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[i]

THE CENTURY OF INVENTIONS.

[ii]

"A practical mathematician, who has quickness to seize a hint, and sagacity to apply it, might avail himself greatly of these scantlings. It is extremely probable, that Savery took from the Marquis the hint of the Steam Engine, for raising water with a power made by fire, which invention alone would entitle the author to immortality."—*Granger's Biog. Hist.* vol. v. p. 278.

"Here it may not be amiss to recommend to the attention of every mechanic the little work entitled a 'Century of Inventions,' by the Marquis of Worcester, which, on account of the seeming improbability of discovering many things mentioned therein, has been too much neglected; but when it is considered that some of the contrivances apparently not the least abstruse, have, by close application been found to answer all that the Marquis says of them, and that the first hint of that most powerful machine, the Steam Engine, is given in that work, it is unnecessary to enlarge on the utility of it."—*Trans. of the Society of Arts*, vol. iii. p. 6.

L O N D O N:
PRINTED BY C. ROWORTH, BELL YARD,
TEMPLE BAR.

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THE
CENTURY OF INVENTIONS
OF THE
MARQUIS OF WORCESTER.

FROM THE ORIGINAL MS.

WITH

HISTORICAL AND EXPLANATORY NOTES AND
A BIOGRAPHICAL MEMOIR.

BY

CHARLES F. PARTINGTON,

AUTHOR OF A DESCRIPTIVE ACCOUNT OF THE STEAM ENGINE,
AND LECTURER AT THE
LONDON, RUSSEL, SURREY, AND METROPOLITAN INSTITUTIONS,
MECHANICS' INSTITUTE, &c. &c.

LONDON:
JOHN MURRAY, ALBEMARLE-STREET.
MDCCCXXV.

[iv]

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[v]

TO
DOCTOR GEORGE BIRKBECK,
PRESIDENT OF THE LONDON MECHANICS' INSTITUTION
AND OF THE CHEMICAL AND METEOROLOGICAL
SOCIETIES, FOUNDER AND PATRON OF THE
GLASGOW MECHANICS' INSTITUTE,
&c. &c. &c.

DEAR SIR,

As a connecting link in the History of the STEAM ENGINE, I know that your attention has been directed to the Marquis of Worcester's CENTURY OF INVENTIONS, and that its merits were duly appreciated by you at a very early period of Life.—That these Illustrations of one of the most valuable scientific productions of the seventeenth century, may deserve your favourable notice, [vi] and prove an acceptable present to the extensive class of Readers which your patriotic exertions are now so rapidly adding to the Scientific World, is the sincere wish of,

Dear Sir,
Your faithful and obliged
humble Servant,
CHARLES F. PARTINGTON.

London Institution,
Feb. 6th, 1825.

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BIOGRAPHICAL MEMOIR
OF

E D W A R D
MARQUIS OF WORCESTER.

[viii]
[ix]

BIOGRAPHICAL MEMOIR
OF

E D W A R D
MARQUIS OF WORCESTER.

There are few persons who have suffered more from party zeal, or gained less from historic candour, than the noble subject of the following brief memoir. Indeed no regular biographer has yet appeared to do justice to his zealous exertions in the cause of his unfortunate but misguided master, or his still more patriotic efforts for the advancement of scientific knowledge. All, however, who have in any shape alluded, either to the political principles, religious tenets, or scientific acquirements of the Marquis of Worcester, appear to have been guided rather by a [x] spirit of fanatic intolerance, or a wish to clear King Charles from the heavy responsibility which attached to instructions given under his own hand and seal, when the Marquis was employed in Ireland. These then appear to have been the concurring causes, that have so long withheld from the noble Author the veneration his memory so justly merits; and we now proceed to follow him through his short but active career in public life.

Edward, sixth earl and second Marquis of Worcester, was born at Ragland near Monmouth; and his family, who had long been distinguished for the most devoted loyalty, possessed the largest landed estate of any nobleman attached to the British court. His grandfather Edward, fourth Earl of Worcester, enjoyed in a most distinguished degree the favour of Queen Elizabeth, and her successor King James. In 1593, he was instituted Knight of the Garter, and received a pension of fifteen hundred pounds per annum for life. Sandford describes him as "a great favourer of learning and good literature:" he died in the 79th year of his age, at Worcester House, in the [xi] Strand; and was buried in Ragland church.

Henry, the fifth earl, and father of the Marquis, succeeded to the title and estates in 1628: the

family revenue derived from those in Monmouthshire alone, at this period amounting to upwards of twenty-thousand pounds per annum. In 1642, the year in which he was created Marquis of Worcester, he raised and supported an army of 1500 foot, and near 500 horse-soldiers, which were placed under the command of his son Lord Herbert, the subject of this Memoir.

