shall begin with that of calcination, which in most places is nearly thus.

A certain quantity of the Ores, called a charge, from ten, to thirty, or forty hundred weight, is put into the calciner, where it is frequently flirred in fuch a heat as will not melt it, during a tide or twelve hours, more or lefs as the nature or mixture of the Ores require : two, three, four, or five hundred weight of this Ore is then put with five, four, three, or two hundred weight of raw Ore into an operation furnace. The fire is made very intenfe, and the whole becoming fluid and thin at the end of four hours the flag is fkimmed or drawn off through the hole of the furnace no. 5, fig. 15, plate VI, by an Iron rake called a Rabble. Another like quantity of Ore is put in, and the fame manœuvres being thrice repeated, the greater part of the remainder, being thus fkimmed, in a flate of fluidity, and under a great heat, is at the end of twelve hours let out by a tap-hole in the fide of the furnace no. 4, fig. 15, plate VI, into a bed of fand where it forms itfelf into pegs or pigs, and is now a regulus. These pegs are taken before they are cold, and on Iron wheel barrows are conveyed and plunged into a trough or ciftern

ciftern of cold water. From thence the regulus is carried to a horfe mill, and there reduced almost to a powder. In fome places this is done by women, girls, and boys, for the fake of employing them, which they term bucking the regulus, and is performed the fame as bucking defcribed in our chapter upon dreffing Copper Ores. In this condition it is carried to a furnace, called a Metal Calciner, where a quantity from fifteen to forty hundred weight (according to the capacity of the furnace) is fpread over the bottom, and, by fuch a fire as will not juft melt it, again calcined for about two tides or twenty-four hours. From thence it is drawn out, cooled by water, and carried to the Metal furnace, where it is fused, skimmed, and tapped out at the end of twelve hours in pegs, much in the manner of the operation furnace before defcribed. The roafting furnace next takes this Metal (as the workmen call it, though it is very far from being in a flate of malleability) whole in the pegs, where they are roafted fixteen or eighteen hours, and when the fire is rifen, they are melted, skimmed, and tapped as before. This operation of roafting and flowing, &c. is repeated three or four times; fome Copper Metal evidently appearing in it, it is carried to the coarfe refining furnace, from whence when melted, fkimmed, and ready for its exit, it is not tapped, but taken out in Iron ladles and thrown into oblong Iron pots or moulds by a ladle full at a time, each mould containing about one hundred and a half. A quantity of this fine Copper from fixteen to twenty-five hundred weight according to the capacity of the furnace and usage of the works, is put into the refiner, or refining furnace, where being again melted by an intenfe heat, fkimmed, and otherwife rendered proper for the purpofe, it is again laded out in fuch shapes and quantities, as the master or director of the works requires, and may beft fuit the rolling mill, the battery mill, or the other demands of the manufacturers.

I shall make no mention of extracting the small quantities of Copper and heterogeneous Metals which remain in the flags or fcoria skimmed off in the several operations, which after extraction is often mixed with some others to make those inferior Metals called Pot-metal, Manillions, &c. nor of the several kinds of fluxes which are few and differently used by different operators, neither can it be of service to any but an adept in the business. My intention is only to give a general idea of the processes in smelting as far as they have fallen under my observation, and not meddle with the private manufactory or aconomical

276 OF SMELTING OF COPPER ORES

mical applications of those objects of trade and commerce. The reader may observe how much more tedious, difficult, and expensive the refinery of Copper is, compared to that of Tin, and therefore may be less furprised at the difference which fometimes happens to be between the buying price of Ores, and the felling price of Copper. That we may illustrate the labour, expence, and complicated calcinations, roastings, fmeltings, and meltings, for the refinery of Copper, which do not amount to less than twelve or fourteen operations, we fubjoin an estimate of the confumption of coal in working one hundred tons of Copper Ore.

| | Weys | Ch. | Bufh. |
|--|-----------|-----|--|
| To calcining fifty tons of Ore, one chaldron of coal to four tons — — — — | 6 | 0 | 18 |
| To reduce ditto with fifty tons of raw Ore to a regulus, each two tons of Ore requiring one chaldron of coal — — — — | 25 | 0 | from they a |
| To calcining forty-two tons of ditto, each ton holding thirty parts of Copper in one hun- dred of regulus, one chaldron of coal to two tons of Ore | 10 | | tunce to the medy I on J |
| | 10 | | lalbal |
| To melting thirty-eight tons of ditto, the other four being evaporated in the calci- | | | and a twent |
| nation | 9 | | 0 |
| To bring forward in the roafters fifteen tons, thirteen hundred of Metal from the regule, holding eighty parts of fine Copper in one hundred, divided into ten loads, each re- quiring three roaftings to bring it to coarfe Copper, each roafting confuming eighteen | | | fkinn agun dirot fallu fallu |
| bufhels of coal | 7 | I | 0 |
| To refining the fame, being twice laded - | 6 | I | ò |
| To reduce the flags of the whole fuppofing them thirty tons | 7 | III | in the second |
| ade the sale fragment is spin of allow frighting | the state | I | 78 |

Thus

IN THE GREAT FURNACES. 277

Thus we fee that the Copper of pyritous Ores cannot be obtained without feveral operations, which vary according to the nature of the Ores. These operations are chiefly by roaftings and fusions; and by the interference of calcinations in some portion of the same Ores likewise. By the first fusion a matt or regulus is produced, which is afterwards to be roafted; and thus the fusions and roaftings are to be alternately applied, till by the last fusion Copper is obtained.

These methods of treating pyritous Ores depend on the two following facts: 1. Sulphur is more disposed to unite with Iron than with Copper. 2. The Iron of these Ores is destructible by the burning fulphur during the roasting or fusion of the Ores, while the Copper is not injured. This fact appears from the daily practice of fmelting cupreous Ores highly impregnated with Mundick that is either fulphureous or arfenical.

From these facts we learn, that fulphur may be employed to feparate and deftroy Iron mixed with Copper; and that on the other hand, Iron, or Gal, or Goffany Ores, may be used to feparate the fulphur from Copper; fo that by adjusting the proportion of fulphureous-mundicky, arfenical-mundicky, and Goffany Copper Ores, to each other in the fmelting, those fubstances may be made to destroy each other, and procure a feparation of the Copper, in which the greatest art and mystery of the fmelting business confists. (Scheffer, Schlutter, Margraaf, Macquer.)

The first Cornish Copper Ores (in order I suppose to avoid having the process of fmelting divulged) were carried to Briftol. A palpable miftake was committed in this cafe, as it was neceffary to fuftain a double expence of carriage. This was, however, foon rectified; and most of the different companies crected their Copper works in fome fpot of Wales, convenient for the carriage of the coals from a neighbouring colliery; and likewife with the advantages of a little harbour. It is a circumftance of fome importance, while we confider this affair, to obferve. that, as the numerous fire engines employ a large fleet of colliers to fupply their demands, fo the back carriage of the Ore is by no means fo confiderable as it would otherwife be. But let us turn our eyes to the flourishing flate of Swanfey, Neath, and those other parts of Wales, which have been fo very fortunate as to become the factories of the different Copper companies; and let us confider those populous towns as owing Bbbb their

278 OF SMELTING OF COPPER ORES

their existence and wealth to our indolence and inattention. The evil hitherto has feemed irremediable to the fpiritlefs inhabitants of our county, from the vaft opulence of the different companies, whole intereft it must be to support the prefent fyftem, the channel of their wealth. They know, that it would require a greater purfe than any one or two private gentlemen are able to furnish. It was however attempted, about feventy years fince, by Mr. Scobell, at Polruddan in St. Auftle, with whom Sir Talbot Clark and Mr. Vincent joined, where the first piece of Copper ever made fo in this county, was fmelted, refined, and brought to perfection. After this John Pollard, Efq; of Redruth, and Mr. Thomas Worth, of St. Ives, made a fecond trial; but both thefe attempts failed of fuccefs, more through ill management, roguery of the workmen, and the improper fituation of their works, than any extraordinary charge of the fuel. After thefe, one Gideon Cofier, of Piran Zabuloe, erected an house for the like purpose at Pen-pol in the parish of Phillack, but being foon taken off by a Fever, when he had made a fair progrefs in it, the fame was carried on by Sir William Pendarves and Robert Corker, Efq; who have both affured the writer (Thomas Tonkin, Efq;) that they could fmelt their Ore as cheap (all hazards confidered) as the companies could pretend to do at their works in Wales. They did fo accordingly for fome years; but being fince dead, and their affairs falling into fuch hands as had other interests to mind, this project too funk with them. A fmall beginning was also made to the fame purpofe at Lenobrey in St. Agnes, where they fmelted fome Copper with good fuccefs; but were obliged to give it over for want of a fufficient flock to go on with it.

From all thefe infant effays and fome obfervations made and gathered from workmen abroad, but chiefly from the late Mr. Cofter, largely concerned in the White Rock Works at Swanfey, who owned to Mr. T. that moft of our Ores might be fmelted nearly as cheap here as abroad; I am convinced (if we allow for the great falaries the faid companies are obliged to give to their agents here and elfewhere; the hazard of Ore on fhipboard in time of war, and double freight to pafs and repafs our own inhofpitable coaft, with the rifk of being caft on their native fhore) nay, I believe it would amount to a demonstration, that it might be done much cheaper and more advantageoufly in fome convenient places in this county than in Wales. Notwithftanding this, it has been the refinement of Cornifh policy to fuffer the

IN THE GREAT FURNACES. 279

the exportation of their raw staple, in order to give other countries the benefit of its manufacture !

To remedy this intolerable grievance, a propofal was made to fome of the principal gentlemen of the county, to join in a petition to her Majefty Queen ANNE (and had not her fudden death prevented it, it might have been effected) that her Majefty would be pleafed to lay it before her parliament, to have our Copper Mines fubject to the ftannary laws in all things (except being under bounds) and have the Copper coined at the neighbouring coinage towns, as the Tin is, under a duty of one fhilling & hundred of fine Copper to be paid to the Duke of Cornwall; which, as it would be an addition to the ducal revenue, and managed without any furcharge by the fame coinage officers, fo would it effectually fecure the fmelting and refining all the Copper Ores within the county, by degrees let us into the true value of our commodity, and the management of it, as eafy as that of Tin; and furthermore confine the labour and profits in the manufactory thereof among ourfelves. This fmall memorial of the above defign, Mr. T. fays, he has left behind him to be digefted in better order by wifer heads, whenever they fee convenient feafon to put it in execution. (Anonym. Addrefs, Tonkins MSS.)

Thus far had been attempted the fmelting of Copper Ore in Cornwall, which it must be owned had been frustrated through the confederacy of opposite interefted companies, and the want of fufficient infight into the art of fufion more than from the attributed extraordinary expence of fuel; till about the year 1754, when one Sampfon Swaine, in conjunction with fome gentlemen of Camborne, crected furnaces at Entral in that parish; but their fituation being too remote from coal, they removed their works to Hayle. The author very well remembers the combinations which were formed to overthrow this laudable effort. The companies left no method unfought to traduce the credit, and flab the vitals of this undertaking. Threats and remonstrances were equally used to oblige or cajole the owners of the Mines to abandon or fupprefs the new company at Hayle. The opponents of this affociation using every expedient to mortify the fpirit of this arduous undertaking, alternately raifed the price of Copper Ores, and lowered the value of fine Copper, to the great lofs of the contending parties; which will ever be the cafe where monopolies are diffurbed, and the almighty power of opulence can prevail. But happening to have

280 OF SMELTING OF COPPER ORES.

have men of fortune and capacity at their head, they were founded in prudence, and withftood the fhocks of power and artifice.

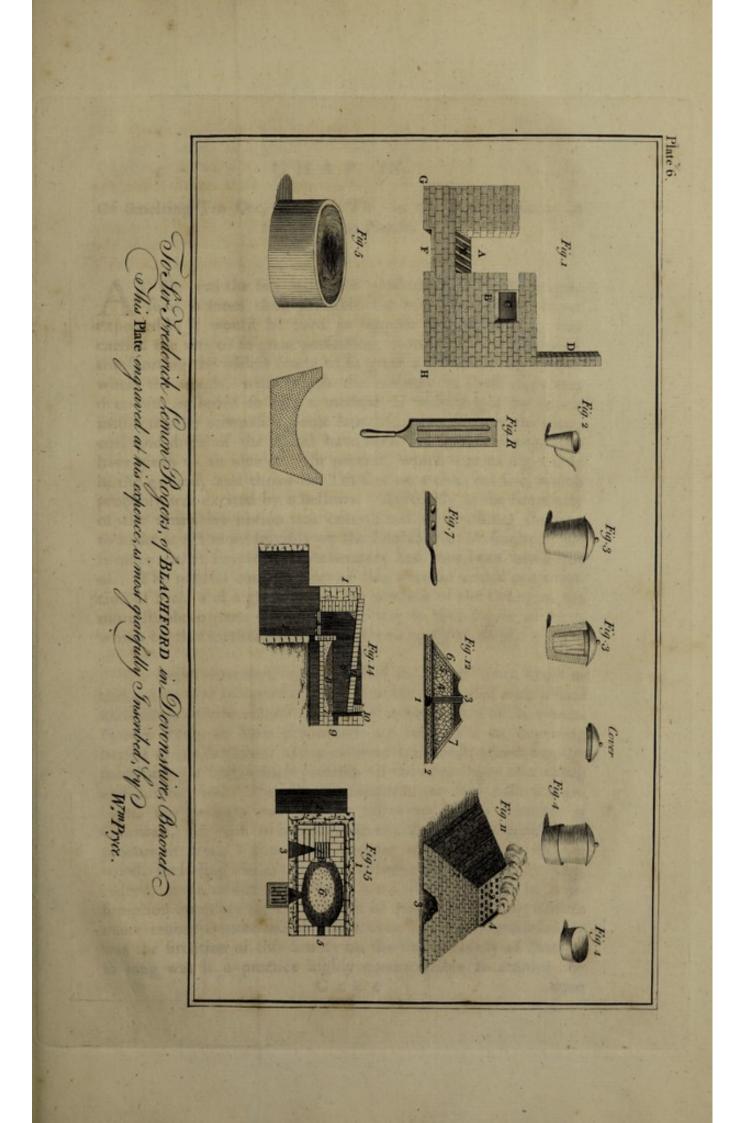
That it will answer to fmelt Copper Ores on this fide the channel, is undeniably demonstrable by the thriving fituation of this Cornish Copper Company, who would not fo vastly increase the number of their furnaces without having experienced the benefit of their undertaking.

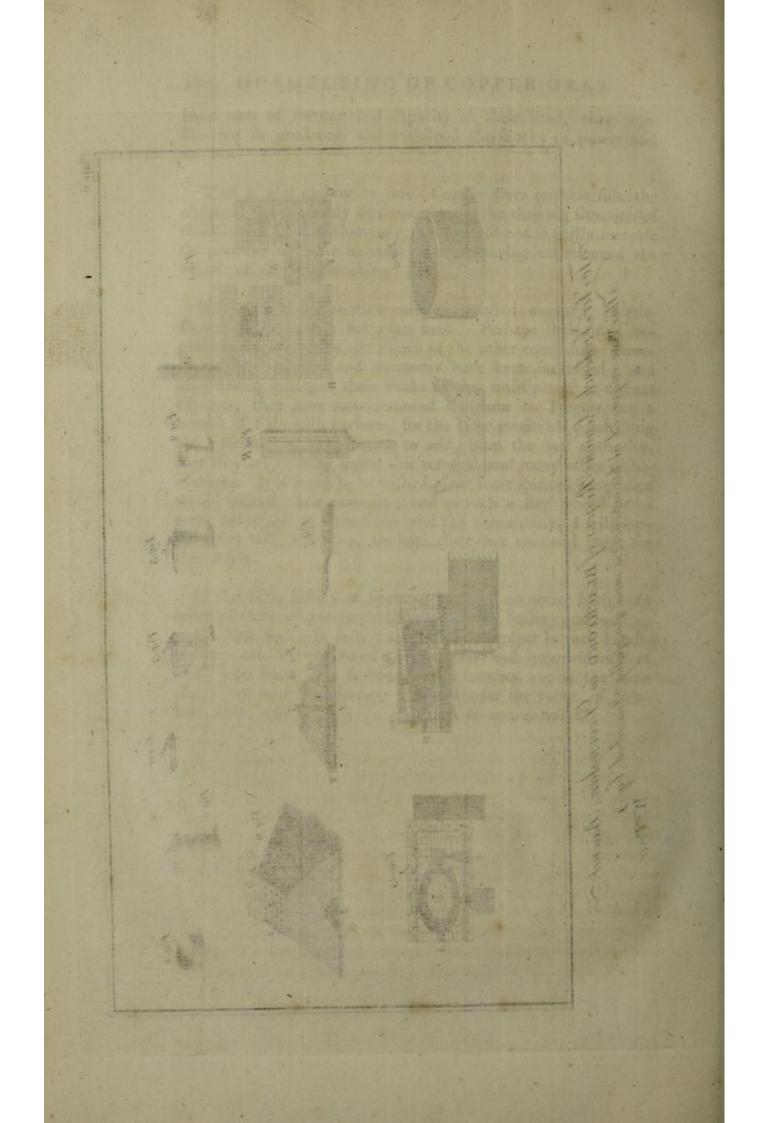
Similar to that, another company crefted works at North-Downs in Redruth a few years back. Perhaps their fmall beginning did not excite the notice of the other companies : however, their induftry and œconomy have been fuccefsful; and after having enlarged their works in that unfit place, at a great expence, they have now removed the fame to Tregew, on a branch of Falmouth harbour, for the more profitable conducting the concern. I have further to add, from the beft authority, that they are thriving under this removal and many other difadvantages. It is much to be wifhed, that fome fpirited gentlemen would imitate their example; and as fuch a ftep would be of great advantage to themfelves and the community, I will fuppofe they will, e'er long, fee with their own eyes and judge for themfelves.

In this little hiftory of fmelting Copper, no notice hath been taken of those who attempted the practice of boiling and roafting at the fame fire. In fact, nothing could prosper in such hands. Neither can we commend the temerity and improvidency of those who built their furnaces like churches, upon the fame plan; not well confidering, that a heat for the fusion of stubborn Ores, can fcarcely be too focal or concentrated.

which will ever be the colorykers monoralies areally arbed, and

.P. A. H. D. men to the prior of Cooper Ores, and lowered the value





C H A P. III. o billib grinik aladw

OF SMELTING TIN ORE, OR BLACK

Of Smelting Tin Ore, or Black Tin, in the great Furnaces at the Smelting-Houfe.

A S Tin was the fole metallick produce of the earlier ages, fo it is more than probable the raw Mineral was never exported. It would be hard to fuppofe the Phenicians, who carried the arts to fo great perfection, would be at the pains of transporting the useless fcoria to fo great a diffance; especially, when the woods, with which the country in those days was over-run, afforded to eafy a method of reducing it by fufion into a fmaller compass. Some late discoveries, where the charcoal and drofs of the Metal have been found mixed together, have given us an idea of their process, which was to dig a hole in the ground, and throw the Tin Ore on a charcoal fire, which probably was excited by a bellows. Agreeably to the fimplicity of the times, no notion was entertained of confining the fire, to make it act more forcibly on the fubftance to be fmelted; no furnace either fimple or reverberatory had ever been made ufe of. The natural confequences of this were an undue confumption of fuel, and a great lofs in the produce of the Ores; as the more flubborn parts would not give way to that degree of heat, which by this method they were able to apply to them.

The little intercourfe that fubfifted in former times between this county and its oppofite fhore, has been attended with a fatal and lafting inconvenience : I mean the devastation of its woods. Nature feems to have difcovered her reluctance in depriving herfelf of the ornament and protection her woods afford her, by fubflituting a foffil which poffeffes all the advantages of a cheap and durable fire. Though this fubterraneous fuel hath not yet been, nor perhaps ever will be difcovered to be a native of Cornwall, yet fuch is its portablenefs, that we are enabled to procure it from Wales, at a cheaper rate than common fire wood, including the expences of felling and carriage. So long, indeed, as an undue quantity of wood land rendered its confumption neceffary for the purpole of purifying the air, and to make room for more ufeful productions (and fuch undoubtedly was the fituation of this county on the first difcovery of Britain) fo long was it a practice highly commendable to employ the Cccc fuper

282 OF SMELTING TIN ORE, OR BLACK

fuper abundant fuel to fo beneficial a purpofe. But when we behold a wide and barren wafte, extending itfelf throughout the whole Mining diffrict of this county, without a tree to intercept the fury of the wind, we have no reafon to commend the prudence of our anceftors, in thus depriving their demession of its neceffary shelter.

It is ftill a pleafing reflection to confider, that one of the moft effential maxims of state has been constantly adhered to, I mean that of manufacturing their Tin at home. The practice at first was obvious: the wood probably grew on the margin of the fhaft from whence the Ore was raifed, and it must have been neceffary to clear large fpots of it, to give the Miner room to place his Tin-ftuff and crect his engines. The great demand for this article which no known part of the world at that time produced, occafioned a fcarcity of fuel to be very early felt, and the heavy expence of fetching wood from diftant parts naturally enhanced the price of Tin. The difcovery, or, rather, the introduction of fea coal, made a great alteration in the Mining fystem : this valuable substitute came into general use, and put a ftop to that ravage of coppice which was travelling infenfibly to the eaftward; and though the observation may be new, yet it appears clearly to me, that we ftand indebted to our neighbours the Welch for even the fmall quantity of wood land that still remains in the eastern part of the country.

Neceflity at laft fuggefted the introduction of pit-coal for the fmelting of Tin Ore; and among others, to Sir Bevil Granville, of Stow, in this county. Temp. Car. I. who made feveral experiments, though without fuccefs: neither did the effectual finelting of Tin Ore with pit-coal take place, till the fecond year of queen Anne, when a Mr. Liddell, with whom Mr. Moult, a noted Chymift, was concerned, obtained her Majefty's patent for fmelting Black Tin with foffil-coal in Iron furnaces. The invention of reverberatory furnaces built with brick, flone, fand, lime, and clay, foon followed this difcovery; the form of which, being fimple, has admitted little improvement to the prefent time.

The Tin fmelting furnace differs little from that made use of for fmelting Copper, only it is not quite so deep, as it is tapped at every charge. The charge for one of these furnaces is from five to fix hundred weight of Black Tin, well mixed with a tenth or a twelfth its weight of culm. This furnace is charged through a hole

a hole in the fide (directly opposite to the tap-hole) through which it is thrown into the furnace with a flovel, and levelled over the bottom with an Iron rake or paddle from the mouth. This done the apertures are immediately closed, and the fire raifed to a very great ftrength, in which ftate it is left between four and five hours, when the door is taken off, and the whole charge is well ftirred together. The foreman of the work at this time examines the flate of the Metal, &c. and if he thinks it convenient, orders an additional quantity of culm, at his difcretion, to be put into the furnace, which is closed again and left in this condition, the fire all the time being kept fully up, till the end of about fix hours from its receiving the charge; at which time it is again examined by the foreman, and, if he finds it proper, is then tapped, and the Metal let out into a fixed bafon made of clay, and of a capacity to hold fomething more than the Metal of the charge : as in fome forts of Tin the fcoria being vitrified to a confiderable degree, part thereof will flow out with the Metal; but this is not commonly the cafe in any large quantity. The fcoria remaining in the bottom of the furnace is raked out at the mouth, and falls into a fmall pit under it made for the purpofe, and has generally adhefion enough to form into a cake. As foon as it is cold, it is carried to the flamping mill in order to feparate the globules of melted Tin diffeminated through the fcoria or flag. The fcoria being broke by hammers to the fize of goofe eggs, are put into the first stamping mill, and passed through small Iron bars, (instead of a holed Iron plate) none paffing through those bars above the fize of a horfe bean. By this means the pillion (for fo all Tin recovered out of the flags is called) of the larger fize is taken out, and thereby prevented from wafte by too much ftamping. The refuse of this first stamping is put into other stamping mills of a fecond, a third, and even fome part thereof into those of a fourth fize. The pillion in the first and second of the stampings is feparated from the fcoria in the fame manner as Copper Ore from its wafte, and that of the flimes of thefe, together with the third and fourth stamping, in the fame method as Tin Ore at the ftamping mills. Of the pillion fo feparated, all the rough or grainy parts are confidered as Metal, and refined accordingly by being fmelted without any flux, and the produce of this fmelting refined with the Tin first tapped. The fandy and flimy parts of the pillion refembling ftamped Tin Ores, are treated as fuch, and are mixed and fmelted with them.

I now

283

284 OF SMELTING TIN ORE, OR BLACK

I now return to the Tin in the bason, or float, as it is called; which, as foon as it is come down to a moderate heat, is laded out into the moulds, in flabs or pigs, of about three quarters of an hundred weight; not larger, because they would be too unweildy to heave into the furnace for refining, to which I now proceed.

The furnace having, by the fide of the fmall float just now defcribed, a larger one capable of holding twenty or more blocks, is for this purpole fuffered to cool to a certain degree, and then charged full with the flobs just mentioned, the tap-hole being kept open, fo that as the Tin melts in this moderate fire, it makes its exit through it into the float, where while running out it is frequently ftirred and toffed by a ladleful at a time held arm high, letting it fall in a ftream into the mass of Metal, when the fcum which arifes is taken off. While the Metal already put into the furnace is melting, more is added, fo as to be just enough to fill the float with good Tin : and this after being toffed and fkimmed as before, and fuffered to cool to a proper temper, is carried in Iron ladles to moulds holding generally fomewhat above three hundred weight, (then denominated Block-Tin) where they are marked as the imelters choose, with their houfe mark, which may be a pelican, a plume of feathers, a ftag, or a horfe, by laying Brafs or Iron ftamps on the face of the blocks while the Tin is in a fluid flate, yet cool enough to fuftain the ftamping iron. The blocks are then ready to beweighed, numbered, and fent to the nearest coinage town to be coined.

There yet remains in the furnace the droffy part with which the Tin was contaminated, and which, not melting with the flow fire made ufe of, holds with it a confiderable portion of good Tin. The fire is, therefore, now encreafed, fo as to melt the whole; which is then tapped out altogether into the fmall float, where the Tin fubfiding, and the drofs rifing to the top, the latter, foon cooling, is taken off and fet by, and the Tin laded into fmall flabs as at firft to be again refined. The furnace is now charged again as before; and after cleanfing again, generally employed to fmelt Tin Ore as ufual. The Tin that remains in and about the fcoria and drofs of the laft tappings, &c. is recovered by repeated fmeltings, till at laft being almoft entirely drained of that Metal, they become what the workmen generally call Hard-heads, confifting of fuch heterogeneous Metals

TIN, IN THE GREAT FURNACES. 285

Metals as were included in the first mixture, and esteemed of no further value.

The qualifications of a good Tin fmelter are a thorough knowledge of the different kinds of Tin Ore, and of the nature and principles of the different Metals and Minerals mixed therewith; as on this knowledge, not only the making good Metal, but also getting the full produce of the Ore, must entirely depend; and for the want thereof, nothing, not even great care and long experience, can compensate. It is to the want of this infight in the fmelting bufinefs, or at leaft to an inattention thereto, that we are to afcribe the great quantity of bad Tin which is paffed the coinage every quarter; much to the fhame of the Tin fmelters, and still more to the reproach of Stannary government, for fuffering a place of great truft and profit to become a finecure to fome mercenary borough man ! Yea, even worfe, a cloak for ill proceedings. Were thefe matters properly attended to, and the duty of the affay-mafter ftrictly enforced, it would operate more towards preventing foreign importations of Tin into Europe, and extending the fale of our own, than any, or all other regulations that can be made refpecting the Tin. trade !

Four fupervifors of the Tin in Cornwall and Devon, were first appointed by king Charles the fecond. Their office is to infpect the blowing and fmelting houses, to see that no cheat or fraud be committed in the blowing or fmelting of Tin, and for fundry other beneficial purposes relative to the common-weal of the Stannaries. But of all offices belonging to the Tin, this, though inftituted on a very good principle, is now the least regarded. If the supervisors, who now receive each of them eighty pounds & annum for doing nothing, were obliged to visit these houses twice a week, their trouble would not be great, and their diligence might answer the end, and make their places ferviceable to their country. (Anon. Addrefs; Tonkins MSS.)

Dddd CHAP.

CHAP. IV.

Of the Sale of Copper Ores; and of Black Tin at the Smelting-Houfe, and after it is fmelted and coined in Blocks.

THOUGH the richness of our Copper works is not a late discovery : yet it is not a bound of the second knowledge of working them to good effect hath been underftood. The most obvious reason is, that it was the interest of the first difcoverers to keep the natives in profound ignorance. Mr. Carew, in the reign of Elizabeth, hints at the little profits made in Cornwall from Copper: "It is found," fays he, " in " fundry places, but to what gain to the fearchers I have not " been curious to enquire, nor they hafty to reveal : for of one " Mine, of which I took view, the Ore was fhipped to be " refined in Wales, either to fave coft in the fuel, or to con-" ceal the profit." Mr. Norden, one hundred and feventy years fince, feems to have had full information that the Cornish Copper Mines were rich, and, therefore, in his letter to king James the first (fee his Surv. of Cornwall) like a faithful fervant, intimates the expediency of a better infpection into the flate of those Mines, and furmises the arts by which the value of them was concealed : " So rich are the works," fays he, " efpecially " fome lately found, as by the opinion of the skilful in the " myftery, the like have not been elfewhere found, though the " worth hath been formerly extenuated by private pryers into " the fecret, and covertly followed for their own gain." Notwithstanding these hints, we do not find any thing material going on here as to the improvement of the Copper Mines, till, about eighty years fince, fome gentlemen of Briftol made it their bufinefs to infpect our Mines more narrowly, and bought the Copper Ores for two pounds ten shillings to four pounds & ton. The gains were answerable to their fagacity and diligence, and fo great, that they could not long be kept fecret, which encouraged other gentlemen of Briftol about fixty years fince to covenant with fome of the principal Miners in Cornwall to buy all their Copper Ores for a term of years at a flated low price, particularly with Mr. Beauchamp, the grandfather of the prefent John Beauchamp, Efq; to buy all the Copper Ore which should rife out of a Mine well flocked, for twenty years, at five pounds ₽ ton ;

OF THE SALE OF COPPER ORES; &c. 287

\$\$\psi ton; and the Ore at Reliftian in Gwinear was covenanted for at two pounds ten fhillings \$\$\psi ton.\$\$

About fifty years back great quantities of Copper Ore were rifen from three principal Mines in this county; viz. Huel-Fortune in Ludgvan, Rofkear in Camborne, and Pool-Adit in Illugan; the produce of which Mines were fold to the few buyers at their own price. The four Copper Companies, viz. the Brafs-Wire Company, the English Copper Company, Wayn and Company, and Chambers and Company, being then united and confederated, there can be no doubt of their beholding with a fingle eye their joint intereft and purfuit; till they were interrupted by a gentleman from Wales, who vifited this county in order to improve his own branch of bufinefs in the fame way. Let his motives be ever fo felfish, the gentlemen Miners at that time, if not their pofterity, were manifeftly benefited by his vifit; for just then, fourteen hundred tons of Copper Ore, which had been lying unfold fome years at Rofkear and Huel-Kitty, were offered to this gentleman, and for which the confederated buyers would give only four pounds five fhillings & ton. But fo contracted were the principles of the Miners in those days of unremediable oppression, that they obliged this friend to their country to deposit a fum of money equivalent to the fuppofed amount of their Ores before they would confent to weigh them off at the advanced price they had agreed to take for their commodity. These confined notions will ever prevail where the trade of a country is fubject to the domination of rapacious and difhonest combinations. However, this gentleman bought the fourteen hundred tons of Ore at the advanced price of fix pounds five fhillings & ton, which he paid for with ready money, and gained much above thirty & cent. as the writer is well informed from the most indubitable authority ! What must have been the profits of companies confederated to ferve their own interefts without limitation or controul? This new comer bought nine hundred tons more at Rofkear at feven pounds at ton; and in lefs than fix months before he left Cornwall he purchafed three thousand tons, upon which he defervedly made, very little, if at all, fhort of forty & cent. profit.

Soon after this, the buyers and fellers mutually agreed to ticket for all Copper Ores which fhould be ready for fale at flated times, and the higheft bidder or ticket fhould be the purchafer. On the very onfet of this compact, three hundred tons of Ore belonging to the fame Mine were to be ticketed for on a day appointed

288 OF THE SALE OF COPPER ORES;

appointed, in Redruth, when the agent of the Mine having abfented himfelf fome time beyond the limited hour of fale, a certain gentleman of great addrefs, power, and fortune, declared himfelf the purchafer by private contract at eight pounds feventeen fhillings Ψ ton, when one of the ticketers prefent produced his ticket before all the company, whofe offer was nine pounds feventeen fhillings Ψ ton, to the fhame and confufion of all the adventurers.

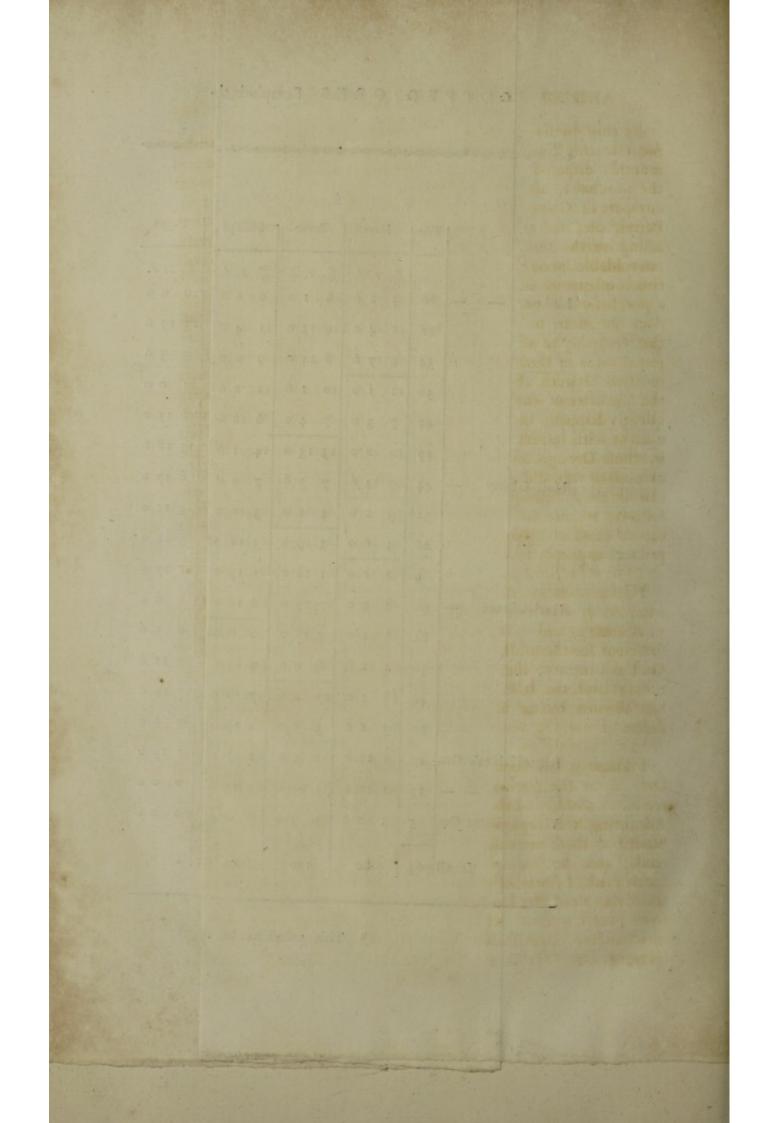
It is to this nefarious transaction that we owe the prefent mode of ticketing for Copper Ores. The proprietors and adventurers in Mines of those times, found themselves in a predicament fingularly ridiculous and diffressing: they possesses a commodity whose value they could not tell how to ascertain; and the buyers, who were acquainted with every requisite for their own advantage, had formed themselves into a confederacy the most pernicious and destructive to the whole Copper Mine interest of this county. It was impossible that such a state of affairs should long continue. The secret at length transpiring, other companies were gradually formed; and from an opposition and rivalship in trade, the adventurer received a better price for his Copper Ore, though far beneath its just value.

In the beginning of my acquaintance with Mining affairs, about twenty-feven years paft, there were fix companies eftablifhed for buying of Copper Ores. At prefent I think there are thirteen companies, which attend by their agents, and throw in their tickets on the day of fale. It will be neceffary to premife that a day of fampling is fixed (fee book iv. chap. ii. p. 245) with a fortnight's interval between it and the ticketing day for trying the famples of Ore and receiving anfwers from their principals. On this ticketing day a dinner almost equal to a city feast is provided at the expence of the Mines, in proportion to the quantities of Ores each Mine has to fell; and the adventurers, with the companies agents, affemble together. Soon after the cloth is removed, the tickets containing the different offers of the different companies are produced and registered by the agents of both buyers and fellers, the originals being delivered to the proprietors of the Mines; and the highest bidders are of course the buyers. In order to evidence the concise and eafy method of ticketing for Copper Ores, I have jubjoined a duplicate of a ticketing paper, by which the reader may apprehend, at one glance, that ten thousand pounds worth of Ores may be fold and appropriated to the refpective buyers in half an hour's time.

| | | | | | | | | | | в | 1 | U | Y | | E | I | 2 | S | | | | N | 1 | Ł | M | [| E | S | | | | | | | | | | |
|-----------------------------|------|----|-------|----|-----|-------|----|-------|------------|----|--------|----|-----|------|------------|-----|------|-----|------|------|-----|----|-------|-----|------|-------|------|------|------|-----|------|-----|------|------|-----|----|-----|------|
| | Tons | I | Iore | | Be | van | P | hilli | ps | W | illiar | ms | 1 5 | Smit | h | Ben | nall | ack | Ed | ward | 1s | E | nnis | | lick | enfor | S | tepl | iens | | arko | cet | 1 11 | Vari | ren | 1 | Pap | ops |
| | | | s. d. | 11 | ζ | s. d. | £. | 5. | <i>d</i> . | ſ. | 5. | d. | L. | 5. | <i>d</i> . | L. | s. | d. | 1000 | 5. 0 | 100 | f. | s. d. | | | s. d. | 1.00 | | | 100 | | d. | L. | | | 1~ | | . d. |
| Rofkear — — | 86 | 5 | 2 6 | | 6 | IO | 6 | 0 | 0 | 6 | 3 | 0 | 6 | 0 | 6 | 5 | 11 | 6 | 6 | 6 | 0 | 5 | 96 | | 5 | 0 0 | 3 | 1 | 5 6 | 5 | 14 | 0 | 6 | 4 | . 0 | 6 | (| 0 0 |
| Manage In Sustain | *68 | 12 | 4 0 | I | 0 1 | 5 0 | 11 | 4 | 0 | 12 | 4 | 0 | II | 2 | 0 | 11 | 16 | 0 | 12 | 4 | 6 | 12 | 4 6 | I | I | 2 6 | 12 | : : | 2 6 | II | 18 | 0 | 12 | 3 | ; 6 | 11 | 1 | 96 |
| | 54 | 9 | 17 6 | | 8 1 | 4 0 | 9 | 0 | 0 | 9 | 16 | 0 | 8 | 19 | 0 | 9 | 13 | 6 | 9 | 11 | 0 | 8 | 18 6 | | 9 | 1 0 | 5 | , : | 16 | 9 | 3 | 0 | 9 | 14 | + 0 | 9 | 1 | 3 6 |
| | 50 | 11 | 1 0 | 1 | 0 | 26 | 11 | 2 | 6 | 11 | 5 | 0 | 11 | 3 | 0 | 10 | 18 | 0 | 11 | I | 0 | 11 | 5 6 | I | I | 3 0 | 10 | 18 | 8 0 | 10 | 19 | 0 | 11 | 5 | 5 0 | 11 | | 0 0 |
| 2 3 4 4 | 42 | 7 | 3 0 | | 7 | 4 0 | 6 | 16 | 6 | 7 | 2 | 6 | 7 | I | 6 | 6 | 19 | 6 | 7 | 2 | 0 | 7 | 3 6 | | 6 1 | 7 ° | 1 | 19 | 96 | 6 | 16 | 6 | 6 | 19 | 0 | 6 | I | 5 0 |
| and the state of the second | 19 | 14 | 2 0 | I | 3 1 | 3 0 | 14 | 1 | 6 | 14 | 0 | 0 | 14 | I | 0 | 13 | 18 | 0 | 14 | I | 6 | 13 | 19 6 | 1 | 3 1 | 6 6 | I | 1 1 | 8 0 | 13 | 19 | 0 | 14 | 5 | ; 0 | 13 | 1 | 8 6 |
| Huel-Gherry — | 44 | 7 | 14 6 | 1 | 7 | 36 | 7 | 9 | o | 6 | 18 | 6 | 7 | 5 | 0 | 7 | 15 | 0 | 7 | 3 | 6 | 7 | 1 0 | , | 6 1 | 90 | 1 | 5 1 | 96 | 6 | 18 | 0 | 7 | 4 | + 0 | 6 | 1 | 7 9 |
| | 32 | 3 | 2 6 | | 4 | I O | 3 | 10 | 0 | 3 | 15 | 0 | 3 | 2 | 6 | 3 | 3 | 0 | 3 | 19 | 0 | 3 | 16 6 | 5 | 3 | 4 0 | | 3 1 | 16 | 3 | 5 | ; 6 | 3 | 19 | 9 6 | 3 | I | 5 0 |
| | 26 | 4 | 6 0 | - | 3 1 | 96 | 3 | 18 | 0 | 3 | 16 | 6 | 3 | 11 | 6 | 3 | 14 | 0 | 3 | 12 | 0 | 3 | 13 6 | 5 | 3 1 | 0 0 | | 3 1 | 7 0 | 3 | 19 | 0 | 4 | | 0 0 | 3 | I | 4 (|
| | 9 | 2 | 2 0 | | II | 8 o | I | 15 | 0 | 1 | 16 | 0 | 1 | 19 | 0 | I | 15 | 0 | 2 | 2 | 6 | 1 | 16 0 | | 1 1 | 4 0 | | 1 1 | 9 0 | I | 13 | 0 | 1 | 19 | , 6 | 1 | I | 7 0 |
| Huel-Chance - | 90 | 8 | 90 | | 7 1 | 90 | 8 | 10 | 0 | 8 | 5 | 0 | 7 | 19 | 0 | 7 | 18 | 6 | 8 | 2 | 6 | S | 3 0 | | 7 1 | 7 6 | 1 | 7 | 56 | 7 | 15 | ; 0 | 8 | - | 3 0 | 8 | | 0 0 |
| | 84 | 6 | 4 0 | | 5 1 | 8 0 | 6 | 6 | 0 | 6 | 11 | 0 | 5 | 15 | 0 | 5 | 17 | 6 | 6 | 5 | 6 | 6 | 4 0 | | 5 1 | 0 0 | | 5 1 | 2 6 | 5 | 15 | ; 6 | 6 | | 4 6 | 6 | | 1 (|
| | 56 | 4 | 2 6 | | 6 | 0 0 | 4 | 19 | 6 | 4 | 14 | 6 | 5 | 9 | 0 | 5 | 15 | 0 | 5 | 18 | 0 | 5 | 16 0 | | 5 | 1 0 | 1 | 5 1. | 4 ° | 4 | 4 | + 0 | 5 | 1 | 3 0 | 5 | I | 2 (|
| aban mana | 44 | 18 | 1 0 | I | 7 | 2 6 | 17 | 17 | 0 | 18 | 2 | 0 | 16 | 19 | 0 | 16 | 19 | 6 | 17 | 17 | 6 | 17 | 9 (| 5 1 | 7 | 0 0 | 1 | 5 1 | 9 0 | 16 | 16 | 0 | 17 | 9 | , 6 | 17 | I | 4 0 |
| Abort 1 | 20 | 3 | 2 6 | | 3 | 5 0 | 2 | 19 | 0 | 2 | 16 | 0 | 3 | 12 | 6 | 3 | I | 6 | 3 | 11 | 0 | 2 | 18 0 | | 2 1 | 15 0 | | 2 1 | 7 6 | 2 | 18 | 6 0 | 2 | I | 96 | 3 | | 0 0 |
| Ditto Halvan's Ore | 20 | I | 19 6 | | 2 | 2 0 | 2 | I | 0 | I | 18 | 6 | 1 | 16 | 0 | I | 15 | 0 | 2 | 2 | 6 | 2 | 0 0 | > | 1 | 16 0 | | 2 | 3 0 | 1 | 15 | ; 0 | I | 17 | 7 0 | 1 | 1 | 9 0 |
| Stampt Ore — — | 15 | I | 10 0 | | 1 1 | 4 0 | I | 15 | 0 | I | 11 | 0 | I | 14 | . 6 | 0 | 0 | 0 | I | 16 | 0 | 0 | 0 0 | 0 | 0 | 0 0 | | 1 1 | 1 6 | 0 | c | 0 0 | 0 | (| 0 0 | 0 | | 0 0 |
| Vivian's Burnt Ore | 5 | I | 26 | | I | 3 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | I | 5 | 0 | 0 | 0 0 | 0 | 0 | 0 0 | | I | 1 0 | 0 | 0 | 0 0 | 0 | | 0 0 | C | | 0 0 |
| In all | - | | 80 | | 13 | | | 90 | | | 128 | | | 20 | | | 44 | | | 49 | | | 84 | | | | | 2 | 0 | | | | | 1 | 0 | | | |

COPPER ORES Sampled the 26th of June 1777, and Sold the 10th of July 1777, at REDRUTH.

* This parcel to be equally divided between Edwards and Ennis, both offering \mathcal{L}_{12} 4 6.



AND OF BLACK TIN AND WHITE TIN. 289

By this method, which has fubfifted fince its first establishment to this time, fixteen thousand pounds worth of Ore are monthly difposed of in entire dependence upon the honour of the purchaser, and which I believe is not to be parallelled in any part of Great-Britain. Sed humanitas et gratior et tutior. Permit me, for argument's fake, to suppose these gentlemen acting on the most honourable principle; yet still there is an unavoidable inconvenience, which may be of the most destructive confequence to the feller. What I mean is this : whenever a purchafer does not want a particular parcel of Ores, or perhaps does not mean to purchase at all, it is usual for the agent of that company to affix a price to his ticket much below his computed value of those Ores. On the supposition of non-communication between the buyers (which is the only foot on which the favourers of the prefent fystem reft their cause) it must frequently happen, that all companies must be in the fame predicament with respect to some parcels of Ores; the confequence is, those Ores go off at a low value, and become the property of perfons who did not mean to buy them. This is putting the cafe in the faireft light; and, to conceive the mifchief which follows, we are to obferve, that those parcels amount to very capital fums of money, and that the lofs fuftained by the proprietors is proportionably large.

I have mentioned, above, the emulation natural to rival companies; but it is to be feared that principle has long ceafed to operate : and as there is Copper Ore raifed in the county fufficient for them all, they do not with to pufh one another. On the contrary, the utmost harmony seems to subfift between them; and the talk of establishing a new company is fure to be followed by an affociation of the old ones, in order to defeat it.

weight upon twenty, and four pounds upon every three hundred

monoficion of walte) m

I know it has been urged, that large quantities of Copper Ores lie at the feveral furnaces unfmelted, that much Copper remains unfold, and thefe to the amount of a confiderable fum. Admitting this argument, let us for a moment confider the benefit of thefe pretenfions to the purchafer. He thereby pretends, that he is buying Copper which muft remain on his hands; and by way of allowing himfelf intereft for his money thus lying dead, he has the modefty to fink the raw commodity from twelve Ψ cent. which is a very handfome profit upon a merchandize unperifhable, to thirty, and more frequently to forty, Ψ cent. It is a great pity that the amazing monthly E c e e expence

290 OF THE SALE OF COPPER ORES;

expence of deep Mines, joined to the narrow circumftances of many of those concerned in them, should make it necessary for those Mines to sell their Ores immediately for the price they can get; as the withholding those Ores, at a profit of twenty, or even supposing ten, Ψ cent. would make a great difference in their favour on the balance of their accompts. But I forbear to dwell longer on this difagreeable subject, as I am convinced that most of the people concerned in Mining have long beheld with indignation the treatment they meet with, and only want a leader to stand forth in their cause. (Anonym. Address.)

I proceed to obferve, in justice to the buyers of Copper Ore, that no payment for any commodity can be more punctual than that which is made by them. I cannot recollect one inftance of tardinefs in all their transactions respecting their payments; for at the month's end, after the Ores are weighed off, cafh or bills of exchange, almost equal in credit to bank notes, are ready for the feller's ufe. This cuftom makes Copper Ore a ready money article, which is of the greatest confequence to the necessities of the Miners, and in truth cannot be difpenfed with, unlefs the fyftem of Mining be quite changed. However, it must be confessed that the purchaser receives some gratification to counterbalance his politeness : for every ton of Ore (prefuming on a fupposition of waste) must weigh twenty-one hundred weight to the ton; moreover, Ore that is wet by rain is allowed for by a further over-weight according to reafon and confcience. At Pol-dyfe Mine the managers will not allow more than four pounds upon every three hundred weight be it wet or dry. The famplers demur to this regulation, and contend for four pounds upon dry Ore, and as much more as they can have, for wet. Whoever approves this rapacity muft be an enemy to the county of Cornwall; for thefe allowances of one hundred weight upon twenty, and four pounds upon every three hundred weight, which is one quarter upon the ton (all together equal to fix per cent. on the foregoing profits) are more than ten times equivalent for all the wet and wafte they can ferioufly pretend to fuffer. Such is the prefent opprefied flate of the Copper trade in Cornwall; upon which reprefentation I shall reft at this time, but with an intention on a future day to lay open the feveral artifices used in that branch of business in a fmall pamphlet, for the mature confideration of the proprietors

merchandize unperifhable, to thirty, and more frequently to ivrojsragendit. It is a great pity that the amazing monthly E c c c c expense

AND OF BLACK TIN AND WHITE TIN. 201

Preparatory to the final disposal of Tin, it must pass an exchange of Black Tin or Ore for White Tin in blocks, by the way of barter between the Tinner and the Smelter, becaufe the latter is not paid in money for fmelting the Tin, but by deduction of a certain fhare in twenty to himfelf out of the quantity brought to be exchanged. Herein confifts a neceffary fkill in the fmelter : for the Metal of the affay of different kinds of Tin Ore being extremely variable, and not properly refinable in fuch fmall quantities, and the manner of agreeing for or buying the Tin Ore of all forts being to give Tin bills or promiffory notes to the owners thereof, engaging to deliver them at the next coinage fo many hundreds of refined Tin for every twenty hundred weight of the Ore or Black Tin; if the manager in this matter is not a judge how much pure Tin his impure affay will produce, it will become a matter of meer chance whether the Tinner has the real value for his Black Tin, or whether he or the buyer fuffers most by the exchange. The fmelter's judgment must be exercifed also on another fcore befides that of the fineness of his affay, as he must deduct from the quantity of Tin the feller's Ore will produce, as much as he thinks will pay for the fmelting and other incidental charges, together with the profit he propofes to allow himfelf thereupon.

The affay being made, weighed, and calculated, and a judgment formed what proportion thereof is to be allowed the fmelter for his charges and profit, the bufinefs is reduced to a fhort treaty : A has brought to B twenty hundred weight of Black Tin (Tin Ore). Suppose the produce of this Tin twelve hundred weight; B offers to deliver A, for this, eleven hundred weight at the next coinage; which if A agrees to take, a promiffory note, commonly called a Tin Bill, is given him in the following terms, or nearly fo : and to and all the second and with the fmelters of the Tin, who take care to operate on the

eady calls to the monied man, who

that, in complationce for his'

credulity of the Tinner by infinuating that he has a lager 9M

out daw and on Carvedras, the 8th day of April 1777.

Received of Mr. Anthony Afhley, twenty hundred weight two quarters and fourteen pounds of Black Tin which at eleven for twenty in White Tin is eleven hundred weight one quarter and nine pounds. Which I promife to deliver to him or bearer this Truro coinage.all it and not ottention more and an angeline that

victim and & Qr. 15 For H. R. Efq; and Co. the greatelt thate of the White I'm in percrolari miT astidW. 03

Thefe perfons who fland between the real and original

IONAS MILFORD,

292 OF THE SALE OF COPPER ORES;

This bill being negotiable and payable by an indorfement, the fame as a bill of exchange, the owner thereof may fell it to any one, or at the fmelting-house, as most frequently is the cafe, for fome certain value per hundred weight ; otherwife he may coin the Tin thereof upon his own account. Thefe bills are frequently bought at a nominal value; the buyer and feller covenanting with each other, that if the real value, when fixed, be different from the nominal, whatever it may be above, the former is to pay to the latter, except one shilling per hundred weight, the premium for laying out his money; if under, the feller is to return the difference, and one shilling per hundred weight, for the reafon just given. This method of purchasing is called Buying on Difcount; and the most usual way of fettling the real price for fuch Tin has been to fix it at that of the first hundred blocks bought or fold by any one perfon, of the Tin belonging to that coinage (or quarter) in which fuch bills were bought.

This makes what they call the Tin bill trade fo noted in this county; for if the Tinner is not of ability to wait the time of the coinage, and perhaps fome time after, till the merchant wants it, upon which also two or three months credit must be added; he fells the bill for ready cafh to the monied man, who defrays all future charges upon the Tin. The buyer has a further profit upon this Tin of two pounds over-weight upon every hundred weight of White Tin, which the fmelter is obligated to render the bill-holder; fo that the buyer of the bill has about two fhillings per hundred weight clear profit by this traffick ; and if he can return his money quarterly, which was formerly the cafe, he makes twelve per cent. profit per annum of his cafh. The Tin bill trade was anciently in the hands of the mercantile part of the county, but it now principally refts with the fmelters of the Tin, who take care to operate on the credulity of the Tinner by infinuating that he has a larger exchange of White Tin for his Black when he parts with the former to the fmelter; and that, in complaifance for his obliging difpofition towards the proprietor of the houfe-This may be true; but, Fallax vulgi judicium.

There is one confideration that is connected with this fubject, that deferves much more attention than it has ever yet met with. These perfons who stand between the real and original proprietors of the Tin-stuff and the exporters, though they have usually the greatest share of the White Tin in their possible for a re not

AND OF BLACK TIN AND WHITE TIN. 293

to be looked on as the real fufferers by the low price it bears, or even by a ftagnation of the Tin trade, unlefs it is unforefeen. Thefe gentlemen take care to make all proper deductions on that account when the Tin is brought to them to be fampled; and the difcount on Tin bills, as I have just observed, is an additional douceur. I would not be fuppofed even to hint at a combination between the fmelter of the Tin and the manufacturer or exporter : the credit and fortune of many of the former place them above a bare infinuation of this kind. I only mean to affert, that however they may join the general cry on account of the low price of Tin, no thinking perfon will ever fet them down as fufferers thereby. There is a known fact I shall mention by way of illustration, viz. That the retailer of any excifeable commodity ftands in the fame predicament, with the merchant who buys to fell again, and has as much reafon to be a lofer on an additional duty laid on that commodity; whereas, on the contrary, he is too frequently a gainer.

Till the reign of Hen. VIII. there were but two coinages a year for Tin, viz. at Midfummer and Michaelmas, when the Tinners by petition and proving the inconveniency arifing from the long vacation between the latter and the former, obtained the liberty to coin their Tin quarterly by adding Chriftmas and Lady-day to the foregoing coinages; for which they pay to the duke of Cornwall an acknowledgment (called Poft-Groats) of fourpence extra for every hundred of White Tin coined in thofe quarters. The privileged towns for coinage of Tin were anciently Lifkeard, Loftwithiel, Truro, and Helfton. For the conveniency of the weftern Tinners, foon after the reftoration Penzance was alfo made a coinage town; in which laft place, there is every quarter abundantly more Tin coined than in all the towns of Lifkeard, Loftwithiel, and Helfton put together, for a whole year.

When the Tin is brought to be coined, it is carried into the coinage hall built on purpofe to receive it, where the affay mafter's deputy affays it by cutting off with a chiffel and hammer a piece of one of the bottom corners of the block about a pound weight, partly by cutting and partly by breaking, in order to prove the toughnefs and finenefs of the Metal. If it is pure good Tin, the face of the block is ftamped with the duchy feal, which ftamp is a permit for the owner to fell, and at the fame time an affurance that the Tin fo marked has been purpofely examined and found merchantable. The ftamping F f f f

294 OF THE SALE OF COPPER ORES;

this imprefiion by a hammer, in like manner as was anciently done to render money current, is coining the Tin, and the man who does it is called the Hammer Man.

The arms of Condorus, laft earl of Cornwall of British blood, (Temp. W. I.) were Sable 15 Bezants (5,4,3,2,1) in pale Or. Richard, king of the Romans, earl of Cornwall, fon to king John, threw these Bezants into a border round the bearing of the earl of Poictou: he bore therefore argent, a Lion Rampant Gules, crowned Or within a bordure garnifhed with Bezants : and this still continues the duchy feal. Befides this impression, the Tin bears that alfo of the particular houfe where it was fmelted, which I have mentioned in my laft chapter, in order that if there be any deceit ufed in the Tin by any foul mixture (making a pye as they call it, by putting hard heads, &c. in the middle, and lading the Tin to cover the cheat, that it may efcape the affayers notice, which has formerly happened) their roguery may be the more eafily detected. The credulous believe, that by the old Stannary laws, the perfon convicted of fuch adulteration and fraudulency was to have three fpoonfulls of melted Tin poured down his throat; a punifhment that would effectually fecure him from a repetition of the fame act. Befides the foregoing officers of the coinage, there are numerators to fet down the number of blocks coined every quarter, together with the fmelting-houfe numbers, and the weight of each block, all which are carefully registered, that no mistake fhall happen, or difpute arife between the revenue officers and the owners of the Tin, or between the latter and the purchasers, the initials of the original proprietors names being likewife stamped on every block.

If we extend our examination to the exportation of Tin, we fhall find that the ancient inhabitants had greatly the advantage of us in this particular. The induffrious republicans of Africa fought our Tin with an ardour equal to what we difcover in fetching gold duft from the fhores of that continent; and the coafting voyage they were obliged to perform from their ignorance of the loadftone, was attended with more delays and hazard than has been experienced fince in the circumnavigation of the world. But let us turn our eyes to the reverfe of this picture : poffeffed of a numerous and, frequently, ftarving poor, with the advantage of a harbour, the fecond in point of fize and fafety in the whole ifland, yet where is there a fingle manufactory of Tin ware among us? The inftances have been very

AND OF BLACK TIN AND WHITE TIN. 295

very rare alfo, of a direct exportion of Block or Bar Tin to Holland, Turkey, or even to America: on the contrary it is fhipped for the port of London, and double commission and infurance is the neceffary confequence; at the fame time that those cargoes which are configned to the Mediterranean or American markets must repais our coasts, and run a risk of being caft on their native fhore. There is one confideration more, that I shall beg leave to mention ; and the inattention is fo great, that, were it not for the poor labourer whose bread depends on the price of his Tin, it would make me diveft myfelf of compatiion for every other perfon concerned either as land-holder or adventurer. The confignments of Tin on commillion for foreign markets have fallen, by I know not what infatuation, into the hands of the pewterer in London. His intereft in keeping down the price of Block Tin, muft infinitely exceed any degree of percentage he could expect on his commiffion for exportation. By this means he is enabled to dictate to his principals; and fix the price of the commodity to his own ftandard. It would be wafting time to dwell on this fubject. I fhould gladly have drawn a veil over it, to fpare the difgraceful inference that must naturally arife on the bare mention of it : but as all things have an end, fo there must be fome period to the ftrongeft degree of lethargy; and fome efforts a few years back made me hope, the gentlemen of the Mining diffricts would not have wanted any fhaking to awaken them. But these efforts, from the little attention paid to the real state of the Tin trade, will hardly be fufficient to convince the unprejudiced, that they were fully awake.

TABLES,

TABLES,

Shewing what Quantity of White Tin must be delivered by the Smelter for any Quantity of Black Tin, from 4 15 of White, for 20 15 of Black, to 13 1 15 of White for 20 15 of Black.

20

8 16

8

| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$ | | nand his | At 4 | for 2 | 10 | dit. | 0 |
|---|--|--|---|--|---|-------------------------|---------|
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$ | Bl. Tin | Whit | e Tin | Bl. Tin | W | Thit | e T |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$ | 15 | 15 | 20 | C. | C. | 2 | њ |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$ | 2 3 4 5 6 7 8 9 10 11 12 13 14 | 1 1 1 2 2 2 2 2 2 2 2 5 11 | $ \begin{array}{c} 8 \\ 12 \\ 16 \\ - \\ 4 \\ 8 \\ 12 \\ 16 \\ + \\ 4 \\ 8 \\ 12 \\ 16 \\ - \\ 16 \\ $ | 2 3 4 5 6 7 8 9 10 20 30 4 5 6 0 9 0 9 0 9 0 9 0 9 0 9 0 9 0 9 0 9 0 | 1 1 1 2 4 6 8 10 12 14 16 18 20 | 2 3 1 2 3 1 1 1 1 1 1 1 | 5 22 16 |

| 13.77 | Sum | At 41 | TOT | 20 | | | a fr |
|---|--|---|---|--|---------------------------|----------|-------------------------------------|
| Bl. Tin | White | e Tin | Bl. Tin | W | /hit | e T | in |
| 15 | њ | 20 | C. | C. | Q | 115 | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 | I I I I I I I I I I I I I I I I | 4 ¹ 9 ¹³¹ 18 ²¹ 7 ¹¹ 16 ¹ 5 ¹¹ 16 ¹ 5 ¹¹ 16 ¹ 5 ¹¹ 18 ² 14 ¹¹ 18 ² | 1 2 3 4 5 6 7 8 9 10 20 30 40 | | I 2 3 I 1 2 3 I 1 2 3 I 1 | 25221916 | 4 8 12 16 4 8 12 16 4 8 12 16 |
| 14 28 56 84 | 3 6 12 18 | 3 6 12 18 | 50 60 70 80 90 100 200 | 11 13 15 18 20 22 45 | 1 2 3 1 2 | H PIPE | IT I FI |

At 41 for 20

At 44 for 20

| Bl. | 2210 | 71100 | BI. | 20 | aio | 1111 | 14 2 |
|--------|-------|--|-----------------------|----|------|------|------|
| Tin | White | e Tin | Tin | N | Thip | e T | in |
| | 11. 1 | | C. | - | 0 | 15 | 20 |
| 15 | 15 | 20 | L. | C. | 2 | TD | 20 |
| | | 41 | I | | | 23 | 16 |
| 1 2 | | 81 81 | 2 | | I | 19 | 12 |
| | | 121 | and the second second | 22 | 2 | 15 | 8 |
| 3 | | A DECEMBER OF STREET, STRE | 3 | | 3 | 11 | 4 |
| 4 | I | 17 14 | 4 | I | 3 | 7 | - |
| 56 | I | 51 | 4 56 | I | I | 2 | 16 |
| | 1 | 91 | - | I | 1 | 26 | 12 |
| 7 8 | Î | 14 | 78 | I | 2 | 22 | 8 |
| 9 | I | 181 | 9 | I | 3 | 18 | 4 |
| 10 | 2 | 21 | 10 | 2 | - | 14 | - |
| II | 2 | 61 | 20 | | I | - | - |
| 12 | 2 | II | 30 | 46 | 1 | 14 | - |
| 13 | 2 | 151 | 40 | 8 | 2 | - | - |
| 14 | 2 | 191 | 50 | 10 | 2 | 14 | - |
| - | | | 60 | 12 | 3 | - | - |
| 28 | 5 | 19 | 70 | 14 | 3 | 14 | - |
| 56 | 11 | 19 18 | 80 | 17 | - | - | - |
| 84 | 17 | 17 | 90 | 19 | - | 14 | - |
| | | | 100 | 21 | I | - | - |
| | | | 200 | 42 | 2 | - | - |

| Bl. Tin | White | e Tin | Bl. Tin | 1 1 | Thie | e T | in |
|---|-------|--|---|--------------------------------------|-----------------------------|--|----|
| Ш | ŤĎ | 20 | C. | C. | 2 | 15 | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 56 84 | | 44 94 19 38 138 24 72 12 17 12 16 13 6 19 | 1 2 3 4 5 6 7 8 9 0 2 3 0 5 6 0 0 0 100 | 1 I I I 2 2 4 7 9 1 1 4 16 19 21 2 2 | 1 2 3 1 2 3 1 3 2 3 1 2 1 2 | 26 25 23 22 21 19 18 16 15 14 14 14 14 | |
| 42.7 | The s | a a the | 200 | 23 | 32 | | - |

T

A

B

L E S.

At 5 for 20

At 51 for 20

| - | | _ | | - | - | _ | _ |
|---|--|---|---|------|---|-----|--------------------|
| Bl. Tin 15 | White 15 | Tin | Bl. Tin C. | W.C. | - | e T | in 20 |
| 10 | 10 | 20 | 2. | 0. | 2 | ID | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 56 84 | I I I 2 2 2 2 2 3 3 3 3 3 7 14 21 | 5 10 15 5 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 15 10 11 1 <th>1 2 3 4 5 6 7 8 9 10 20 30 40 56 7 8 9 10 20 30 40 56 7 8 9 10 20 30 40 56 7 8 9 10 20 30 40 56 7 8 9 10 20 30 40 56 7 8 9 10 20 56 10 5 56 10 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5</th> <th></th> <th></th> <th></th> <th>ITTTTTTTTTTTTTTTTT</th> | 1 2 3 4 5 6 7 8 9 10 20 30 40 56 7 8 9 10 20 30 40 56 7 8 9 10 20 30 40 56 7 8 9 10 20 30 40 56 7 8 9 10 20 30 40 56 7 8 9 10 20 56 10 5 56 10 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 | | | | ITTTTTTTTTTTTTTTTT |

| Bl. Tin | Whit | e Tin | Bl. Tin | w | hite | e Ti | in |
|---|-----------------------|--|---|---|--|---|--|
| 1b | 1b | 20 | C. | C. | 2 | 1b | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 | I I I I 2 2 2 3 3 3 3 | 5 ¹ / ₁ 16 ¹ / ₂ 2 7 ¹ / ₁ 18 ¹ / ₂ 4 9 ¹ / ₂ 15 6 11 ¹ / ₂ | 1 2 3 4 5 6 7 8 9 10 20 30 40 | I I I I I I 2 2 2 5 8 11 | I 2 3 I 2 3 I 3 2 I 1 3 2 I | 2 5 8 11 14 16 19 22 25 | 16 12 8 4 16 12 8 4 16 |
| 14 28 56 84 | 3 7 15 23 | 17 14 8 2 | 50 60 70 80 90 100 200 | 13 16 19 22 24 27 55 | 3 2 1 3 2 | TITITI | |

At 51 for 20

| Bl. Tin | Whit | e Tin | Bl. Tin | 1 | Vhit | e T | in |
|----------------|---------|-------------------------------|------------------|----------------|-------------|----------------|----------|
| ТЬ | Ťb | 20 | C. | - | 2 | 115 | 20 |
| 1 2 | T | 5 ¹ / ₂ | I 2 | ++ | 1 2 | 4 8 | 48 |
| 3456 | 1 1 1 | 17± 3 8± | 345 | II | 3 | 12 16 21 | 12 16 |
| 6 78 | 2 | 141 | 4 56 78 | 12 | 2 | 25 1 | 48 |
| 8 9 10 | 2 2 2 | 6 111 171 | 8 9 10 | 2 2 2 | 1 2 3 | 5 9 14 | 12 16 |
| 11 12 | 3 | 3‡ 9 | 20 30 | 58 | 32 | 14 | |
| 13 14 | 3 4 | 14= | 40 50 60 | 11 14 17 | 2 1 1 | 14 | |
| 28 56 84 | 8 16 | I 2 | 70 80 | 20 23 | 1-1-0 | 14 | I |
| | 24 | 3 | 90 100 200 | 25 28 57 | 332 | 14 | 1 |

At 51 for 20

Gggg

A

в

20

GEEE

L

E S.

| | _ | 1 | - | - | _ | - | _ |
|---|--|--|---|---------------------------------------|------|--|--|
| Bl. Tin | White | e Tin | Bl. Tin | 1 | Thit | e T | in |
| 15 | 扔 | 20 | C. | C. | 2 | ŤБ | 20 |
| I 2 3 4 5 6 7 8 9 10 11 12 13 14 28 56 84 | IIII III III III III III III II | 6 12 18 4 10 16 2 8 14 6 12 18 4 8 16 4 8 16 4 | 1 2 3 4 5 6 7 8 9 10 20 30 40 50 60 7 8 9 10 20 30 40 50 7 8 9 10 20 10 200 | 1 1 1 2 2 2 3 6 9 12 15 18 21 247 360 | | 5 11 16 22 5 11 16 22 5 11 16 22 5 11 16 22 | 12 4 16 8 12 4 16 8 |

T

At 6 for 20

At 61 for 20

| Bl. Tin | White | e Tin | Bl. Tin | 1 | /hit | c T | in |
|---|-------------------------------|--|---------------------------------------|--------------------------------------|---|------------------------------------|--|
| 15 | 1b | 20 | C. | C. | 2 | 15 | 20 |
| I 2 3 4 5 6 7 8 9 10 11 12 13 14 28 5 6 84 | 1 1 1 2 2 2 3 3 3 4 4 9 18 27 | 6 ¹ / ₂ 13 19 ¹ / ₆ 12 ¹ / ₂ 19 5 ¹ / ₂ 12 18 ¹ / ₄ 5 ¹ / ₄ 11 2 4 6 | 1 2 3 4 56 78 9 10 20 30 40 560 78 90 | I I I I 2 2 2 3 6 9 13 16 19 22 6 29 | 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 1 2 3 1 1 2 3 1 1 2 3 1 1 2 3 1 1 2 3 1 1 2 3 1 1 2 3 1 1 2 3 1 1 1 1 | 816 255 14 22 11 19 | 8 16 4 12 8 16 4 12 |
| - | 10 | 00 | 100 200 | 32 | 2 | 1.1 | 1 1 |

| | or | |
|--|----|--|
| | | |
| | | |

| Ib Ib 20 C. C. Q Ib 20 I - $6\frac{1}{4}$ I - I 7 2 - $12\frac{3}{2}$ 2 - 2 I4 3 - $12\frac{3}{2}$ 2 - 2 I4 3 - $18\frac{3}{4}$ 3 - 1 1 4 I 5 I 2 7 - 1 4 I 5 I 2 7 - - - 6 I $17\frac{3}{4}$ 6 I 3 I4 - - 7 2 $3\frac{1}{7}$ 2 2 1 - | Bl. Tin | White | e Tin | Bl. Tin | w | hit | e T | in |
|---|---|---|--|---|---|-----------------------------|--|----|
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$ | tb | 15 | 20 | C. | C. | Q | 15 | 20 |
| 200 62 2 | 5 6 7 8 9 10 11 12 13 14 28 56 | I I 2 2 2 3 3 3 3 4 4 4 8 17 | 12 18 5 11 17 3 10 16 2 8 15 15 15 10 15 10 | 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 0 10 | 1 2 2 2 3 6 9 12 15 18 21 25 28 31 | 2 3 1 2 3 2 3 1 1 2 2 3 3 1 | 14 21 7 14 21 7 14 14 14 14 | |

At 61 for 20

| Bl. Tin | White | Tin | Bl. Tin | Whi | te Tin |
|--|--|----------------------------------|-------------------------------------|---|--|
| o B | 16 | 20 | C. | C. Q | 115 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 56 4 | I I 2 2 2 2 3 3 3 3 4 4 4 4 4 4 4 9 18 28 | 6134713 24 254 274 254 1 74 98 7 | 1 2 3 4 56 78 9 10 0 30 40 50 78 90 | 1 1 2 1 1 2 2 1 1 1 2 2 2 1 2 2 2 3 3 1 1 6 3 1 6 3 1 6 3 1 6 3 1 6 3 1 6 3 2 0 1 2 3 2 2 7 3 0 1 | 9 16 19 12 1 8 11 4 2 16 12 12 22 8 4 4 14 14 14 14 14 |
| | 5 18 | 1 00 | 100 | 33 3 | == |

TABLES.

299

At 7 for 20

| - | - | - | - | - | - | | - | |
|---|---------------------------------|--|---|---|--|--|-----------------------------|--|
| Bl. Tin | White Tin | | Bl. Tin | White | | e T | Tin | |
| 15 | 15 | 20 | C. | C. | 2 | 15 | 20 | |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 56 84 | I I I 2 2 2 3 3 3 4 4 4 9 19 29 | 7 14 1 8 15 2 9 16 3 10 17 4 11 18 16 12 8 | I 2 3 4 5 6 7 8 9 10 20 30 40 5 60 90 100 | 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 | 1 2 1 3 1 3 2 2 2 2 2 2 2 2 | 11 22 5 16 11 22 5 16 11 22 5 16 1 1 1 1 22 5 16 | 48 12 16 48 12 16 4 1 1 1 1 | |
| | 51- | 1,000 | 200 | 20 | _ | - | - | |

| Bl. Tin | White | Tin | Bl. Tin | w | hite | T | in |
|---|---|--|-------------------------------|--|---------------------------|---|----|
| 1b | 15 | 20 | C. | C. | 9 | 1b | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 5 6 | 1 1 1 2 2 3 3 4 4 4 5 10 21 | 7 = 10 17 = 10 | 1 2 3 4 56 78 9 0 2 3 4 56 78 | IIII 1 1 1 1 1 2 2 3 3 3 3 7 1 1 1 5 1 8 22 26 30 | I 3 2 3 I 2 I 3 2 I 3 2 I | 1 2 2 2 2 2 2 2 2 2 1 2 1 2 1 2 1 2 1 2 | |
| 84 | 31 | 10 | 90 100 200 | 33 | 3 2 | | |

30

At 71 for 20

At 71 for 20

| Bl. Tin | White | : Tin | Bl. Tin | w | 7hit | eT | in |
|---|--|---|---|--|---|--|----|
| 15 | 节 | 20 | C. | C. | 2 | 15 | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 5 6 84 | I I I I 2 2 3 3 4 4 5 10 20 30 | 71 14 14 9 16 34 9 16 34 5 12 19 19 7 14 14 19 7 14 14 19 7 14 14 19 19 7 14 14 19 19 7 14 19 19 7 14 19 19 19 19 19 19 19 19 19 19 19 19 19 | 1 2 3 4 5 6 7 8 9 10 20 3 40 5 60 7 80 9 10 20 10 10 10 10 10 10 10 10 10 10 10 10 10 | I I I 2 2 2 2 3 7 10 14 18 21 25 29 32 36 72 | I 2 I 3 2 3 I 2 I 3 2 2 3 2 2 3 2 2 3 2 2 3 2 2 3 2 2 3 2 2 3 2 2 3 2 3 2 2 3 2 2 3 2 2 3 2 2 2 2 2 2 2 2 2 2 2 2 2 | 12 25 9 22 7 19 4 16 1 14 14 14 14 14 | |

At 71 for 20

| Bl. Tin | White | : Tin | Bl. Tin | N | Thit | | in |
|--|--|---|---|--|---|----------------------|---|
| oath | њ | 20 | C . | Ċ. | Q | 115 | 20 |
| 1 2 3 4 5 6 7 8 9 0 11 12 13 14 2 8 5 6 8 4 | 1 1 1 1 1 1 2 2 3 3 3 4 4 5 5 10 21 32 | 741534 1534 144294 1753 8 17 141 17 141 | 1 2 3 4 5 6 7 8 9 0 2 3 0 6 0 7 8 9 0 2 | I I I 2 2 3 3 3 7 I I 5 19 2 3 7 3 4 3 8 1 | I 3 2 3 I 2 I 3 3 2 2 I I 3 3 2 2 I I 3 3 2 2 1 I 3 3 2 2 1 I 1 3 3 2 2 1 I 1 3 3 2 2 1 I 1 1 3 3 3 2 2 1 I 1 1 3 3 3 2 2 1 I 1 1 3 3 3 2 2 1 I 1 1 3 3 3 2 2 1 I 1 1 3 3 3 2 2 1 I 1 1 3 3 3 2 2 1 I 1 1 1 3 3 3 2 2 1 I 1 1 3 3 3 2 2 1 I 1 1 1 3 3 3 2 2 1 I 1 1 1 1 3 3 3 2 2 1 I 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | 152185112614 4 4 4 4 | 8 16 4 12 8 16 4 12 |
| -1-1 | 12 14 | 1.00 | 200 | 77 | 2 | - | - |

L

В

E S.

| а. | t | • | 45 | 2 | 24 | - |
|----|------|---|----|----|----|---|
| | 1000 | • | 24 | υ. | 2 | |
| | | | | | | |

At 81 for 20

| Bl. Tin | Whit | e Tin | Bl. Tin | 1 1 | Thit | e T | in |
|---|-----------------------------------|--|--|-------------------------------------|---|---|--|
| 15 | ŤБ | 20 | C. | c. | Q | 115 | 20 |
| I 2 3 4 5 6 7 8 9 10 11 12 13 14 28 56 | I I I 2 2 2 3 3 4 4 5 5 5 5 11 23 | 81 17 52 14 21 11 19 8 16 2 19 19 18 16 | 1 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 0 7 8 0 | I I 2 2 2 3 3 4 8 12 17 21 25 29 34 | 1 3 1 2 2 3 1 3 1 2 3 1 1 2 3 1 1 1 2 3 1 1 2 3 1 1 1 2 3 1 1 1 1 | 19 11 222 14 5 25 16 8 | 12 4 16 8 12 4 16 8 |
| 84 | 35 | 14 | 90 100 200 | 38 42 85 | 1 2 | 12121 | Lill |

At 81 for 20

| Bl. Tin | Whit | e Tin | Bl. Tin | v | White Tin | | | |
|-----------------------------------|---|---|---|---|---------------------------------|--|--|--|
| 16 | th | 20 | С. | C. | 2 | 15 | 20 | |
| 1 2 3 4 56 78 9 0 1 1 2 3 4 56 84 | I I 2 2 2 3 3 4 4 4 4 5 5 1 I 2 3 3 4 1 4 4 5 5 1 I 2 3 3 4 | 84 16 44 13 14 97 44 13 14 17 6 14 19 7 15 11 2 13 14 15 14 15 14 15 14 15 15 15 15 15 15 15 15 15 15 | 1 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 0 10 10 10 10 10 10 10 10 10 10 10 10 1 | I I 2 2 2 3 3 4 8 12 16 0 24 8 33 7 4 I 8 2 | 1 3 2 1 3 1 2 1 1 2 2 3 3 1 1 2 | 18 8 26 16 7 25 5 5 23 14 14 14 14 14 14 | 48 12 16 48 12 16 48 12 16 1 1 1 1 1 1 1 1 | |

| | 0. | ~ | |
|-----|-----|-----|----|
| At | XX | for | 20 |
| 220 | UT. | TOT | 20 |
| | 1 | | |

| Bl. | 1.000 | | Bl. | | 1 | | |
|----------|----------|---|----------------|----------|-----|-----|----|
| Tin | Whit | e Tin | Tin | N | hit | e T | in |
| th | 肪 | 20 | C. | C. | 2 | 115 | 20 |
| 1 | I | 81 171 | 12 | | 13 | 21 | - |
| | I | 61 15 | 3 | I | I | 7 | - |
| 3 4 56 | 2 | 31 | 4 56 | 2 | 3 | 21 | - |
| 78 | 2 | 12 ¹ / ₃ 1 ¹ / ₄ | 78 | 23 | 2 | 14 | - |
| 8 | 33 | 10 181 | 8 | 33 | 2 3 | 21 | - |
| 11 | 4 | 7 ¹ / ₁ | 10 20 | 4 8 | 13 | 14 | - |
| 12 | 4 4 5 56 | 5 | 30 | 13 | - | 14 | - |
| 13 14 | 6 | 131 21 | 40 50 | 17 21 | 23 | 14 | - |
| 28 | 12 | 5 | 60 70 80 | 26 30 | 12 | 14 | - |
| 56 84 | 24 36 | 10 15 | 80 90 | 35 39 | - | 14 | - |
| | - | 100 | 100 | 43 87 | 3 2 | 11 | 1 |

301

At 9 for 20 A

| Bl. Tin | White | Tin | Bl. Tin | TW | BL. | | |
|---|--|---|---|---|-------------------------------|---|--|
| The | 115 | 20 | C. | C. | 2 | ŤЪ | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 5 6 84 | I I I 2 2 3 3 4 4 4 4 5 5 6 12 25 37 | 9 18 7 16 5 14 3 12 1 9 8 17 6 12 4 16 | 1 2 3 4 5 6 7 8 9 10 20 30 40 50 60 7 8 9 10 20 30 40 50 6 7 8 9 10 20 30 40 50 7 8 9 10 20 30 40 50 10 10 10 10 10 10 10 10 10 10 10 10 10 | 1 1 1 2 2 3 3 4 4 9 13 18 22 27 31 36 40 45 | 1 3 1 3 1 2 2 2 2 2 2 2 2 2 2 | 22 16 11 5 22 16 11 5 11 5 11 1 5 11 1 1 1 1 1 1 1 1 | 18 16 4 12 8 16 4 12 16 4 12 14 12 14 12 14 12 14 12 14 12 14 14 14 14 14 14 14 14 14 14 14 14 |
| | 1 1 | Part o | 1200 | 190 | - | - | |

| Bl. Tin | White | Tin | Bl. Tin | w | hite | T | 18 inf |
|---|--|---|--|-----|---|--|---|
| outbill | 15 | 20. | C.0 | C. | 21 | tb | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 56 84 | I I 2 2 3 3 4 4 5 5 6 6 13 26 39 | 91 19 19 18 18 17 61 15 15 15 15 14 14 13 6 12 18 | 1 2 3 4 5 6 7 8 9 10 20 30 40 50 60 70 80 90 100 | | 1 3 1 3 1 3 1 3 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 | 25 22 19 16 14 11 '8 5 2 | 4 8 12 16 4 8 12 16 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 |
| | -18 | 1.00 | 1200 | 195 | | | 1- |

*

At 91 for 20

At 91 for 20

At 91 for 20

| Bl. Tin | Whit | é Tin | Bl. Tiw | w | hit | eh | BI. inT |
|---|--|--|---|--|-----------------------------------|----|---|
| The | 15 | 20. |) C. o | C. | 0. | 15 | 20 |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$ | 1 1 2 2 3 3 4 4 5 5 6 6 12 25 38 | 9 18 7 17 6 15 4 14 32 14 11 1 9 19 18 19 19 18 17 19 18 17 15 15 15 15 15 15 15 15 15 15 | 1 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 0 0 10 10 10 10 10 10 10 10 10 10 10 10 | I I 2 2 3 3 4 4 9 13 2 3 7 3 2 7 3 2 7 3 2 7 4 4 6 | 1 31 31 3 2 2 1 2 3 2 4 3 1 1 2 1 | | #6 12 8 16 12 8 4 1 |

| Bl. (Tin | White | : 18 Din | Bl. Tin | M | hit | | a in |
|--|---------------------------------|--|---|-----|---|--|---------|
| 05 16 | Stb | 200 | C. | C. | 2 | 115 | 120 |
| 11 2 3 4 4 5 6 7 8 9 10 14 12 13 14 28 56 84 | 1 1 2 2 3 3 4 4 5 56 6 13 27 40 | 94 194 194 194 184 184 184 174 174 175 164 164 13 6 19 | 1 2 3 4 5 6 7 8 9 10 20 30 40 50 60 70 8 0 9 10 20 10 10 10 10 10 10 10 10 10 10 10 10 10 | | I 3 1 3 1 3 3 2 2 I I 3 3 3 2 3 3 3 3 3 3 3 3 3 3 | 26 25 23 22 21 19 16 15 14 14 14 14 14 | |
| | - 120 | 1100 | 200 | 197 | 2 | - | - |

Hhhh

A B L

At 10 for 20

3 -

| | _ | _ | | 1 | - | _ | _ |
|--|-------------------------------------|----------------------|--|--|---------------------------------|-----------------------|----|
| Bl. Tin | Whit | e Tin | Bl. Tin | w | hite | Ti | n |
| 15 | 15 | 20 | C. | C. | 2 | 1Ь | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 5 8 4 | I 1 2 2 3 3 4 4 5 5 6 6 7 J 4 28 42 | 111 1010101010101010 | 1 2 3 4 56 78 9 0 20 30 0 78 9 0 0 100 78 9 0 0 100 78 9 0 0 100 78 9 0 0 100 100 78 9 0 0 100 100 100 100 100 100 100 100 1 | 1 1 2 2 2 3 3 4 4 5 10 15 20 25 30 35 40 45 50 | 2 2 2 2 2 2 2 1 2 1 1 1 1 1 1 1 | 144414441414141414111 | |
| 1-1 | 1-13 | 1 22 | 200 | 100 | - | - | - |

| 211 | 101 | 101 | 20 |
|-----|-----|-----|----|
| | | | |
| | | | |

| Bl. Tin | White Tin Bl. | | Bl. Tin | White Tin | | | |
|--|-------------------------------------|--|--|--|--|----|--|
| њ | tb | 20 | C. | C. | Q | 15 | 20 |
| 1 2 3 4 56 7 8 9 0 1 1 2 3 4 56 7 8 9 0 1 1 2 3 1 4 2 8 56 4 | I I 2 2 3 3 4 4 5 5 6 6 7 I 4 29 44 | 10 ¹ / ₁ 1 1 ¹ / ₂ 2 12 ¹ / ₃ 13 ¹ / ₄ 4 14 ¹ / ₄ 5 15 ¹ / ₆ 16 ¹ / ₂ 7 14 8 2 | 1 2 3 4 5 6 7 8 9 10 20 30 40 56 7 8 9 10 20 30 40 56 7 8 9 10 20 30 40 56 7 8 9 10 20 30 40 56 7 8 9 10 20 56 7 8 9 10 20 56 7 8 9 10 20 56 7 8 9 10 20 56 7 8 9 10 20 56 7 8 9 10 20 56 7 8 9 10 20 56 7 8 9 10 20 56 7 8 9 10 20 56 7 8 9 10 20 56 7 8 9 10 20 56 7 8 9 10 20 56 7 8 9 10 20 56 7 8 9 10 20 20 20 20 20 20 20 20 20 20 20 20 20 | 1 1 2 2 3 3 4 4 4 5 10 15 21 26 31 36 42 47 52 | 2 2 2 2 2 2 2 2 1 2 3 1 1 2 3 1 2 3 1 2 2 1 2 1 | | 16 12 8 4 16 12 8 4 |
| - | | 00 0 | 200 | 105 | - | - | - |

At io! for 20

| Bl. Tin | Whit | e Tin | Bl. Tin | w | hite | Ti | n |
|---|---|--|---|--|-----------------------------|--------------------------------------|--|
| the | 助 | 20 | C. 1 | C. | 2 | 115 | 20 |
| 1 2 3 4 56 78 9 0 11 2 3 4 56 78 9 0 11 2 3 4 56 58 4 | 1 1 2 2 3 3 4 4 5 5 6 6 7 4 4 2 8 4 3 4 4 5 5 6 6 7 4 4 8 4 3 | 104 104 104 104 114 114 224 124 124 134 34 7 14 1 7 14 1 | 1 2 3 4 5 6 7 8 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | 1 1 2 2 3 3 4 4 5 0 15 20 25 30 35 41 46 51 | 2 2 2 2 2 2 1 1 2 2 3 3 1 1 | 1 2 4 5 7 8 9 11 2 4 4 4 4 4 4 4 4 4 | 8 16 4 12 8 16 4 12 8 16 4 12 16 4 12 16 4 12 16 16 16 16 16 16 16 16 16 16 |
| | | 00 | 200 | 102 | 2 | - | 1 |

At 101 for 20

| Bl. Tin | Whit | e Tin | Bl. Tin | w | hice | Ti | n |
|---|-----------------------------------|--|---|--|---------------------------|--------------------------|-----|
| Ш | 15 | 20 | C. | C. | 2 | th | 120 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 56 84 | 1 1 2 2 3 3 4 4 5 5 6 6 7 5 3 4 5 | 101 12 12 12 12 12 12 12 12 12 12 12 12 12 | 1 2 3 4 5 6 7 8 9 10 20 30 4 5 6 7 8 9 10 20 30 4 5 6 7 8 9 10 20 30 4 5 6 7 8 9 10 | I I 2 2 3 3 4 4 5 10 16 21 26 32 37 43 48 53 | 2 2 2 31 31 3 2 3 2 4 1 3 | 48 12 15 1 5 9 4 4 4 4 4 | |
| | - | 1010 | 200 | 107 | 2 | +- | - |

302

TABLES.

303

At 11 for 20

At 111 for 20

-

| Bl. Tin | White | e Tin | Bl. Tin | w | hite | Ti | n | | | |
|---|-------------------------------------|--|--|--|---------------------------|---|----|--|--|--|
| 15 | 甛 | 20 | C. | С. | 2 | 15 | 20 | | | |
| 1 2 3 4 5 6 7 8 9 0 11 12 3 4 5 6 7 8 9 0 11 12 3 4 5 6 7 8 9 0 11 12 3 4 5 6 7 8 9 0 11 12 3 4 5 6 7 8 9 0 11 12 3 4 5 6 7 8 9 10 11 12 12 12 12 12 12 12 12 12 12 12 12 | I I 2 2 3 3 4 4 5 6 6 7 7 1 5 3 4 6 | 11 2 13 4 15 6 17 8 19 10 1 12 3 14 8 16 4 | 1 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 3 4 5 6 6 7 8 9 0 100 | 1 1 2 2 3 3 4 4 5 11 6 2 2 7 3 3 8 4 4 9 5 5 | 2 2 3 1 3 1 3 2 2 2 2 2 2 | 5 11 16 22 5 11 16 22 5 11 16 22 11 16 22 11 16 22 11 16 22 11 16 22 11 16 22 11 16 22 11 16 22 11 16 22 11 16 22 11 16 22 11 16 22 11 16 22 11 16 22 16 16 16 16 16 16 16 16 16 16 | | | | |
| | | 110 | 200 | 55 | - | - | - | | | |

| Bl. Tin | Whit | e Tin | Bl. Tin | w | hite | Ti | n |
|---|------------------------------|---|-------------------------------|---|-------------------------|---|---|
| 15 | tb | 20 | C. | C. | 2 | 15 | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 56 | I I 2 2 3 4 4 5 566 78 16 32 | 11 ¹ / ₁ 3 ¹ / ₁ 14 ¹ / ₂ 17 ¹ / ₂ 9 ¹ / ₂ 12 ¹ / ₂ 15 ⁶ / ₂ 18 ¹ / ₂ 18 ¹ / ₂ 1 ² / ₄ 1 ³ / ₄ 1 ³ / ₄ 1 ⁴ / ₂ 1 ⁵ / ₆ 1 ⁴ / ₂ 1 ⁴ / ₂ 1 ⁵ / ₆ 1 ⁴ / ₂ 1 ⁵ / ₆ 1 ⁵ ⁵ / | 1 2 3 4 56 78 9 0 2 3 4 56 78 | 1 1 2 2 3 4 4 5 5 1 1 7 2 3 2 8 3 4 0 6 | 2 2 1 3 1 2 3 2 1 3 2 1 | 8 16 25 5 14 22 2 11 19 | 8 16 4 12 8 16 4 12 |
| 84 | 48 | 6 | 90 100 200 | 51 57 115 | 32 | | |

At 111 for 20

| Bl. Tin | Whit | e Tin | Bl. Tin | w | hite | Ti | n |
|---|---|---|--|---|-----------------------------------|---|---------------------------------------|
| t5 | 肪 | 20 | C | C. | 2 | 1b | 20 |
| 1 2 3 4 56 78 90 11 2 3 4 28 6 4 28 6 4 | 1 1 2 2 3 3 4 5 5 5 6 6 7 7 1 5 3 1 4 7 1 5 1 4 7 | 112 2 2 3 5 16 7 18 0 1 2 2 3 5 6 2 2 1 16 7 18 0 1 2 2 3 5 6 2 2 1 15 10 5 | I 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 3 4 5 6 7 8 9 10 2 0 10 2 0 10 10 10 10 10 10 10 10 10 10 10 10 1 | 1 1 2 2 3 3 4 5 5 1 1 6 2 2 8 3 3 9 5 5 6 5 2 | 2 2 1 3 1 3 2 2 1 3 2 3 1 2 1 3 2 | 7 14 21 7 14 21 7 14 14 14 14 14 | I I I I I I I I I I L L L L I L L I I |

| Bl. Tin | Whit | e Tin | Bl. Tin | w | hite | Ti | ŋ |
|--|--------------------------------------|--|--|---|-----------------------------|---|----|
| tb | 訪 | 20 | C. | C. | 2 | ŤБ | 20 |
| I 2 3 4 5 6 7 8 9 10 11 12 3 4 5 6 7 8 9 10 11 12 3 4 5 6 7 8 9 10 11 12 3 4 5 6 7 8 9 10 11 12 3 4 5 6 7 8 9 10 11 12 3 4 5 6 7 8 9 10 11 12 12 12 12 12 12 12 10 10 10 10 10 10 10 10 10 10 10 10 10 | I I 2 2 3 4 4 5 5 6 7 7 8 16 3 2 4 9 | 11 ¹ / ₂ 3 ¹ / ₂ 15 ¹ / ₂ 15 ¹ / ₂ 16 ¹ / | 1 2 3 4 56 78 9 0 20 30 0 78 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | I I 2 2 3 4 4 5 5 I I 7 2 3 9 3 4 I 7 2 8 3 4 4 5 5 1 1 7 2 3 9 3 5 I 1 7 5 8 | 2 31 32 2 1 3 3 2 2 1 1 3 3 | 9 19 11 21 22 42 14 14 14 14 14 14 14 | |
| | 11 | sil 2 | 200 | 117 | 2 | - | - |

At 111 for 20

LE

At 12 for 20

T

At 121 for 20

S.

| Bl. Tin | Whit | hite Tin Bl. White Tir | | | White | | |
|--|---|------------------------|---|--|-----------------------|-----------------------------------|--|
| 15 | ŤΒ | 20 | C. | C. | 2 | 115 | 20 |
| 1 2 3 4 5 6 7 8 9 0 11 2 3 4 5 6 7 8 9 0 11 2 3 14 2 8 5 8 4 | 1 1 2 3 3 4 4 5 6 6 7 7 8 16 33 50 | 12 4 16 8 | 1 2 3 4 5 6 7 8 9 0 2 0 4 0 6 7 8 9 0 2 0 1 0 0 7 8 9 0 0 0 1 0 0 7 8 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | 1 1 1 2 3 3 4 4 5 6 6 1 2 4 3 6 6 4 2 4 4 5 6 6 6 1 2 2 4 5 6 6 6 1 2 1 2 3 3 3 4 4 4 5 6 6 6 1 2 1 2 3 3 3 3 4 4 4 5 6 6 6 1 2 1 2 3 3 3 4 4 4 5 6 6 6 6 1 2 2 4 5 6 6 6 1 2 2 4 5 6 6 6 7 1 2 1 2 1 2 4 5 6 6 6 7 1 2 4 5 6 6 6 7 1 2 4 5 6 6 6 7 1 2 4 5 6 6 6 7 1 2 4 5 6 6 6 7 1 2 4 5 6 6 6 7 1 2 4 5 6 6 6 7 1 2 4 5 6 6 6 6 7 1 2 2 4 8 8 5 4 2 4 8 5 4 5 4 5 4 5 6 6 6 6 6 6 6 6 7 1 2 2 4 8 8 5 4 2 4 8 5 4 2 4 8 5 4 5 4 5 6 6 6 6 6 6 7 7 7 7 7 7 7 7 7 7 7 7 7 | 2 31 2 31 1 1 1 1 1 1 | 11 22 516 11 22 56 | 4 8 12 16 4 8 12 16 |

Bl. Tin White Tin Bl. White Tin C. Q 15 20 15 肪 C. 20 TI 121 2 14 1 2 3 4 5 6 7 8 9 10 11 I 1 0 2 3345566 5 17 10 788 12 13 21 14 15 28 17 35 52 10 -56 -84 -10

At 121 for 20

| Bl. Tin | White | e Tin | Bl. Tin | w | hite | Ti | n |
|---|--------------------------------|---|---|---|--|---|-----|
| 15 | 15 | 20 | C. | C. | Q | 15 | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 56 | 1 1 2 3 3 4 4 56 6 7 7 8 17 34 | 124 45 16 1 9 13 5 1 8 10 2 14 1 7 19 11 3 6 | 1 2 3 4 5 6 7 8 9 10 0 0 4 5 6 7 8 9 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | 1 1 2 3 3 4 4 4 5 6 6 1 2 2 1 8 8 2 4 3 0 3 6 4 2 4 9 | 2 3 1 2 1 3 2 1 1 2 2 3 3 1 | 12 25 9 22 7 19 46 1 14 14 14 14 | |
| -84 | 51 2 | 9 | 90 100 200 | 55 61 122 | 1 2 | 14 | 111 |

At 121 for 20

| Bl. Tin | Whit | e Tin | Bl. Tin | w | hite | Ti | n |
|---|--|---|---|--|---|---|-----------------------------------|
| 15 | 115 | 20. | D.C. (| C. | Q | 15 | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 56 84 | 1 1 2 3 3 4 5 5 6 7 7 8 8 17 3 5 3 1 1 7 5 5 3 | 12 5 18 1 1 3 5 18 1 1 3 5 16 9 2 14 5 18 10 9 2 14 5 18 10 9 2 14 5 5 18 10 10 10 10 10 10 10 10 10 10 | 1 2 3 4 5 6 7 8 9 10 20 30 40 56 7 8 9 10 20 40 56 7 8 9 10 20 40 56 7 8 9 10 20 40 56 7 8 9 10 20 40 56 7 8 9 10 20 9 10 20 9 10 20 9 10 20 9 10 20 9 10 20 9 10 20 9 10 20 9 10 20 9 10 20 20 20 20 20 20 20 20 20 20 20 20 20 | 1 1 2 3 3 4 5 5 5 6 12 19 2 5 3 18 3 4 4 5 1 5 7 6 3 127 | 2 I 3 2 3 I 2 1 3 2 3 I 2 1 3 2 3 I 2 1 3 2 3 I 2 1 3 2 3 I 2 1 3 2 3 I 2 1 3 2 3 I 2 1 3 2 3 I 3 2 1 3 1 3 | 15 21 8 5 21 8 23 11 26 14 14 14 14 14 | 8 16 4 12 8 16 4 12 1 1 1 1 1 1 1 |

T A B L E S,

305

At 13 for 20

| Bl. Tin | White | e Tin | Bl. Tin | w | hite | Ti | n |
|---|---|--|--|---|---------------------------|---|--|
| Ťb | 1b | 20 | C. | C. | 2 | 15 | 20 |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 28 56 84 | 1 1 2 3 3 4 5 56 7 78 9 18 36 54 | 13 6 19 12 5 18 11 4 17 10 3 16 9 2 4 8 12 | I 2 3 4 5 6 7 8 9 10 20 30 4 5 6 7 8 9 0 20 30 4 5 6 7 8 9 0 | 1 1 2 3 3 4 5 5 5 6 13 1926 32 2 39 4 5 2 5 8 | 2 1 3 2 1 3 2 3 2 2 2 2 2 | 16 5 22 11 16 5 22 11 16 5 22 11 | 16 12 8 4 8 12 8 4 12 8 4 1 1 1 1 1 |
| atter. | | 1 | 100 | 65 | = | = | = |

| Bl. Tin | Whit | e Tin | Bl. Tin | | hin | Ti | - |
|------------|-------------|-------|------------|------|------|----|----|
| A III | winte | c I m | 1 m | ** | mite | | n |
| ŤЬ | 15 | 20 | C. | C. | 2 | 1b | 20 |
| I | - | 131 | I | - | 2 | 19 | 12 |
| 2 | I | 7 | 2 | I | I | II | 4 |
| 3 4 56 | 2 | 1 | 3 | 2 | - | 2 | |
| . 4 | 2 | 14 | 4 | 2 | 2 | 22 | 8 |
| 5 | 3 4 4 5 6 6 | 71 | 4 56 | 3 | I | 14 | - |
| | 4 | I | | 4 | - | 5 | 12 |
| 78 | 4 | 143 | 78 | 4 | 2 | 25 | 4 |
| | 5 | 8 | 8 | 56 | I | 16 | 4 |
| 9 | 6 | Ił | 9 | 6 | - | 8 | 8 |
| 10 | 6 | 15 | 10 | 6 | 3 | - | - |
| 11 | 7 | 81 | 20 | 13 | 2 | - | - |
| 12 | 78 | 2 | 30 | 20 | 1 | - | - |
| 13 | 8 | 151 | 40 | 27 | - | - | - |
| 14 | 9 | 9 | 50 | 33 | 3 | - | - |
| - | | | 60 | 40 | 2 | - | - |
| 28 | 18 | 18 | | 47 | | | - |
| 56 | 37 | 16 | 70 80 | 54 | | - | - |
| 84 | 56 | 14 | 90 | 60 | 3 | - | - |
| - | | | 100 | 67 | 2 | - | - |
| | 1. 19 | | 200 | 135 | | - | ¥. |
| | 1116 | | | - 20 | | | |

At 131 for 20

| _ | _ | | | | - | | 100 C |
|----------------------------------|-------------------------|---|---|---------------------------------|---|--|---|
| Bl. Fin | White | e Tin | Bl. Tin | w | hite | Ti | n |
| 15 | 15 | 20 | C. | C. | 2 | 15 | 20 |
| I 2 3 4 5 6 7 8 9 10 11 12 13 14 | I I 2 3 3 4 5 56 7 78 9 | 13 ¹ 6 ¹ 19 ¹ 13 6 ¹ 19 ¹ 12 ¹ 6 ¹ 19 ¹ 12 ¹ 6 ¹ 19 ¹ 12 ¹ 5 ¹ 19 12 ¹ 5 ¹ 5 ¹ | 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 5 | 1 1 2 3 3 4 5 5 6 1 3 9 2 6 3 3 | 2 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 3 2 1 1 1 3 2 1 1 3 2 1 1 1 3 2 1 1 3 2 1 1 3 2 1 1 3 2 1 1 3 2 1 1 3 2 1 1 3 2 1 1 1 3 2 1 1 3 2 1 1 1 3 2 1 1 3 2 1 1 1 3 2 1 1 3 2 1 1 3 2 1 1 1 3 2 1 1 3 2 1 1 1 3 2 1 1 3 2 1 1 1 3 2 1 1 3 2 1 1 3 2 1 1 1 1 | 18 26 16 7 25 15 5 23 14 14 14 | 4 12 16 4 8 12 16 4 8 12 16 16 16 16 16 16 16 16 16 16 |
| 28 56 84 | 18 37 55 | 11 2 13 | 60 70 80 90 100 200 | 39 46 53 59 66 | 3 1 2 1 2 | 14 | 1111 |

| B1. | 1 | 1 | Bl. | | | | |
|--------|-------------------|--------|----------|-----|------|-----|----|
| Tin | White | e Tin | Tin | W | hite | Ti | n |
| ŤЪ | 15 | 20 | C. | C. | Q | 115 | 20 |
| I | _ | 131 | I | | 2 | 21 | 1 |
| 2 | I | 71 | 2 | I | I | 14 | _ |
| | 2 | 11 | 3 | 2 | _ | 7 | 1 |
| 3 4 56 | | 15 | 3 4 56 | 2 | 3 | - | - |
| 5 | 3 | 81 | 5 | 3 | I | 21 | - |
| 6 | 4 | 2분 | 6 | 4 | - | 14 | - |
| | 2 3 4 4 5 6 6 7 8 | 161 | | 4 | 3 | 7 | |
| 78 | 5 | 10 | 78 | 56 | 2 | - | - |
| 9 | 6 | 34 | 9 | 6 | - | 21 | - |
| 10 | 6 | 171 | 10 | 6 | 3 | 14 | - |
| 11 | 7 | IIż | 20 | 13 | 3 | - | - |
| 12 | 8 | 5 | 30 | 20 | 2 | 14 | |
| 13 | 8 | 181 | 40 | 27 | 2 | - | |
| 14 | 9 | 121 | 50 | 34 | 1 | 14 | - |
| - | | | 60 | 41 | I | - | - |
| 28 | 19 | 5 | 70 80 | 48 | - | 14 | - |
| 56 | 38 | 10 | | 55 | - | - | - |
| 84 | 57 | 15 | 90 | 61 | 3 | 14 | - |
| | | | 100 | 68 | 3 | | - |
| | 1 | al and | 200 | 137 | | - | - |

At 131 for 20

Iiii

At 131 for 20

T

| | | | | | 2 m | | | | | 1 | | |
|---|---|--|--|--|----------------------------|--|---|---|--|--|--------------------------------------|--|
| | | | | | | | 1 | | | | White | 1 |
| | | | | | | | | - | | | | |
| | | | | | | | | | | | 15 | |
| | | | | | | | | | | | | |
| | | | | | | | | i | | | T | |
| | | | | | | | | | | | 1 I w | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | W 10 | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | the care | |
| | - | | | | | | | | | | 12 | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | 20 | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | 53 | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | and the second |
| | | | | | | | | | | | | The second second |
| | | | | | | | | | | | White | The second second |
| | | | | | | | | | | | | La sul la sul sul |
| | | | | | | | | | | | White | ALMAN A ALMAN |
| | | | | | | | | | | | White | The second secon |
| | | | | | | | | | | | White | |
| | | | | | | | | | | | White | |
| | | | | | | | | | | | White | |
| 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | | | | | | | | O Full ward to | 1 1 1 1 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 | | White | The second is the second secon |
| 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | | | | | | | | O Full ward to | 1 1 1 1 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 | Line and the second | White | |
| | | a output - C Ain | | elity of the state of the | | | | Of Full war a war w | 5 0 1 | Line and the second | We want and the second | |
| | | and the second s | an of tests and so on the | elity of the state of the state | | | | 19 Energy and | 5 0 | The second secon | We want and the second | |
| | | a HEAD was no was est | The second second | and the second second | | | | 19 1 | S Office and a state of the sta | The second secon | We want and the second | |
| | | and the second s | The second second second | ada date y - at - 1 - 1 - 1 | | | | O Line war and - war w | an adam of a state of a | TA DE ALL DE LE | We want and the second | |
| | | a HEAD was no was est | The second secon | and a state of the | | | | 0 | and a set of the set o | | Martin and Martin and Indiana | |
| | | and and the second seco | The second second second | ada date y - at - 1 - 1 - 1 | the lot and the lot of the | | | O the war war war with | a for a start of the second of the second se | | a main an | |
| | | and and the second seco | The second secon | a main and a serie of the series of the | the lot and the lot of the | | | O Comment of an and a well in | A CALLER CONTRACTOR CONTRACTOR | | a man awak was a il a h | |
| | | a Hit O we we we all the set of the set | | a main and a serie of the | the lot and the lot of the | | | Of the way is start - way a with I way | Charles and a service of the service | | a main an | |
| | | and and the second seco | The second secon | a main and a serie of the series of the | | | | Of the way is start - way a with I way | A CALLER CONTRACTOR CONTRACTOR | | a man awak was a il a h | The second se |

.

APPENDIX.

A MONG the variety of improvements that may be fuggefted for the intereft of Mining, those certainly are most beneficial, which tend to the perfection of mechanicks and hydraulicks; for had there not been great progress made in those branches of philosophy within the last improved ages of fcience, Mining would still confiss of merely digging a few fathoms deep, and raising the stuff and water, by dint of human labour.

About four-fcore years back, fmall wheels of twelve or fifteen feet diameter, were thought the beft machinery for draining the Mines; and if one or two were infufficient, more were often applied to that purpofe, all worked by the fame ftream of water. I have heard of feven in one Mine, worked over each other. This power muft have been attended with a complication of accidents and delays. However, foon after the above date, Mr. John Coftar, of Briftol, came into this county, and taught the natives an improvement in this machinery, by demolifhing those petit engines, and fubftituting one large wheel of between thirty and forty feet diameter in their ftead.

Hitherto we are all affured, that a large water wheel engine, if water is plenty and cheap, is most effectual and steady for the purpose of draining our Mines; but this power is limited; and beyond a certain gauge we dare not undertake. We know, that if we add to our power, we experience a loss in time or motion, more than equivalent to the acquisition. Upon this principle we understand, that a thirty-eight feet wheel, or thereabout, is the best medium we can prescribe to ourfelves; pursuant to which we know, that, beyond a certain depth, we cannot fink with ease and conveniency to our interest; and that another power becomes necessary for our purpose.

It fhould feem as if we had been led by the kind hand of Providence in those discoveries; for as soon as we found out the ne plus ultra of the power of water, and the necessity of further 308

P

P

A

E

I

X.

further improvements in hydraulicks, a new and more fcientifick machinery prefented itfelf to the attention of the Miner. For want of another piece of machinery, we had been ftinted to a certain depth, beyond which the fucceeding generation by the water wheel and bobs would be unable to fink. So that, happily for us and our pofterity, Mr. Newcomen's invention of the fteam fire engine, even in the weaknefs of its infancy, promifed that future excellence to which it is fince arrived, whereby we are enabled to fink our Mines to twice the depth we could formerly do by any other machinery.

N

D

Since the improvement of this machine's working itfelf, by opening and clofing the regulator and injection cock, most other attempts have been very unfuccefsful. The vaft confumption of fuel in those engines, is an immense drawback upon the profits of our Mines. It is a known fact, that every fire engine of magnitude confumes to the amount of three thousand pounds worth of coal in every year. This heavy tax upon Mining, in fome refpects, amounts to a prohibition. No wonder then, that we should be more defirous to lesien the expence of maintenance in those devouring automatons, than frugal in their crection. Many trials of mechanical skill have been made by our engineers, to very little purpose, for the total application of heat and the faving of fuel. The fire place has been diminished, and enlarged again; the flame has been carried round from the bottom of the boiler in a fpiral direction, and conveyed through the body of the water in a tube (one, two, or three) before its arrival to the chimney; fome have ufed a double boiler, fo that fire might act in every poffible point of contact; and fome have built a Moorftone boiler, heated by three tubes of flame paffing through it.

Indeed, the only improvement which has been made in the fire engine for thirty years paft, the publick will very juftly attribute to the fagacity of Mr. Watt, whofe fkill in pneumaticks, mechanicks, and hydraulicks, is evidenced by the powerful application of elaftick vapour, and by making a more perfect vacuum, nearly like that of the barometer, in his new conftructed fire engine.

But before I can explain Mr. Watt's engines, it is neceffary to premife a fhort account of the imperfections of the common fteam engines, and their caufes.

The

P

P

I

X:

309

The fleam, or vapour, which arifes from water confined in a clofe veffel, and heated a few degrees above the point at which it boils in the open air, becomes an elaftick fluid uniform and transparent, about half the gravity of atmospherick air, very much greater in bulk than the water of which it is composed, and capable of being again reduced to water, when brought into contact with matter of a lefs degree of heat than itfelf.

The preffure of the atmosphere, or any equivalent refiftance, prevents the production of fteam, until the water be heated to 212 degrees of Fahrenheit's thermometer; but when that preffure is removed, or the water placed in a veffel exhausted of air, fteam is produced from it, when it is colder than the human blood. On the contrary, if water be prefied upon by air or fteam, which are more compressed than the atmosphere, a degree of heat above 212 degrees is necessary for the production of fteam; and the difference of heats, at which water boils under different prefsures, increases in a less proportion than the prefsures themselves: so that a double prefsure requires less than a double increase of fensible heat.

The experiments which have been published concerning the bulk of water, when converted into steam, are erroneous, and the conclusions drawn from them make that bulk greater than it really is. It has been known for some time, that water would boil in an exhausted receiver, at a low degree of heat; but Mr. Watt was the first that made a regular set of experiments upon the subject, and determined the progression in which the heats followed under various preffures; and, at the same time, made experiments that were decisive upon the true bulk of steam, when compared to the water it is composed of. The result of these experiments he intends to lay before the publick, in a treatise upon that subject.

If we confider the common fleam engine, we fhall find it defective; firft, becaufe the vacuum is produced by throwing cold water into the cylinder to condenfe the fleam; that water becomes hot, and being in a veffel partially exhaufted produces a fleam, which in part refifts the preffure of the atmosphere upon the pifton, and leffens the power of the engine. The fecond defect is the deftruction of fleam, which unavoidably happens upon attempting to fill a cold cylinder with that fluid : for the injection water, at the fame time that it condenfes the K k k k fleam, PPEND

I

х.

fteam, not only cools the cylinder but remains there, until it be extruded at the eduction pipe, by the fteam which is let in to fill the cylinder for the next ftroke; and that fteam will be condenfed into water as faft as it enters, until all the matter it comes into contact with be nearly as hot as itfelf.

Every attempt to make the vacuum more perfect by the addition of injection water, will cool the cylinder more effectually, and caufe a greater deftruction of fteam in the next filling; and if the engine hath already a proper load, the deftruction of fteam will proceed in a greater ratio, than the increase of power by the amendment of the vacuum.

Though it appears, that the conftructors of fteam engines have never inveftigated these causes; yet they have been so fenfible of the effects, that a judicious engineer does not attempt to load his engine with a column of water, heavier than seven pounds for each square inch of the area of the piston.

Mr. Watt's improvement is founded upon thefe, and fome other collateral observations. He preferves an uniform heat in the cylinder of his engines, by fuffering no cold water to touch it, and by protecting it from the air, or other cold bodies, by a furrounding cafe filled with the fteam, or with hot air or water, and by coating it over with fubftances that transmit heat flowly. He makes his vacuum to approach nearly to that of the barometer, by condenfing the fteam in a feparate veffel, called the Condenfer, which may be cooled at pleafure without cooling the cylinder, either by an injection of cold water, or by furrounding the condenfer with it, and generally by both. He extracts the injection water and detached air, from the cylinder or condenfer, by pumps which are wrought by the engine itself, or he blows it out by the steam. As the entrance of air into the cylinder would ftop the operation of the engines, and as it is hardly to be expected that fuch enormous piftons, as those of steam engines, can move up and down, and yet be absolutely air tight in the common engines; a ftream of water is kept always running upon the pifton, which prevents the entry of the air; but this mode of fecuring the pifton, though not hurtful in the common ones, would be highly prejudicial in the new engines. Their pifton is, therefore, made more accurately; and the outer cylinder having a lid which covers it, the steam is introduced above the piston; and when a vacuum is produced under it, acts upon it by its elafticity, as the atmofphere

310

fphere does upon common engines by its gravity. This way of working, effectually excludes the air from the inner cylinder, and gives the advantage of adding to the power, by increasing the elasticity of the steam.

The internal ftructure of the new engines fo much refembles the common ones, that to those who know that machine, a drawing is fcarcely neceffary, and I expect they will understand it from the following description.

The cylinder, the great beams, the pumps, &c. ftand in their ufual pofitions. The cylinder is fmaller than ufual in proportion to the load, and is very accurately bored. In the most complete engines, it is furrounded at a fmall diftance with another cylinder, furnished with a bottom and a lid. The interffice between the cylinders, communicates with the boiler by a large pipe, open at both ends; fo that it is always filled with fteam, and thereby maintains the inner cylinder always of the fame heat with the fteam, and prevents any condensation within it, which would be more detrimental than an equal condensation in the outer one.

The inner cylinder has a bottom and pifton, as ufual; and as it does not reach up quite to the lid of the outer cylinder, the fteam in the interflice has always free accefs to the upper fide of the pifton. The lid of the outer cylinder, has a hole in its middle; and the pifton rod, which is made truly cylindrical, moves up and down through that hole, which is kept fteam tight by a collar of oakum fcrewed down upon it.

At the bottom of the inner cylinder, there are two regulating valves, one of which admits the fteam to pafs from the interffice into the inner cylinder below the pifton, or fhuts it out at pleafure; the other opens or fhuts the end of a pipe, which leads to the condenfer. The condenfer confifts of one or more pumps furnifhed with clacks and buckets, (nearly the fame as in common pumps) which are wrought by chains faftened to the great working beam of the engine. The pipe, which comes from the cylinder, is joined to the bottom of thefe pumps, and the whole condenfer ftands immerfed in a ciftern of cold water fupplied by the engine. The place of this ciftern is either within the houfe under the floor, between the cylinder and the lever wall; or without the houfe, between that wall and the engine fhaft; as conveniency may require.

A P P E N D I X.

312

The condenfer being exhaufted of air by blowing, and both the cylinders being filled with fteam, the regulating valve which admits the fteam into the inner cylinder is fhut, and the other regulator which communicates with the condenfer is opened, and the fleam rufhes into the vacuum of the condenfer with violence; but there it comes into contact with the cold fides of the pipe and pumps, and meets a jet of cold water which was opened at the fame time with the exhauftion regulator; these instantly deprive it of its heat, and reduce it to water; and the vacuum remaining perfect, more fleam continues to rufh in, and be condenfed until the inner cylinder is exhaufted. Then the fteam which is above the pifton, ceafing to be counteracted by that which was below it, acts upon the pifton with its whole elafticity, and forces it to defcend to the bottom of the cylinder, and fo raifes the buckets of the pumps which are hung to the other end of the beam. The exhauftion regulator is now fhut, and the fteam one opened again, which by letting in the fleam allows the pifton to be pulled up by the fuperior weight of the pump rods; and fo the engine is ready for another stroke.

The working of thefe engines is more regular and fteady than the common ones, and from what has been faid, their other advantages are apparently very confiderable; but to fay exactly how much they excel common engines, is difficult, as common engines differ very much among themfelves. I am told, that the favings amount at leaft to two-thirds of the fuel, which is a very confiderable object where coals are as expensive as they are in Cornwall.

The new engines will raife from twenty thousand to twentyfour thousand cubick feet of water to twenty-four feet high, by one hundred weight of good pit-coal : and I am informed, that Mr. Watt's improvements do not reft here; for he means soon to exhibit to the world engines upon the same principles, though differing somewhat in construction, which will use much less fuel than those described, and will also be more convenient for, the purposes of Mining, than any kind of engine yet used.

He has alfo contrived a kind of mill wheel, which turns round by the powers of fleam exerted within it; but as he has not made its flructure publick, I cannot favour my readers with a defcription of it.

It

A

313

Χ.

It may not be unacceptable to give a fhort hiftory of the invention. These improvements were invented by Mr. James Watt, at Glafgow in Scotland, in 1764. He obtained his Majefty's letters patent for the fole use of his invention in 1768, and then made a larger machine than what he had formerly tried his experiments upon ; but feveral mechanical difficulties occurring in the execution of the machine, and his attention being engaged in other bufinefs, he laid afide the undertaking until 1774, when he came to Birmingham, and in conjunction with Mr. Boulton, of Soho near that place, he completed both a reciprocating and a rotative or wheel engine. He then applied to parliament for a prolongation of the term of his patent, which was granted by an act paffed in 1775. Since that time the bufinefs has been carried on by Mr. Boulton and him in partnership.

They have erected feveral engines in Staffordfhire, Shropfhire, and Warwickshire, and one small one near London. They have also lately finished another at Hawkesbury colliery near Coventry, which is justly supposed to be the most powerful engine in England. It has a cylinder fifty-eight inches diameter, which works a pump fourteen inches diameter fixty-five fathoms high, and makes regularly twelve ftrokes of eight feet long each in a minute. They are also now creeting three engines more in Cornwall, viz. at Ting Tang, Owanvean, and Tregurtha Downs: and have lately fet to work a fmall engine at Huel-Buffy Mine, which has a cylinder thirty inches diameter, that works a pump of fix inches and a half diameter in two fhafts by flat rods with great friction, three hundred feet diftant from each other, forty-five fathoms high in each fhaft, equal in all to ninety fathoms, and can make fourteen ftrokes of eight feet long in a minute, with a confumption of coal lefs than twenty bushels in twenty-four hours.

The terms they offer to the publick are, to take, in lieu of all profits, one-third part of the annual favings in fuel, which their engine makes when compared with a common engine of the fame dimensions in the neighbourhood. The engines are built at the expence of the ufers, and Meffrs. Boulton and Watt furnish such drawings, directions, and attendance, as may be neceffary to enable a refident engineer to complete the machine.

LIII

AN

It may not be unacceptable to give a front hiltory of the avention. Thele improvements were invented by Mr. James Man, 'ar Ghalgow in Scotland, in 1764. He obtained his and then made a large machine that what he had formerly and then made a large machine that what he had formerly are his experiments doon ; but feveral mechanical difficulties being dogsged in other bulinets, he had alide the undertaking with Mr. Herlion, of Schonner, her had alide the undertaking with Mr. Herlion, of Schonner that place, he completed both with Mr. Herlion, of Schonner that place her undertaking misch was granted by an aft paffed in 1775. Since that three which was granted by an aft paffed in 1775. Since that three the bulke her bulk an explored in the the then the misch was granted by an aft paffed in 1775. Since that three the bulke her her carried on the Mr. Houlton and him in

They have crefted leveral empires in Sufford bite, Shrouthire, and Warwick hire, and one tmall one near London. They have allo larely finified another at Hawketbury cellicry near Corentry, which is juftly fuppoled to be the moft powerful engine in Royland. Tehas a cylinder fifty-eight inches dameter, which works 2 pump fourtern inches diameter firey-five fathoms high, and in hes regularly twelve firoker of eight feet long each in a minute. They are allo now crefting these engines more morks a pump fourtern inches diameter firey-five fathoms in Conwall, viz, at Ting Tang, Owanvean, and Trecourtha Buffy Mine, which has a cylinder thirty inches diameter, that works a pump of the inches and a half diameter in two finds by flat rods with great friction, there hundred the fire duct ofther, forty-five fathoms high in cach that, equal in all the to all a state and a half diameter in two finds and the state friction, there hundred the fourter in the by flat rods with great friction, there hundred the firet different forther in the with a state fourter in the first the duct ofther, forty-five fathoms high in each that, equal in all the inset has a confirmation of coal left that two ducts ofther, forty-five fathoms high in each that, equal in all by the state insets, with a confirmation of coal left that two buffees in twenty-fice hours.

The terms they easer to the publick are, to take, in hea of all profits, one-third wort of the sonnal favings in fuel, which, their engine makes when compared with a common engine of the fame dimensions in the fielgbbouchood. The engines are built at the expense of the uters, and Messes. Boulton and Watt furnish fuelt drawings; directions,' and attendance, as may be necessary to enable a referent angineer to complete the machine.

NA

EXPLANATION

A N

OF THE

CORNU-TECHNICAL TERMS AND IDIOMS

INNERS,

Including those which are used in the Lead-Mines and Collieries

of GREAT-BRITAIN.

T

- ADIT, Tye, or Level. A Sough in the north of England. An Adit, quali, ab aditu ad aquas. (Carew's Survey). An Adit is a Conduit or Channel, begun on a valley or low ground at a diftance from the Mine, and thence continued at the fame depth or level home to the Mine, to cut in depth and drain off the water. Sometimes it may be brought home for the purpole before mentioned acrofs the country, and at other times on the courfe of a Lode to prove it as they go. And at other times, for the greater eafe and fpeed on the courfe of a Crofs-Lode, Goffan, or branch, according as circumftances are favourable.
- ADIT-END. The furthermost end or part of an Adit from its beginning, or the very place where the Miners are working under-ground towards the Mine.
- ADVENTURE. A Mine in working is fo called, and fo is the affair of being concerned in a Mine, as it is ufual to fay, "A perfon is about to take up an Ad-"venture."
- ADVENTURERS-Are those perfons concerned in a Mine who have Doles, fhares, or parts thereof. Out-Adventurers are those who contribute their quotas of the charge, but do not give

a daily attendance. But In-Adventurers are fuch who have Doles, and alfo work in or attend the affairs of the Mine for wages, or pay their cost by account for goods.

AFTER-LEAVINGS. See LOOBS.

- AIR-PIPE. A wooden pipe or tube, one end of which is above-ground, and the other end reaches down to the bottom of the Shaft, fo that the motion of the wind forces down air to the labourers.
- ALIVE. That part of the Lode which contains Tin, Copper, or Lead, and is worth the faving and dreffing for the furnace, in oppolition to that part of the Lode which is dead or barren, and holds no Metal.
- ANVIL. Cornifh Anvon. A hard ftone or any other thing on which they fpal or break up the large ftones of Ore for the better feparation of their different kinds.
- ARCH, or Pillar. A piece of the Lode or Country left ftanding up to fupport the Mine; the Arch being a Drift or hole broke through the pillar.
- Assay and Assaying. The product in Metal of one ounce of Tin or Copper Ore, or the process for knowing the product of any other Metal or Mineral.
- Astret. A board or plank. (Lhuyd).--Stull-An arch or ceiling of boards over the mens heads in a Mine, to fave them from the falling flones, rocks, or fcales of the Lode or its walls. To " throw the Deads to Stulls," is to throw the refufe part of the Mine on these arches or Stulls, both to fave the trouble of bringing it up to grafs, and because this helps to make the Mine the more fecure.-Stidalls. In Du Cange's Gloffary of Latin Words, Aftulla, or Haftulla,

ACCOMPT. Account, or Accountday—Either a monthly or any other day of meeting of the Mine-Adventurers; when they affemble together to adjust the charges of working the Mine, the particulars whereof are entered in a book called the Accompt-Book. The houfe of meeting, if on the Mine, is called the Accompt-Houfe.

Haftulla, fignifies a chip or fegment of wood cut off from a greater piece. (Vid. Pref. p. 15. Leland's Itinerary, vol. vii. 1769). Stull, a Bunding in Derbyfhire.

- AssistANTS. The commons or lower house of convocation or parliament of Tinners. Each Convocator appoints his own Affiftant, who is generally fuppofed to be a gentleman of veracity, integrity, and underftanding in all Mining affairs. There are twenty-four Convocators, and twenty-four Affiftants every convocation. See STANNARIES.
- ASTYLLEN. A fmall ward or ftoppage on purpofe in an Adit or Mine to prevent the free and full paffage of the water, by damming it up to a certain height, though not entirely to ftop its current. Alfo, a kind of hedge or rude wallwork to feparate Lode and Deads from each other when brought to grafs. Alfo, a hedge under-ground, as a wall to prevent the running of Deads.
- ATTAL, Attle, Adall, Addle. Corrupt, impure, of no value, off-cafts, Deads, or refuse parts of the working that the Miners find under-ground on reaffirming an old Adventure; that earth alfo which moulders away and falls down to the bottom of the Shaft, or pit, is called Attal, and fo is all the ftony earth broke in Mining which is not of a veiny nature. (Waftrey or Deads in Derbyfhire).
- ATTALL-SARAZEN. Saxons or Jews offcaft. (Carew's Survey).
- AXLETREE. A thick piece of timber in form of a cylinder with a large rope wound about it, and with which they bring up the work or Ore, and ufually let the men defcend and come up; but the windlass includes the axletree with its appurtenances, as layers, upftanders, ftays, and brace boards - Defined -Stows in the north of England, which are feven pieces of wood (fet up on the fuperficies of the earth) faitened together by pins of wood. Two are called Soultrees; two Stow-blades; two Hang-benches; and a Spindle; thefe Stows give a Miner, or any perfon who owns them, as good right to a meer or meers of ground (fo that every meer has a pair of Stows fet on them) as a deed of conveyance doth to any purchafer.

BACK-Of the Lode. That part of the Lode which is nearest and uppermost

alarge of qu at Bill

towards the grafs or furface. (The Roof, Derbyshire).

- BAL. A shovel, a plague, a place of digging; Balas, To dig—Palas, idem. (Borl. Vocab.) When many people are employed in a Mine of note, in fpaling, and forting the Ore, where it is brought to grafs, then they ftile this place where the concourfe of people meet and work, by the name of the Bal, efpecially if the place be feated on an eminence, for they fay, "A perfon is "gone up to Bal;" but if the place or Mine lies low, it is ufual to fay, "He " is gone to Moor ;" if in the valley, they fay, " He is gone to Coomb." Baly, fignifies, To caft up.
- BAR. Any courfe or vein which runs acrofs a Lode or Mine is often termed a Bar; but they fometimes meet with a very hard kind of ftone, called an . Ire-ftone, which forms a fort of courfe like as it were a Lode, but perhaps feveral fathoms wider : this is named a Bar. Bar-Mafter among the Lead Miners, is he which keepeth the Gage or difh to measure the Miners Ore, he or his fervant being prefent when meafured. (Houghton's Rara Avis, &c.)
- BARGAIN. See FATHOM.
- BATCH. A parcel or quantity of any thing. "A Batch of Tin"—"A Batch "of Bread," &c. BEAT—" away the ground." Signifying the working away on the course of the
- Lode : or the ftopeing away any ground in a Mine.
- BEU. Alive. (Cornifh).
- BEU-HEYL. A live ftream, i. c. rich for Tin.
- BINDER-Or Timber-man, fo called, who undertakes to bind and keep a Mine open, or prevent any part from cruthing or falling together.
- BING. See COBB.
- BLACK-JACK. See MOCK-LEAD. BLACK-TIN. Tin Ore, triturated, wafhed, and clean for fmelting.
- BLOCK-TIN OF WHITE-TIN. Is Tin brought
- to its fineft purity by fmelting. BLOWERS. The perfons that melt Stream Tin with charcoal fires, excited by bellows worked by water wheels.
- BLOWING-HOUSE. The houfe wherein the furnace for blowing is. (Blaft-Houfe in Derbyshire).
- BORIER. An inftrument of iron fteelpointed to bore holes with in large rocks, in order to blow them with gunpowder.
- BOTTOMS. The deepeft working parts of a Mine that is wrought either by ftopeing.

316

ing, driving, or otherwife breaking the Lode. (Bottom, Sole, in Derbyfhire). BOTTOM-CAPTAIN. A fuperintendant over the Miners in the Bottoms.

- BOTTOMS-in Fork. When all the Bottoms are unwatered, they fay, " The " Bottoms are in fork ;" and to draw out the water from them, or any Dippa, or any other particular part of a Mine, is faid to be "forking the water;" and when accomplifhed, "Such Dippa, &c. " is in fork." Likewife when an engine has drawn out all the water, they fay, " The engine is in fork."
- BOTTOM-LIFT. The deepeft or bottom tier of pumps.
- BOUNDS and BOUNDERS. Are limited parcels or pieces of land enjoyed by the owners of fuch Bounds. See book iii.
- chap. iii. page 137. BRACE. Includes the fpot of ground where the chief working Shaft of the Mine is, with the materials and implements thereunto belonging, as axletree, rope, &c. See AXLETREE.
- LAY DOWN AT THE BRACE. If a perfon is defirous of relinquishing his Dole in a Tin Mine, he does to either by writing in the account-book, after having paid his coft to that time; or elfe he lays down, or declines his Dole at the Brace, by putting his hand on the axletree, and publickly declaring that he will be no longer concerned in the Mine.

This was an ancient cuftom, but it was observed only in Tin Mines; and how far it is lawful fo to do, or binding upon the reft of the concerned, is matter of doubt.

- BRANCH. A leader, ftring, or rib of Ore, that runs in a Lode; or if a Lode is divided into feveral ftrings, they are called Branches, whether they contain Ore or not : likewife ftrings of Ore which come transversely into the Lode are called Branches, and fo are all veins that are very fmall, dead or alive, i. e. whether they contain Ore or not.
- BROOD. Any heterogeneous mixture among Tin or Copper Ore, as Mundick, Black-Jack, &c.

BRYLE. See page 125. BUCKING and BUCKED ORE. A method of breaking the poor foul Copper Ore fmaller by hand with fmall flat irons, called Bucking-Irons, in order to wafh and feparate the pure Ore from the ufelefs wafte. The fame term is ufed in the Lead Mines. But Pettus, in his Fleta Minor, gives it the fignification of washing, or wet stamping Ores.

BUDDLE. Pits dug in the earth near the

ftamping mill, feven feet long, three feet wide, and two and a half feet deep, where the ftamped Tin is curioufly washed from its impurities by water conftantly running through the Buddle, while a boy; called a Buddle-boy, is ftanding in the body of it, and working both with a fhovel and with his feet. BUNDING. See ASTEL.

- BUNNY-Of Tin or Copper Ore. A Sombrero in Alonzo Barba. A pipe of Ore. A great collection of Ore without any vein coming into or going from it.
- BUNCH OF BUNCHY. A Mine that is fometimes rich, and at other times poor, is faid to be bunchy. We also fay a rich Bunch of Ore; and if it is fhort, we fay it is a Bunch.
- BURDEN. The top, wafte, or deads in ftream works, that lie over or upon the ftream Tin, which must be cleared away before they can work effectually. All wafte covering of Tin, &c. which muft first be removed, is called the Over-burden, Top-burden, or the Burden.
- BURROW. That heap, or heaps of attle, deads, or earth (void of Ore) which are rifen out of a Mine, and commonly lie around the Shafts. Any heap or hillock of deads or wafte.

C

- CAPLE. A fort of Stone fomething like a Limeftone, but will not burn. The walls of most Lodes are of this kind of Stone, therefore it is common to call the wall of a Lode, by the name of its Caple. Alfo fome veins which abound with this Stone, are termed Caples, or Caple Lodes.
- CAL. (It fignifies in Cornifh, Cunning, Lean). Properly, Gal. A kind of Iron Goffan Stone found in the Bryle and backs of Lodes, much of the colour of old Iron, reckoned a poor brood with Tin; therefore it may be fo applied becaufe it impoverifhes the Lode and deftroys the fatness of the Metal. (See Gal). It is termed Wolfram by Cronftedt, and defined a kind of Manganeic.

CALK. Cornish, for Lime.

CALLYS. (Cals, Califh, Cales, ac idem, Callys,) Killas. (Cornifh) Hard , fmart. The most common and agreeable Stratum in our Mine country, ufu-ally called Killas, (Killow, by Woodward). Of the many forts of this Stratum, fee book i. chap. i. I believe Mmmm this

318 AN EXPLANATION OF THE CORNU-TECHNICAL

this to be the proper name for Killas, as it means a hard firm Stone.

- CAPTAIN. An experienced Miner, who directs and overfees the workmen and bufinefs of the Mine.
- CARN. A rock. A heap of rocks. A high rock. The flony Stratum. CASED TIN. That which is reframed by
- CASED TIN. That which is reframed by the gentleft current of water, and prevented from running off the frame by turf placed at the bottom.
- CASES. Probably a corruption of Chafm. Very fmall fiffures in the ftrata of the earth, through which fmall ftreams of water flow when they are opened by working under-ground, greatly to the hinderance of the workmen, &c.
- CAST after CAST. Is throwing up of Tin-ftuff, &c. from one ftage of boards to another, each caft about five or fix feet high.

CAST OF THE COUNTRY. See COUNTRY. CASUALTIES. See LEAVINGS.

- CAUNTER and CAUNTING. Contra. When two Lodes run across, the one, or either of them, with respect to the other, is called a Caunter or Contra, for they run caunting, or contra-ing each other. As all Lodes which run cardinally east and west, go through every kind of vein except Cross-Gosfans, I define fuch to be Caunters.
- CHARGE. Any quantity of Ore put at one time into a furnace to fufe, they call a Charge. Letting it out, they call "Tapping the Charge." CHOAK. An Adit is faid to be choaked
- CHOAK. An Adit is faid to be choaked when any earth or ftone falls in and prevents the current of the water through it. The place or part fo filled, they call "The Choak."
- CLACK. The valve of the pump pilton. The Can-lead, in Derbyshire.
- CLACK-DOOR. A fquare iron plate fcrewed on to the fide of a bottom pump or fmall bore, for convenience of changing the Clack, or valve.
- the Clack, or valve. CLEARING—The Deads, Clearing a Shaft or Drift, &c. When any part of a Mine or Drift is filled or incommoded by Attle or Deads, the removal of fuch is called "Clearing the Deads," "Clearing of Attle," or the like. In old workings it is the first thing to be done, and in the north they term it, "Clearing the old man."
- COB. (Dho Cob, Cornifh). To break or bruife. A Cobber, a bruifer of Tin. Cobbed Ore is the fpalled which is broke out of the folid large ftones with fledges, and not put to water, being ufually the beft of the Ore; the fame as

Bing Ore in the Lead Mines. Nocking, Derbyfhire.

- COCKLE. The Skiorl of the Swedes, and the Schorl of the Germans. Anglicè, Shirl, (Cronftedt). A laminated Mineral fubftance of a blackifh brown colour like Tin, often intermixed with it, and taken for it, to the frequent detriment and difappointment of the Tinners. Cockle is a Weed in Cornifh; whence, a Weed or Brood in Tin. See Pope's Gloffary to Shakfpeare.
- CôFER. (Côfar or Kopher, Cornifh, a Cheft). A fmall wood trough under the frame, which receives the Tin cleared from its impurities or flime.
- COFFIN. Old workings which were all worked open to grafs, without any Shafts, by virtue of digging and cafting up the Tin-ftuff from one ftage of boards to another. Workings all open like an intrenchment.

COKE. Charked pit-coal.

COLLAR.—" of a Shaft," is the timber and boards which fecure the uppermoft part of a Shaft in the loofe rubble from falling in.

COOMB. See BAL.

- CONVOCATION and CONVOCATORS, or Parliament of Tinners. All ftannary laws are enacted by the feveral convocations, and carry with them all the force and law of acts of parliament. A Convocation is but too feldom held, to the difgrace of the county and the injury of the Tinner, for the laws now in being are very weak, contradictory, and inconclutive. See Assistants and Stan-NARIES.
- CORE. (i. e. Corps ; body, company, fociety. French. Boyer's Dict.) Corps is used among the military, and pro-nounced Core. With the Tinners it has also a respect to time, fuch as their proper change or turn of working. Thus it is faid, the first Core by night is eight o' clock, for inftance; the fecond Core is four after midnight, and the day Core commences perhaps at noon-day, according as the labourers will fettle among themfelves. But in difficult and hard working places, where water is too troublefome, or air is very deficient, they divide their Cores into four; that is, every fix hours. In fuch cafe, they relieve upon the fpot; for at the known hour, fresh men come underground, and take the tools from them who have just finished their working time. See DAY-PAIR.

COSTEAN.

- COSTEAN. (From Cothas, to find; Stean, Tin; or Dropt-Tin. Cornifh). Cof-tean pits, are fhallow pits to trace or find Tin. Cofteaning, ditto. COUNT-HOUSE. (Reckoning-Houfe, in
- Derbyfhire). A houfe or room on the Mine, wherein the Adventurers and their agents transact the business and keep the accompts of the Mine. See
- ACCOMPT. COUNTRY. The Strata of the earth. When Miners drive an Adit out of the Lode or vein in the folid Strata, they fay, "They are driving in the Coun-"try;" fo if they fink a Shaft to cut a Lode, they are faid to be finking in the Country until they come to the Lode. Likewife, an Adit or Drift which is driving north or fouth, is " across the Country." Also, the fimi-larity of the Strata for fome continu-ance, is denominated " The run of the " Country" and " the eaft of the Coun-" try."
- COURSE. Any vein or Lode is often termed a Courfe. A Tin-Courfe. A Copper-Courfe. A Crofs-Courfe. And the phrafe of "Working on the Courfe " of the Lode," implies to work along on its direction or length; but when it is faid, " A Mine is in full Courfe of " working," the meaning is, that it is fully occupied; fo, likewife, when it is faid, "The men keep a due Courfe "of working," it fignifies, they duly mind their labour.
- CREAZES. The work or Tin in the middle part of the Buddle in dreffing, viz. the head or fore part of the Buddle, the Creaze or middle, and the tail or laft, though fome call that the Hind-Creazes
- CROP. Ore or Tin of the first quality after it is dreffed or cleanfed for fmelting. The fineft black Tin is called the Crop, worth, at a medium, one for two; i. e. forty pounds of fuch black Tin you may exchange for twenty pounds of Block-Tin, called White Tin. The fecond fort is called Rows, a corruption of Roughs, being poorer and larger in fize; faleable at fix for twenty.
- CROSS. Crofs-Courfe. (See BAR, COURSE). Crois-Bar; Crois-Goffan; Crois-Lode. Is either a vein of a metallick nature, a Crofs-Goffan, or elfe a foft earth, clay, or Flookan like a vein, which unheads and interfects the true Lode. (A crofs vein in Derbyfhire).

CUARE. (Cornifh) A quarry of ftones. CUT. To interfect a vein, branch, or Lode, by driving horizontally or finking perpendicularly at right angles. " I cut " the Lode at twenty fathoms depth." " I cut the north branch in driving ten " fathoms." "We cut a large ftream " of water in the Adit-end."

(Carew), " Diffice or bowls are not " force filled wig Ore by the Morer

- DAMP: (Dampff, Teutonick). A vapour, or pernicious Halitus, from or in the bowels of the earth. A want of circulation of air under-ground.
- DAY. Ore is faid to be difcovered near the Day, when it is found near the furface.
- DAY-PAIR. Are those who work underground by day; and Night-Pair, vice
- verfa. See Core. DEADS. Any thing that is broken underground unmetallick, or not worth the faving; in opposition to that part of a Lode which is rich for Metal : there-fore Lodes which are unmetallick, are called Dead Lodes. DERRICK. (Cornifh) A Sexton, a Dig-
- ger, a Miner. (Nomen Familiæ).
- DIALLING. Is the method of taking a traverfe under-ground by the compafs, fo that by laying out the fame above-ground, they find where an Adit-end is; or the end of any other drift or working, in order to fink a new Shaft on it perpendicularly. Alfo, by Dial-ling they find the juft limits of their ground underneath, to know if it cor-refponds with their limits above, &c.
- DILLUEING. (Dilleugh, To let go, let fly, fend away. Dylyr id. Cornifh). A method of washing or finishing the dreffing of Tin in very fine hair fieves, called Dillucing fieves or Dilluers.
- DIPPA. (A pit, Cornifb). A pit or hole funk in a Lode by way of a little fumph to collect water to draw out by finall barrels; alfo a pit funk in a bunch of Ore, which is a very irregular and ruinous way of working a Mine. The Tinners fay, " It is eating the calf out " of the cow's belly."
- DISH. That part of the Ore or fterling poundage, which the Lord or owner of the fee referves to himfelf, free of all charges, in confideration of the liberty he grants the Adventurers to dig and fearch for Metals, or occupy the Mine. The Difh is also fliled the Lord's Dues, (See BOUNDS, FARM, SETT, and TOLL). In the Lead Mines, a Difh is a trough of wood twenty-eight inches long, four deep, and fix wide, by which they measure that part of the Ore which is called

319

Ke whereof

called the Lord's Lot-and, no doubt, | this was the method formerly ufed in Cornwall, from whence the Lord's Difh is a term now in ufe.

Difh is the ancient name of a measure ufed for black Tin, containing a gallon. (Carew). "Difhes or bowls are mea-" fures filled with Ore by the Miners, " whereof, fome are paid to the king, " others to the church," &c. (See Pettus, on the word Metallick).

- DIZZUE. (From Dyz-hui, to difcover unto, Cornifh). To Dizzue the Lode, is this: If it is very fmall and rich, they commonly only break down the country or ftratum on one fide of it, by which the Lode is laid bare, and may be afterwards taken down clean and free from wafte. To Dizzue the leader of a Lode is much the fame thing ; for if there is a fide or part of the Lode better than the reft, but not a Working Big, they keep the beft part separate and let it ftand in its place, until they first break and remove the poor part ; afterwards they break the Dizzue or beft part, and referve it to be feparately handled and dreffed : thus the good Ore is dreffed with lefs charge, and proves better in value than if it were promifcuoufly with the poor Ore. (See HULK). The refuse or deads of a Dyzhued Lode, is called in fome places, " The " Dyzha."
- DOAR. (Cornifh. The earth. An Oar, idem) Whence Ore, the earth of Metals.
- Dol. (Irifh, Daal; Saxon, Deald, divided, fee Verstegan; Cornish Dôl.) Any part or fhare of the Adventure or Tin Ore, as one-eighth, one-fixteenth, onethirty-fecond, or the like. " Anciently " where a meadow was divided into " feveral fhares, it was called a Dôl-" meadow." Jacob's Law Dictionary.
- Dol. Pronounced Doll, is Cornish for a valley or dale. Dol-côth, the old field or meadow. Dol-côth, the old valley or dale. The name of a great Mine in Camborne, Cornwall.
- DOUBLE-PICK, DOUBLE-MEN. Is when two men are allowed to attend one pickaxe by day, and as many by night, if needful, fo that the pick is kept conftantly at work.

DREDGED-Ore. See Powdered-Ore.

DRESSER. Any perfon who fuperintends the boys at ftamping mills; or men, boys, and girls in the Copper Bals, commonly called Pickers, Cobbers, and Jiggers. The man that directs the various manuductions and lotions of Ore for fale, is called the Dreffer.

- DRIFT. Is the level that the men drive under-ground from one Shaft to another, from one Winds to another, or north and fouth out of the Lode, in which, only one man at a time can work, it being but a working big, and about five or fix feet high. In the northern counties this is called a Gate; a Waygate; a Waggon-gate.
- DRIGGOE OF DRIGGER. The lower pump of the fet or tier of pumps belonging to a water engine. See TIER. DRIVE. To drive is to work in a Drift,
- fo that if you drive or work on ftraight in a Lode or in the country, the vacant paffage behind your back is the Drift. To cut, in Derbyfhire. See DRIFT, fee CUT. DRY. See VAT.

DUES. See DISH.

- DUMB'D. When Tin or Copper Ore is ftamped under fize or too fmall, it is apt to choak the grate, or flow away with the water in dreffing, then they fay, " It is Dumb'd."
- DURGY. A fmall low hedge of turf. Any thing low or fhort. " A Durgy-" man or woman."
- DURNS. Frames of wood like the jambs of a door or the frame of a window, commonly fet in loofe ground in Adits and places that are weak and liable to fall in or tumble down. (Forks and Sliders; Stop Rods and Grove Tim-bers, in Yorkshire. Piers and Pairs, in Derbyshire).

E

- ELBOW. A Lode makes an Elbow thus ~ when it is preffed or fqueezed by hard Strata or rocks which caufe it to deviate from its true courfe or direction, making an obtufe angle and finall turning, though feldom difordered in any other refpect.
- ELVAN. (Elven, in Cornish, an element, a spark of fire). A very hard close grained ftone, thought to be a baftard limeftone; but I do not find that it has any calcarious quality. A very unpromifing Stratum for Copper Ore.
- END. An End is the furthermost end or part of an Adit, or any other Drift from its beginning, or the actual working part of a Drift or Adit. (A Stool-and Forefield, in Derbyfhire. Forehead, in Yorkshire).
- ENGINE. A machine to unwater Mines. Those which are worked by water, are termed Water-engines. Others which perform

perform their office by fire, are Fireengines. There are other forts called Horfe-engines. The perfons who undertake to erect and take care of them, are called Engineers.

- FARM. That part of the Lord's fee, which is taken for liberty to work in Tin Mines only, that are bounded, which is generally one fifteenth of the whole. See BOUNDS, DISH, SETT, TOLL. FAST. The firm rock or ftone unmoved
- by the deluge, which lies immediately under the loofe rubble.
- FATHOM. Six feet in height, depth, or length. All work in the Cornifh Mines, is generally performed by the fathom; fuch as ftoping, driving, and finking.
- FEASIBLE-GROUND ; is Ground that can be fpeedily wrought, and yet will ftand without the fupport of timber and boards.
- FIRM. Firm shelf. See FAST and SHELF. FISSURE OF GULLY ; is that crack or fplit in the Strata of the earth, which is the receptacle of mineral particles, whole contents are fliled a Lode.
- FLATS OF FLAT-RODS ; are horizontal rods or poles fixed by a femicircular wheel to the perpendicular rods of a fire or water engine, by which the pifton in a pump at fome diftance from the engine draws water.
- FLOOKAN. An earth or clay of a flimy glutinous confiftence; in colour, for the most part, blue or white, or compounded of both. A Crofs-Flookan runs across through a Lode, unheads it, and throws it on one fide out of its place. There are Flookans alfo which run parallel with metallick Lodes, and take the name of Courfe-Flookans. Some metallick Lodes abound with a large part of this clay on either or both walls of the Lode; and when it is throughout the vein, it is called a Flookan Lode. A fmall flide is also a fiffure filled with clay or Flookan. See SLIDE.
- FLOOR. A Floor is a bed of Ore in a Lode, though fuppoled not to continue to any great depth or time; therefore is a Stratum of Ore.
- FLORAN. Is an exceeding fmall grained Tin, fcarce perceivable in the ftone, though perhaps very rich. Alfo, any Tin which is ftamped exceeding fine, and underfize, is called Floran Tin-quafi, Flower Tin.

- FOCE. (Cornifh) A forge or blowinghouse for smelting of Tin.
- FOOT. An ancient measure for black Tin, two gallons; now a nominal measure, but in weight 60 15.
- FOOTWAY. In fhallow Mines, the common way of going down is by a rope or windlafs: but in deep Mines, they have old Shafts with ladders in them, and landing places at the foot of each ladder called a Saller, by means of which they defcend into the Mines; whence this is ftiled the Footway; and those Shafts, when applicable to no other ufe, Footway Shafts. (Waygate and Climbing Shaft, North of England).
- FORCER. A fmall pump worked by hand, ufed in finking of fmall Sumphs, Dippas, or Pits.
- FORCOUE, Fork ; the bottom of the Sumph. Forking the water, is drawing it all out; and when it is done, they fay, "The "Mine or the water is Forked;" and "the Engine is in Fork." The Forcque or bottom of the Sumph in the North of England, is called the Lodge; Forking the water, " Rolling the water ;" the Engine in Forcque, " the Engine in " rowl."
- FRAME or RACK ; composed of two planes of boards a little inclined, over which runs a very fmall equable ftream of water to wash off the fordes from flime Tin, &c.

not of an is G mayous nambhow

- GAD. (Gedn is Cornish for a wedge; Gad an iron wedge; Gad is Armoric for a Hare). A Gad is an iron wedge to drive between the joints of rocks, in order to loofen the ground for the pickaxe.
- GAL. The proper name for Cal. Gal fignifies ruft and rufty in Cornish; and, accordingly, Gal, ufually pronounced Cal, is a Goffany, or rufty Iron Ore. Kal is a falle word for it, that term fignifying Phallus; Membrum Virile. GANGWAY. When a Fiffure or Lode is
- excavated in the backs or former upper workings of the Mine, it is fallered with boards, and the deads are thrown there, which they also call Stulls: however, if they leave room fufficient for the workmen to roll ftuff, or walk upon them from one Shaft to another, they call it a Gangway. Gang, in the Teutonick, fignifies a Vein ; but it is a fea term alfo.

Nnnn Gatchers,

F

GATCHERS. The after leavings of Tin. See LOOBS.

GLIST. A fhining black or brown Mineral of an iron caft, fomewhat like Cockle.

- Gossan. A kind of imperfect Iron Ore, commonly of a tender rotten fubftance, and red or rufty iron colour. It is often found fhallow in Tin, Copper, and Lead Mines, and is the proper Nidus or Matrix for the two latter. It is an upper covering to the Ore, levels above thirty fathoms, and is very abundant; whence those Lodes are called Goffan Lodes.
- GOUNCE. See STREKE, and the chapter on Stream Tin.
- The Ore of Tin that is GRAIN TIN. fometimes dug very rich in the form of grains or pebbles, or elfe in larger pieces, composed of many fuch diffinct grains, united in one entire mais, always of a black or dark rofin colour, pointed like diamonds. Alfo, the pureft and fineft block or white Tin, fmelted with char-coal in the blaft or blowing-houfe furnace, which never had any brood or foreign mixture in the Mine. Grain Tin is peculiarly produced from ftream work, and is worth feveral fhillings ⊕ ⊕ more than Mine Tin.

- GRANT. See SETT. GRASS, or at Grafs, fignifies on the fur-face of the earth. " Is Tom Trevifcas " under-ground ? No ; he's at Grafs." A Grafs Captain is an Overfeer of the workmen above-ground, as the bottom or under-ground Captain fuperintends his men down in the Mine.
- GRATE. An iron plate punched full of fmall holes; which belongs to the ftamping mill, and fizes the ftampt Ore, be-caufe it must all pais through these holes by a fmall ftream of water.
- GREUT OF GRIT. A kind of foffil body, of fandy rough, hard, earthy, particles.
- GRIDDLE. A large wire fieve, uled inftead of a hurdle, for fifting and forting of Copper Ore, as it rifes from the Mine. Erckern calls it a Ratter, or Riddle, Screen or Sieve, to feparate the clean from the unclean Ores before they come to the fire. " This inftrument doth " unriddle them by feparation : and for " the word foreen, it is doubtlefs from " fecernere to divide, and fieve from " fegregare or fever." Pettus on the word metallick.
- GROUAN. (Grou, Cornifh) Gravel, rough fand. Grouanen, a pebble. Hard Grouan is Granite or Moorftone. (Gronften, Swedish) Soft Grouan is the fame materials in a lax and fandy state.

Grouan Lode, any Tin Lode which abounds with this gravel. Grouder, a mixture of Grouan and clay, much uled for fcouring of timber-ware in houfewifry.

- GROUND. (See COUNTRY, and SHUT). We fay, a hard rock or Stratum is " Hard Ground." On the contrary, foft clayey Ground they call " Fair " Ground;" and if fair, yet firm to ftand without timber, " Feafible " Ground."
- GUAG. (Hunger, emptinels; ac idem, Leary, Cornifh). Tinners holeing into a place which has been wrought before, call it "Holeing in Guag." GULPH OF ORE. Where a Lode throws
- up very great quantities of Ore, and proves lafting and good in depth, they fay, " They have a gulph of Ore."
- GUNNIES-means breadth or width. A fingle Gunnies is three feet wide ; a Gunnies and a half is four feet and a half; and a double Gunnies is fix feet wide. The former vaults or cavities that were dug in a Mine, are termed "The old Gunnies;" and if they are full of water, they are fometimes called " The Gunnies of water ;" yet more commonly " A Houfe of water.
- GURT. A fret or channel made by great rain or floods in a highway; alfo, a channel to carry off water from one place to another for dreffing of Copper Ore, Tin, or the like. Gurt, in Cor-nifh, implies large, great. " Gurt " Mawr of Vufs," Great root of furze.

Hand

HALVANS, HALVINGS, HANAWAYS. All which names imply the refuse Ore, or the poor Ore and Stone after the prime Copper Ore or Crop is first taken out ; but they often cull over these Halvans again, and take more Ore out of them, which is called Halvan Ore. (Halvans, wafte hillocks, North of England). The poor refuse part of Tin-stuff goes not by this name, but that of Leavings, or Cafualties.

- HEADS. See STAMP-HEADS. HEAVE. See plate of Heaves in Goonlaz, &c. and book ii. chap. iii.
- HEWNS. The fides of a calciner or burning-houfe furnace, from their being formerly built with hewn Moorftone.
- HOGGAN. In Cornish fignifies a Hawthornberry; alfo, any thing mean or vile : but here it means a Pork Pafty; and now indeed any Tinner's pafty that he carries

" carries to Bal with him, is called a Hoggan.

- HOLE. To hole, is to make a communication through one part of a Mine to another. To hole a Shaft, is to fink it through into the Mine or hollows.
- HOOKHANDLES, are the handles of the turn or windlafs for winding up the work from underground. (The Sweeps, North of England.)
- HORSE. A portion of dead ground in a Lode, which widens like a horfe's back from the fpine. (See plate of Bullen-Garden Mine, fig. 57.) A Rider and a Rither in Yorkfhire.)
- House. See GUNNIES, and TURNHOUSE. HUEL. A Work, a Mine; as Huel Stean, a Tin Mine: Huel Kalifh, the hard work.
- HULK. An old excavated workings. " To " hulk the Lode," is this : when the Lode is very wide, and only one fide of it is rich for Copper or Tin, but much fofter and more fair than the other poor part of it, they hulk in with their picks as far as they can upon the rich tender Ore, and leave the hard unmetallick part of it to ftand by itfelf, which they afterwards blaft by gunpowder, or otherwife break down and throw away. See DIZZUE.
- HURDLED ORE. That which is fized by paffing through a hurdle, like earth for mortar.
- HYRLIAU. (Hurling, Cornifh). A Cor-nifh cuftom of playing with a ball. Hyrliau yu ghen guare wyi — Hurling is our fport. The ball is generally plated with Tin or Silver, and has ufually a Cornifh motto alluding to the play, as "Guare wheag, yw Guare teag; that is, Fair play, is good play."

JETTERS. See POKKERS and JETTERS. See FLATS.

JIGGING. Is a method of dreffing the fmaller Copper and Lead Ores by a peculiar motion of a wire fieve in a kieve or vat of water, where the fmallest particles pafs through the Jigging-fieve, and those which are larger and folid lie at the bottom of the Jigging-fieve or Jigger; fo that the uppermost light ftony wafte may be eafily feparated and fkimmed off by a piece of femicircular board, called a Limp. In the Lead Mines, the Jigged Ore goes by the name of Peafy; and they also term this ope-ration, "Setting in the Sieve," and "Washing."

- INFECTION. (A BROOD, which fee). Any heterogene Mineral mixed with Tin or Copper Ore.
- IRESTONE. Takes not the name from its participation of Iron, though there is fome Iron in it, but from its exceffive hardnefs. Its colour is a bluifh grey, and fometimes it runs feveral miles, keeping its courfe on directly like a Lode. Being very difficult to work and break through, it is therefore often termed an Iron Bar, or a Bar.
 - K
- KAL. (See CAL and GAL). Kal. A Phallus; Membrum Virile. Llhwyd. Kalifh, hard.

KAZER. A fieve.

- KERNED. A heap of Mundick or Copper Ore will harden by lying exposed to
- the fun, when they fay it is kerned. KERNOU. Cornwall. Kernuâk, Cornifh. KIBBAL. (A bucket, a little tub. Ar-moric. Quibell, idem). A Kibbal is the bucket in which all work or Ore is raifed out of the Mines. Gear barrels, in the North of England. A Whym-Kibbal is a larger one, which belongs to the machine called a Whym, and ferves to draw water with, or bring up the Ore to grafs. Some of those larger barrels or Kibbals contain 120 gallons when they are intended for drawing of water out of the Mine.
- KIEVE. A vat or large iron-bound tub
- for washing of Ores, &c. KILLAS. (See CALLYS) Woodward fays, "We call any ftone Killas that fplits with a grain," p. 6. Killas, plate, in Yorkshire, &c.

KIVULLY. Loofe, hollow, fhelfy ground. KNOCKING. See COB.

- L
- LANDING-PLACE; the place where they caft the work out of the Kibbal, contitiguous to the working Shaft, which they also term the Landing Shaft, being a Whym Shaft.
- LAPPIOR. (Cornifh). A dancer. See book iii. chap. ii. pag. 136. LATHS. Are deal boards pointed at one end, for driving betwen durns or frames of timber and loofe deads, in that manœuvre called " Shutting of attle ;" they are called Laths, from fome re-femblance to laths for plaiftering. LAUNDERS. Troughs of deal boards to
- fave the water, and prevent its falling down

down into the bottoms; alfo, to convey water acrofs Shafts, Drifts, and Gunnies, and for conveyance to any place for driving engine or mill wheels.

- LAYER-and laying of Tin. See SERVING. LEADER. A branch, rib, or ftring of Ore, that leads along to the Lode.; or elfe if it be in the vein, and points, or leads away, fo that they hope for a parcel or bed of Ore by following it, then this ftring is a Leader or Guide ; moreover when they purpofely drive on, and follow veiny natured ftrings, though without any Ore or life in them, yet fuch are Leaders to follow. See LODE.
- LEARYS-or lear; emptinefs. Old men's workings. Vide Gloffary Pope's Shakefpeare.
- LEAT. A water courfe, or level for conveyance of water, to engine or mill wheels.
- LEAVINGS-or Cafualties, in Tin, is the fame as hanaways of Copper or Lead Ores, both being gleanings : but it ra-ther implies the very minute Tin, that flows away with the water, in dreffing the crop or prime Tin ; but being gathered together is redreffed to cleanfe it from its impurities and flime, &cc.
- LEVELLING and Levels. The art of finding a true Level to convey water from one place to another, or elfe to find the Level or depth of an Adit at a prefixed place.
- LIFE-ac idem, Alive; which fee. LIFTERS-are folid pieces of afh timber 8 or 9 feet high, flod with iron ftampheads for pounding the Tin-ftuff, &c.
- LITTLE-WINDS. (A fump in fome parts of England) An under-ground Shaft, funk from a horizontal drift, by which the top of the Winds communicates with the fide or bottom of the grafs working Shaft.
- LIVER-or ly-very ftone. A hard livercoloured ftone, and in a Lode is very hurtful
- LODE. (Main Rake, N. England) The word Lode is an old Anglo-Saxon word, idem ac, Lead; fo Lode-ftone, quafi Lead-ftone : fee Lye's edition of Junius ad verbum. Any regular vein or courfe, either metallick or not ; but more commonly it means a metallick vein : and being occupied and proving good, may indifferently be called a Lode, Mine, or Work.
- LODE-PLOT. A Lode that underlies very fail or horizontal, and may be rather called a Flat Lode.
- LOFTY TIN-in contradiffinction to Floran Tin, for Lofty Tin is richer, maffive, and rougher, and not fo weak or

imperceptible in the ftone, or in powder on the fhovel.

- LOOBS. Tin flime or fludge of the after leavings, or leavings flime.
- LORD OF THE LAND OR FEE. The perfon in whofe land the Mine is; therefore, the part which he referves to himfelf for liberty to work a Mine in his land, is the one-fixth, one-feventh, one-eighth, pence, and called the Dues, Difh, which ice.
- LOST-SLOVAN. (Loft, a tail, a rump, Cornish) Vulgo, Low-slovan; the beginning of an Adit, though the tail or end; that part which lies open like a trench, before they drive under-ground.

M

- MAD WATER. Water that has been drawn from a Shaft, or any part of a Mine, and returns back again to the fame place from whence it was drawn, is called Mad-Water, and implies a great want of fkill in the managers.
- MATERIALS. All tools and tackle, timber and implements, that belong to a Mine; and in large Mines a perfon is appointed to take care of them, who is called the Material-Man.
- MEAT-EARTH-Soil ; the fuperficial earth, fit for agriculture.
- MOCK-LEAD. Wild Lead, black Lead, black Jack. A ponderous black Mineral, which does not readily incorporate in the fire. A Zinc Ore.
- MOOR. (See BAL) This wood fignifies a root, or a quantity of Ore in a particular part of the Lode ; as " A Moor " of Ore." " A Moor of Tin."
- MOORHOUSE. A hovel built with turf for workmen to change cloaths in. A Coe, Derby.

- MOORSTONE. See GROUAN. MUN. Any fufible Metal; unde Dunmwyn, a hill of Metals; unde Dunmonii, the Cornish Britains.
- MUNDICK. An exceeding ponderous Mineral, whitifh, beautiful, and fhining, but brittle. Pyrites ; Marcafite, &c. too well known for defcription here.

N

NEEDLE. A piece of ftout iron wire, ufed to make a touch-hole with in blowing of rocks with gunpowder. A pricker, Yorkshire.

NIGHT-PAIR. See DAY-PAIR, and CORE. NOCKING. Knocking. See COB.

OLD

OLD MEN'S WORKINGS. See LEARYS.

ORE. Earth. (See DOAR) Round Ore; rough, or Row Ore; ftraked, ftamped, bucked, jigged, and flime Ores; which fee.

ORE-PLOT. (See PLOT) The Ore Plots at grafs; where they keep apart the dreffed Ore for fampling, &c.

Owners. See Adventurers.

- PACKING. A further or final dreffing of Tin or Copper Ore, by putting of either in a kieve or vat with water, often flirring the water, and flriking the fides of the kieve, by which means the heavy particles fink to the bottom, and the light wafte fwims uppermoft; which is afterwards fkimmed off, and thence called the Skimpings; which fee.
- led the Skimpings; which fee. PAIR. Any indeterminate number of Miners who work together in a Mine in a Pitch upon Tribute, in a But-Bargain, &c. Alfo, they call any number of horfes, from five to twenty, a pair of horfes. See CORE and DAY-PAIR.
- horfes. See CORE and DAY-PAIR. PARCEL. A parcel of Ore, is a pile or heap of Copper dreffed for fale.
- PEACH. Peach-Stone, a bluifh green foft Stone. When a Lode is moftly compofed of this fort of Stone, it is called a Peach or Peachy-Lode.
 PEDNAN. Pedn or Pen. (Cornifh). A
- PEDNAN. Pedn of Pen. (Cornifh). A head or promontory. In Mine affairs, the Pednan is the head of the buddle where Tin is dreffed.
- PICK. The common name of a Tinner's pick-axe; allo, to pick or cull the good Ore from the bad by hand; whence those who do it, are called Pickers.
- Prize-Of Ore, A heap of Ore; a parcel of Ore; and fometimes a Dole of Ore.
- PILLAR. An upright piece or part of the Lode left to support the incumbent weight.
- PILLION. The Tin which remains in the fcoria or flags after it is first fmelted, which must be separated and remelted.
- PIONEER. An able Pickman or underground Tinner.

PIPE. See BUNNY.

- Pir. A Shaft, Dippa, Sumph, or Coftean Pit; all Pits of different depths.
- PITCH. Any part or portion of a Mine, being a few fathoms in length on the course of the Lode, is fo called : and if granted to the Miners for raising the

Ore at fo much out of the pound fterling, it is called, "A Pitch upon Tri-" bute;" if it is higher up in the Mine at a fhallow level, it is called, "A " Pitch upon the Backs;" and lower down, "A Bottom Pitch." PLOT. (Vulgo, Plat). "To cut a Plot,"

- PLOT. (Vulgo, Plat). "To cut a Plot," is to make room, or fquare out a piece of ground by the fide of the Lode or Shaft, for holding the broken work or deads before they are brought to grafs; or for other convenient purpofes. (A Plot, a Brigging-place in Derbyfhire).
- PLUMP. A corruption of the word Pump. PODAR. Rotten, corrupt; Mundick-Copper Ore was formerly called Podar.
- PORKERS and JETTERS. Are blocks or pullies, over which the fweep rods of fome engines move and play. (See FLATS). Pokkia (Corn.) unde Pokker, to thruft, poke.
- Pol.-Rôz. (Pol, a pool; Rôz, a wheel, Cornifh). The pit under a mill-wheel; the wheel-pit.
- POL-STEAN. (Pol, a head alfo; Stean, Tin. Cornifh). A Tin pit. A miry head. (Carew).
- Powdered Ore. When a Lode is fpotted with Ore, or ftones of Ore, but in fo diffeminate a quantity and appearance as to be fcarce worth the charges of dreffing, they fay, "It is "Powdered Ore, or Dredged Ore."
- PRIDE—Of the Country. When Ore is found near the furface, at a level where it is rarely met with, and in great abundance and very rich; also, when a bunch of Ore is found out of a Lode like stones scattered in a quarry, they fay, "It is the Pride of the Country."
- PRYAN. (From Pryi, Clay, Cornifh). Pryan Ore, Pryan Tin, Pryan Lode; that which is productive of Copper Ore or Tin, but does not break in large folid ftones, only in grofs pebbles, or fandy with a mixture of clay.
- fandy with a mixture of clay. PUPPY. The fet or tier of pumps below the Lilly under-ground.
- PURSER. A perfon deputed to keep and adjust the accompt-book, to receive the costs, and discharge the demands on the Mine; usually, both treasurer and fecretary of a Mine.

Quanti Bon tran

QUAREY. When a Lode or Stratum breaks in large hard rocks, being jointed as it were, it is called a Quarey Lode or Stratum, from its joints or Quares.

0000

QUARTS.

Diriogoniumus Paider ed C

QUARTS. A hard, opaque, and fometimes femi-transparent crystalline ftony mass, vulgarly called Spar, which it is not, being a chrystalline bass. It is common in all our Lodes, fome being little elfe. It is very plenty on our barren heaths, and is useful only for hedging and paving the ftreets.

R

RABBAN-Stone. A yellowish dry ftone, refembling Goffan.

RABBLE. An iron rake for ftirring and fkimming of Copper Ore in calcination and fmelting.

RACK. See FRAME.

RAFFAIN. Raf. Raffain Ore; poor Ore of no value.

- RAG-PUMP. A chain pump. RAKE, See RABBLE. A true vein or Lode. (North of England).
- RAMMING-BAR. A beater. (North of England).

RED-RABB. Red Killas.

RELIEF-Time. See Core and DAY-PAIR.

RENEWING. See TOLLUR.

- RIB-Of Ore. A leader, branch, or ftring of Ore.
- RIDAR: A fieve. (Cornifh). A Riddle. See GRIDDLE.
- Rip-up a Shaft. To clear it of the deads or attle fallen into it.
- RISE-in the back. To work upwards towards the furface.
- Ron-Shaft. An engine Shaft ; becaufe of the ftraight Rods which go down in the Shaft, and are fixed to the piftons of the pumps.

ROOF. See BACK.

- ROUNDHOUSE. The vortex or round of a whym or engine race if hedged about and covered, is called the Roundhoufe.
- ROUGHS. Vulgo, Rows. See CROP. Rôz. A wheel. Graver-Rôz, a wheelbarrow.
- RUN. To " run from a Bargain," is when a Pair or fet of men undertake a piece of work, and quit it before it is quite finished. "Run of the Lode," is the courfe or direction of it. " Run
- " of the Country," fee COUNTRY. RUNNING-Tackle. See TACKLE, AXLE-
 - TREE, and BRACE.

SALLER. Solarium, (low Latin) a garret or chamber. Soler, (Cornifh) a ground

in large hard real & being junch

room, an entry, paffage, or chamber. Sol, is a foundation. A Saller, in a Mine, is a ftage or gallery of boards for men to ftand on and roll away broken ftuff in wheel-barrows-a Bunding, in Derbyshire. There is also another kind of Saller in an Adit, being boards laid hollow on its bottom, by means of which air is conveyed under feet to the workmen; this is called the Adit Fang, in Derbyshire. In a footway Shaft, the Saller is the floor for a ladder to reft upon.

- SAMPLE. The taking certain portions of Tin or Copper Ores to affay or try the value of by fire or water, they call, " Taking a Sample ;" the perfon employed are named Samplers; and the bufinefs itfelf Sampling. See TICKET-ING.
- SCAL. A corruption of the word Scale. When a part of the wall or fide of a fiffure falls away, after the Lode has been digged and removed, they call it a Scal or Scale: fo if the fide of a quarry falls down in large flakes of ftone, it is called a Scal, or Scaling.
- SCOVAN-Lode. Is a Tin Lode, only in contradiffinction to all other Lodes.
- Scove. Tin-ftuff fo rich and pure as it rifes out of the Mine, that it has fearce any need of being cleanfed by water. SCOOP. See TEEM.
- SCROWE. When a metallick Lode is interrupted and cut off by a Crois-Goffan, it may fometimes be found again by the tendency of fome loofe ftones of the true Lode in the body of the Goffan; i. e. a Scrowl.
- SEAM. A Seam of Tin is a horfe load, viz. two fmall facks of black Tin. I believe it is borrowed from the German Mine term, Saume of Quickfilver, about 315 h in two fmall barrels on a horfe, See Brown's Travels.

SEARGE. A fieve.

- SERVING. A Serving, is one or more hand-barrows full of Tin Ore ready for the burning-house or calciner, as it is lodged in the dry or vat for the next ferving or fupplying the furnace. Called, alfo, a Layer or Laying of Tin.
- SET. A Set is the ground granted to a company of Adventurers. The taking of a Set, fignifies the having a grant of the ground or Mine. Sometimes it implies the deed or leafe by which they enjoy the premifes.

SET-a Price. To fet a price on a fhare or Dôl in a Mine, is this : when A, who owns a Dôl in a Mine, agrees to give B, another Adventurer in the fame Mine.

Mine, a price or fum of money, on condition that B will fet a price or value on fuch or fuch a Dôl (for inftance, one-eighth part) if B accepts the money, he names a price, and fo A is at his own option whether he will take B's Dôl at that price, or whether B fhall take A's Dôl, and pay him the given price for it. Now this double advantage in favour of A, is in confideration of the earneft-money he gave B; fo that let the Dôl be disposed of either way, the earneft-money is out of the queftion, and belongs to B : on the other hand, A is obliged either to take B's mentioned Dôl, or elfe to let him have an equal Dol at the price that B fet on it; fo that A has his choice of the agreement, and B contents himfelf with what A refuses or declines.

- SHAFT. (Schaft; fee Agricola de Re Metallica). A groove or pit. All deep pits on a Mine, or on an Adit, are Shafts, provided they are funk down from grafs. Of those there is the landing or working Shaft, where they bring up the work or Ore to the furface; but if it be worked by a horseengine or whym, it is called a Whim-Shaft; and where the water is drawn out of the Mine, it is indifferently named an Engine-Shaft, or the Rod-Shaft.
- SHAMMEL. A ftage of boards used in old Coffins before Shafts were in common use. So they now call any stage of boards for shovelling of Ore or Deads upon, a Shammel. See COFFIN.
- SHED. A fhade or fhelter from the weather, under which the Cobbers cob the Ore.
- SHELF. The loofe ftones immediately over the faft, or firm rocks. Shelf is diftinguifhed by loofe and firm Shelf; those imall loofe ftones that are under the earth, are loofe Shelf; those which are larger and not fo loofe, and juft on the faft, or firm rock, are the firm Shelf; and a double Shelf is where there are two fuch Strata : fo that the Miners are often deceived in Shoding, imagining they have but one Shelf to shode upon.
- SHODE. Perhaps from the Teutonick, Shutten, to pour forth. Shoding is the method of finding veins of Tin by digging fmall pits in order to trace out the Lodes of Tin, by the fcattering loofe ftones and fragments that were difperfed from them by the retiring waters of the deluge : those loofe ftones thus difperfed, are Shode ftones.

SHUT-up a work. To difcontinue the working a Mine. "A Shut of hard " ground," implies a ftope or piece of denfe Stratum, that will probably be of fhort continuance. Shutting or Shooting ground; ground which requires to be blown with gunpowder. SHUTTING-of Attal. When a Gunnies

- SHUTTING—of Attal. When a Gunnies is filled with Attal or Deads, and they want to have a paffage through it, they thruft in deal boards on every fide of Durns or frames of timber, whereby they gain a paffage through, which they fecure with all imaginable fpeed, as faft as they can clear the Attal. Those boards and Durns in the north of England, they call Groove-timbers and Stop-rods. See DURNS and LATHS.
- SIDE-ADIT. When an Adit is partly fallen in or choaked, and it is thought most advisable to drive on the fide of the choak, it is called a Side-Adit.
- SINK. To fink on the Lode or eliewhere, is to work in depth or deeper from the furface; or to fink a deeper Dippa or Sumph in a Mine.
- SKIMPINGS. (From Scum or Skimming) In dreffing ftampt Tin in the kieve or vat, after it is tozed and packed, that is, ftirred and fettled, the beft and heavieft part precipitates to the bottom, and the lighteft and poorer part lies uppermoft, which is fkimmed off and dreffed again by itfelf, by the name of Skimpings Tin.

SKIPSINGS. (ac idem, Stope).

SKIT-Pump, is made like a fhip's pump, and draws a little water at a finall depth.

SLAB OF TIN. A block of Tin.

- SLIDE. A Slide is a Courfe-Flookan or Courfe-Goffan, that either inclines fafter or in direct oppofition to a metallick Lode, which it is wrongly fuppofed to elevate or deprefs.
- SLIME—Ore, or Slime Tin; the pulverized Mineral mixed with water in the flate of Slime or mud; or the fuperfine particles of Ores which are carried down by the water in flamping or dreffing until they fettle in a pit of water called the Slime-Pit. In order to recover the Ore in this Slime, they drefs it on a frame, whereby they wafh off Sludge earth and fave the Ore.
- SLOCKING-STONE. A tempting, inducing, or rich ftone of Ore. Some Miners produce good ftones of Ore, which induce the concerned to proceed, until they expend much money perhaps, and at laft find the Mine good for nothing : fo, likewife, there have been fome inftances of Miners, who have deceived their employers by bringing them Slocking-Stones

ing-Stones from other Mines, pretend-ing they were found in the Mine they worked in; the meaning of which impolition is obvious.

SLOTTERE. (Cornifh) Dirty, flovenly, muddy.

SLOVAN. See LOST-SLOVAN; vulgo Low-Slovan.

SMALL-MEN. Fairies. The Miners are fometimes perfuaded, that they hear a pick at work under-ground, as if fome invifible fpirit was at work underneath or near them. This noife, I fuppofe, proceeds from the running or falling of waters through the crevices and apertures of the earth. The opinion the Miners have of its being a good omen, encourages them to follow or work to it; fo that it has more than once occafioned a lucky difcovery.

SMALL ORE. Copper Ore dreffed to a fmall fize.

SMALL TIN. Tin dreffed from flime, &c.

called Smaals. Alfo Floran Tin. SOAPY HEADS. The joints of ftones, fmeared with a faponaceous flippery foil.

SOLE. See BOTTOMS.

- SPAL. To fpal, is to break large folid rocks of Ore with fledges to a fmaller fize, in order to cull out the barren ftony parts.
- SPAL. To fpaal. A fconce, amerciament, forfeiture. To deduct fo many ftems or days wages as a perfon has been wanting from his labour; or elfe to mulct him more than his wages, according to the usage of that particular Mine.

SPALIARD. A Pickman; a working Tinner. See SPAL.

- SPAR. A Missioner for Quartz and Crys-tal in Cornwall. Sulphur and pure chalk united from the real fubftance, Spar.
- SPEED. A quick, but wafteful way of dreffing, or rather coarfe cleanfing of Copper Ore, by an iron grate in a quick ftream of water.
- SPEL. A lift, help, or turn ; thus if two men are at any kind of work, and alternately change and relieve one the other, they call it "To give and take " a Spel," or Spel and Spel.
- SPEND-the Ground. To break and work it away to prove a Mine.
- SPILL and WEDGE. Mortices and wedges for locking or fixing large props of timber, which fupport a Mine, to the walls thereof, that they may hold firm in their places.

SPREADERS. Are pieces of timber that

are placed athwart a Shaft, &c. which is likely to fall in, in order to keep it open and fafe, till they can board and fecure it.

- SQUAT. Woodward calls it a Mineral; but in the Miner's fenfe of it, " The " Squat of the Lode," means a large Lode, or heap of the Lode in one place.
- STAMPS-or Stamping-Mill. A mill worked by water for pounding and pulverizing Tin or Copper Ores; having large irons, called Stamp-Heads, fixed to pieces of wood (fee LIFTERS) which alternately rife and fall and break the ftones.
- STAMPS-CAPTAIN. The fuperintendant dreffer at the flamping mill.
- STANDING-GROUND. Ground that will ftand firm and require no timber and boards to bind and fupport it.
- STANNARY-Laws, Stannaries, and Stan-- nary-Courts; are Laws, Precincts, Cuftoms, and Courts peculiar only to Tinners and Tin Mines.
- STANNATORS. The upper house of convocation or parliament of Tinners, twentyfour in number, being chofen by the mayors and corporations of Launcefton, Loftwithiel, Truro, and Helftone, for the Stannaries or Precincts of Foymore, Blackmoor, Tywarnhayle, and Penwith and Kirrier. See Assistants and Con-VOCATION.
- STEM. A day's work. A double Stem, is to work fix hours extra.

STEMMYN. Ditto.

STEMPEL. A flant beam used in Tin Mines. Large pillars or pieces of timber placed in Mines to fupport them.

STENT. Rubble, loofe dead earth.

STILLEN. See ASTYLLEN.

STOPE. A Step. When a fumph or pit is funk down in a Lode, they break and work it away as it were in ftairs or fteps, one man following another, and breaking the ground, which manner of working in a fumph or any other part of a Mine, is called Stopeing; and that height or ftep which each man breaks, is called a Stope. Likewife, hewing away the Lode overhead, is "Stopeing " in the back."

STOWS. See AXLETREE.

STRAKE. See STREK.

STREAMERS, STREAMING, and STREAM-WORKS. First, the Tinners which work upon Stream Tin. Second, the Stream-Working. Third, the Stream-Works which are very different from Lode-Works. The first implies Streaming upon the furface, the latter fuch Works 35

as are wrought in the bowels of the earth.

- STREK. (A Stream, Cornifh) unde Strake. Strakes, are frames made of boards, fixed on or in the ground, where they wash and drefs the small Ore in a little ftream of water; hence termed Straked Ore.
- STREP. See STREK.
- STRik. (Active, fwift; Cornifh) To ftrik or ftreeck down, or ftrike down; is to let a man down in a Shaft by the windlafs, and if he calls up to the men above-ground to ftreeck, they let him go farther down; if he fays, Hold, they ftop; and when he wants to afcend, he cries, Wind up. The phrafe of "Striking a Mine idle," is to difcontinue the working of her.
- STRING. A fmall vein, rib, or branch of a Lode or vein.
- STRUCK-OUT. When a Lode by any Flookan, or any other accidental interference, is interrupted or cut out, they fay alfo, "She is ftruck out," or, "She " is loft."
- STUL. (See Astel; Stul, a rafter or fyle; Cornish). Stil, (Cornish) a house beam.
- SUCKED-Stone. A honeycombed porous ftone.
- SUMPH. (Sumpff, Agricola) A pit funk down in the very bottom of the Mine, to cut or prove the Lode ftill deeper than before; and in order to ftope and dig it away if neceffary, and alfo to drive on the Lode in depth. The Sumph principally ferves as a bafon or refervoir, to collect the water of a Mine together, that it may be drawn out by an engine or machine.
- SURVEY—or Outcry for fetting of Pitches upon Tribute in a Mine; or ground to fink, ftope, or drive by the fathom, &c. &c.
- SWEEP-RODS. See FLATS, and POKKERS and JETTERS.

- TACKLE OF TAKLE. (Turn-tree, Derbyfhire) The Axle, Rope, Kibbals, &c. appertaining to a Shaft, called "The "Running-Tackle."
- TAILS. The roughest refuse of stampt Tin thrown behind the tail or end of the buddle, which are stamped again with poor Tin-stuff, in order to take out all the Tin remaining in them.
- TAKERS, are those who take or farm a Mine, or a Pitch upon Tribute in a

Mine of the Adventurers, for any limited time, agreeing to pay them a confideration in money or in kind, after the Tin or Ore is made faleable at the Taker's expence. "To take an end," is to contract for driving the end of an Adit or Drift for fo much $\frac{1}{49}$ fathom. "To take up an Adventure," is to engage in, or put on, a Mine affair.

TAMPING A HOLE. (Stemming a hole, North of England) When a hole is bored in the rock for blafting with gunpowder, they fill the upper part of it, upon the charge of powder, with clay and ftony matter rammed down very clofe and tight, which is Tamping the hole, and the clay and ftone is called the Tamping.

TAPPING. See CHARGE.

- TEARY-GROUND. Lode or Stratum that will break and tear up eafily, by a multiplicity of finufes or joints croffing each other. Speedy-Ground.
- TEEM. (To pour; Swift) To lade out water with bowls or fcoops in Stream works, or Dippas under-ground.
- TICKETING. (See SAMPLE and ASSAYING) The method for fale of Copper Ore, thus: on the appointed day each of the Copper buyers attends and produces a Ticket or written paper, in which is expressed the price that he will give for the Ore; and the best bidder has it.
- TIDE. Twelve hours. Two Tides, twenty-four hours.

TIMBERMAN. See BINDER.

- TIN. See TIN-STUFF, FLORAN TIN, GRAIN TIN, &c.
- TIN-STUFF. Tin Ore; the Ore of Tin as it rifes out of the earth, is called Tin-ftuff, and not Ore, as the Mineral of other Metals is.

TINNERS. All Cornish Miners.

- TOAS. (Pafte; Toazer, Armoric, a kneading-trough) unde, to Toaz; that is, to fhake or Tofs the wet Tin to and fro in a kieve or vat with water, to cleanfe and drefs it.
- ToL. (A hole, Cornifh) The bounder's part of the Tin-ftuff.
- TOLLUR. (See BOUNDER) A man that infpects or fuperintends Tin Bounds; becaufe Bounds are defcribed and limited by holes cut in the graffy earth, which muft be repeated once every year, which they call Renewing.
- TOMALS. (Cornish) A quantity, much, great heaps of any thing.
- Tools. All hand implements for working a Mine, fuch as Picks, Gad, and Shovels.

Pppp

TRACE!

329.

T

AN EXPLANATION OF THE CORNU-TECHNICAL

- TRACE. To trace the Lode, is the fame thing as backing of it; that is, to lay open the Bryle, and difcover the back of the Lode, by many pits, for feveral fathoms in length, eaft and weft.
- TRAIN. Training the Lode. See TRACE. Where a Lode has been difcovered for fome length upon its back, ut fupra, it is called, "The Train of the Lode," and "The Run of the Lode."
- TRELOOBING. A flirring and working the Loobs or flimy earth of Tin, &c. in a flime-pit, that the mud may partly wash off with the water, and the Ore fettle at bottom.
- TRIBUTE. (A Cope, North of England) A confideration or fhare of the produce of a Mine either in money or kind, the latter being first made merchantable, and then paid by the Takers or Tributors to the original Adventurers or owners, for the liberty granted to the Takers of enjoying the Mine, or a part thereof, called a Pitch, for a limited time.
- TROIL. A Tinner's feaft or way of merriment, by eating and drinking; called alfo a Duggle.
- TRUNK. A Strêk or ftrakes, with a very fmall ftream or dribble of water to wafh the flime of Tin or Copper Ore, whereby the lighter earthy parts are carried off with the water. The operation is called, "Trunking the flimes."
- TURN-HOUSE. When a Drift is driven acrofs the country N. and S. to cut a Lode, they make a right angle from their Drift, and work on the Lode itfelf, which, as it is in a contrary direction to their paft Drift, they call Turning-house, in order to work on the course of the Lode.
- TUT. Tut-bargain; i. e. by the lump: as when they undertake to perform a piece of work at a fixed price, prove how it may.
- Tyz. The fame as Strêk, but worked with a fmaller ftream of water. Tye or Ty, is a word made use of also in the stannary of Blackmore, to fignify an Adit or drain.
- TYER-or Tier of Pumps. A fet of pumps belonging to the engine, of which the lower pump or piece is called the Driggoe, but more frequently the Working-piece; the others have names appropriated to them, as the Tye or Adit-lift, the Rofe-lift, the Crown-lift, the Lilly, the Puppy, &c. each being a feparate Tier or Tyer.

- VAN. (From the French, Avant, foremoft). To make a Van, is to take a handful of the Ore or Tin-ftuff, and bruife, wafh, and cleanfe it on a fhovel; then by a peculiar motion of the fhovel, to fhake and throw forth upon the point of it almost all the Ore that is freed from wafte. This operation being repeated, the Ore is collected and referved, and from thence they form an eftimate how many tons of Copper Ore, or how many hundred weight of Block Tin, may be produced out of one hundred facks of that work or ftuff of which the Van is made.
- VATE or VAT. A fquare hollow place on the back of a calcining furnace, wherein they lay the next ferving of Tin Ore to dry before it is let down into the furnace, into which it paffes through a plug hole in the bottom of this Vate or Dry.
- VINNEWED or VINNEY. (Ainfworth) Mouldy. Vinnewed Ore; Copper Ore that has a blue or green fpume, or efflorefcence upon it like verdigris.
- UNDERGROUND CAPTAIN. See GRASS-CAPTAIN.
- UNDERSIZED. See DUMB'D.
- UNHEAD A LODE. When a Lode is fractured or interrupted, fo as to be entirely interfected by a crofs vein, flide, &c. then it is faid to be Unheaded.
- VOOGA. (Cornifh) Smoak. We alfo call a hollow cavern, either in the earth, or the Mines, or by the fretting of the fea, a Vooga; in the Mines, a Vooga-hole.
- Vou-HOLE; from Vau, or Vauw, A natural cavity, hole, or chafm, in the earth or a Mine; ac id. Vooga. (A Shack, in Derbyfhire).
- UPSTANDERS. Pieces of timber or boards which are fixed in the ground at a Shaft, to fupport the axletree, &c. See BRACE.

W

WASTREY. See ATTAL.

WATER-BARREL. A large barrel bound with iron hoops, which ferves to draw water out of a Mine.

WATER IN FORK. See FORCOUR.

- WATERMEN. Those who are any way particularly employed about water under-ground; effectially those who draw water at the Rag and Chain Pump.
- WHEEL. An abbreviation of Water-wheel, implying a Water-engine.

WHEEL-PIT.

- WHEEL-PIT. A very large but fhallow pit that is funk in the ground, or at fome depth under-ground, in order to erect a water-wheel and engine in it.
- WHELE. Id. Huel, or Wheal. See HUEL. WHYM or WHIM. A horfe engine. Sometimes its use is to draw water; but moftly it is intended to wind or roll up the work out of a deep Mine, being wrought by horfes. An Engine, Derbyfhire.
- WHYM-ROUND. A Volt, (Johnfon). En-
- gine-Race, North of England. WHYM-SHAFT and WHYM-KIBBAL. See SHAFT and KIBBAL.
- WHIP. See page 179. WHITE TIN. Block Tin, or purified Tin, brought to its ultimate perfection by fire.

- WILD LEAD. See MOCK LEAD. WINDLASS. See AXLETREE. WINDS. See AXLETREE, LITTLE-WINDS. The Turn, North of England.
- WORK. (From the Teutonick, Werke; a Mine). Work often fignifies the Ore or deads, or other earth or ftone, that

is broken in a Mine, and brought up to grafs. This word often implies the Mine itfelf, as when they fay, a Rich Work, or a Poor Work, inftead of a Rich Mine, or a Poor Mine. A Tin Work. A Copper Work. They like-wife term Copper finelting furnaces, Copper Works.

WORKING-BIG. Is the fpace of about two feet and a half wide, fo that a man may have room enough under-ground in a Lode or in a Drift to use his Pick and other tools without breaking any of the contiguous Strata not of a veiny nature : hence they fay, a Lode is a Working-big, that is, two feet and a half wide.

Z

Zighyr. (Slow, Cornifh) When a very fmall flow ftream of water iffues through a cranny under-ground, it is faid to Zighyr or Sigger.

F

I

N

S.

I

FERMS AND LOTOMS OF TIMMERS

Therest Prov. A very large but Inallem to the set is function the ground, in order the set of a set of the set of the set of the book a set of the set of the set of the book a set of the ments is a set of the set of the ments is a set of the set of the ments is a set of the set of the ments is a set of the set of the ments is a set of the set of the ments is a set of the set of the ments is a set of the set of the ments is a set of the set of the ments is a set of the set of the ments is a set of the se

Warrackowa, A Vole, (Johnon), En. gine-Rass, North of Ramard, Warrachart and Warrackomole, See Swart and Arazas.

Warrz Tree, inner The, or puiffielt "Im, brought to in ultimate persyllion "by fine.

Witten Scincers Witten

(1) 2 1 m, worn or haginni: (2000) (Provide the Tontoniel, Werke; a Willo). World often fignifics the Ore or denis, or other earth or home, that

F I N

is't aleen af a filine, and transfer of to graft. This word often imples the Must car a store Work, indeed of a Work or a store Work, indeed of a Work. A construction Mark. They like whe term Coper Work. They like whe term Coper Work.

outerroubito, is the figure of shour two lots and a full wide, to there man any have here on ough under ground is a loade of a bole to ule his Pick and other tools will not breaking any of the comfigures intera net of a veiny hartnet hence they hay, a Lede is a Working day, that is, two sets and a

Strayft, (2009, Confight) Who a very mult flow firrady of white illues through a crainty under-ignined, it is find to Zightyr or Singet.