During the civil commotions, Charles made several visits to Ragland castle, where he was entertained with the greatest magnificence,[1] and on those occasions particularly distinguished the young Lord Herbert. On an open rupture taking place between the King and Parliament, his [xii]
Majesty invested Lord Herbert with the command of a large body of troops then raising in his native country, and an opportunity was soon offered for calling his military talents into action. [xiii]
Prince Rupert, shortly after the battle of *Marston Moor*, directed his attention towards the Marches of Wales, which awakening the jealousy of the Parliamentary General Massey, he by a [xiv]
feigned counter-movement surprised the city of Monmouth, which had always been considered as the key of South Wales, and thus threw the inhabitants of Ragland into the greatest confusion and alarm.

On the first intelligence of the fall of Monmouth reaching the Marquis, he despatched Lord Herbert with a considerable body of forces, who joining a troop of cavaliers from Godridge, lodged themselves undiscovered behind a rising ground near that city. A party of about forty men, who volunteered for the occasion, were headed by Lord Herbert, and proceeded to reconnoitre the town. Having climbed an earthen redoubt which had been thrown up by the Parliamentary forces, they passed the ditch and fell upon the guard, who were immediately put to the sword, and a few seconds more sufficed for breaking the *port-chain* and forcing an entry for the horse, who, having by this time joined their brave comrades, entered the town at full gallop; surrounding the main guard, the whole of whom they took prisoners. The result of this brilliant [xv]
and chivalrous enterprise was the capture of Colonel Broughton, four captains, as many lieutenants and ensigns, the committee, all the private soldiers, and a considerable quantity of arms and ammunition.

So signal a display of bravery and devotedness to the royal cause in the young cavalier procured from his Majesty the warmest commendations; and in the month of January, 1644, he had the honour to receive his first commission to negotiate with the Irish Catholics; while at the same time he was recommended by the king to the Earl of Ormonde, as one whose loyalty might be relied upon. With regard to his *Lordship's* fitness for this appointment, there can be but one opinion: educated among Catholics, and as such not likely to excite the same suspicions as would naturally attach to any negotiation with their avowed enemy, the Earl of Ormonde, and possessing considerable influence at the court of Rome, he seemed peculiarly qualified to fill the office of mediator; and having become popular with the people at home by his known liberality [xvi]
and patriotism, the appointment was not likely to excite much dissatisfaction on the part of the Puritans.

The deranged state of his Majesty's affairs, which were now growing desperate from the continued advantages of the rebels in Ireland, and his still more violent and fanatic subjects at home, rendered it necessary that some sacrifices should be made to conciliate the Irish Catholics; as he would thus procure a powerful and efficient force to aid him against the Covenanters. In proof of his anxiety on this subject, there were no less than eight letters written by the king himself, beside those of his secretaries, pressing for a speedy adjustment of the differences that had so long agitated the sister kingdom.

The first commission under the great seal was dated the sixth of January, and furnished the Marquis with full power to levy any number of men in Ireland or elsewhere; to make governors of forts, &c.; and to receive the king's rents. Upon the twelfth of March following, the Marquis [xvii]
received another commission, equally as extensive as the preceding; a copy of which is preserved by Rushworth, in his Collections, which we here subjoin.

> "CHARLES R.
>
> "CHARLES, by the grace of God, of England, Scotland, France, and Ireland, Defender of the Faith, &c., to our trusty and well beloved cousin, EDWARD Earl of Glamorgan, greeting. We, reposing great and especial trust and confidence in your approved wisdom and fidelity, do by these presents, as firmly as under our Great Seal, to all intents and purposes, authorise, and give you power to treat and conclude with the confederate Roman Catholics in our kingdom of Ireland, if upon necessity any be to be conscended unto, wherein our lieutenant (the Earl of Ormonde) cannot so well be seen in, as also not fit for us at present publicly to own. Therefore we charge you to proceed according to this our warrant with all possible secrecy; and for whatsoever you shall engage yourself, upon such [xviii]
> valuable considerations as you in your judgment shall deem fit, we promise, upon the word of a king and a Christian, to ratify and perform, the same that shall be granted by you and under your hand and seal; the said confederate Catholics having by their supplies testified their zeal to our service: and this shall be in each particular to you a sufficient warrant.
>
> "Given at our Court at Oxford, under our Signet and Royal Signature, the twelfth of March, in the twentieth year of our reign, sixteen hundred and forty-five."[2]

Who, it may be asked after perusing this document, will be hardy enough to pronounce with [xix]
Hume that "the king was incapable of dissimulation?" especially when coupled with his Majesty's subsequent declaration to both Houses of Parliament; in which he expressly says, that the Marquis, having made an offer to raise forces in Ireland and conduct them into England for his service, had a commission to that purpose; "but then," adds the king, "it was to that purpose only, and not to treat of any thing else without the privity and direction of the Lord Lieutenant."

What degree of credit ought to be given to the latter part of his Majesty's declaration, is pretty

plainly shewn by the following letter to the papal legate, which fully accords with the instrument we have just quoted of the twelfth of March: [xx]

> SIR,
>
> Hearing of your resolution for Ireland, we do not doubt but things will go well, and that the good intentions began by means of the last pope, will be accomplished by the present, by your means in our kingdoms of Ireland and England, you joining with our dear cousin the Earl of GLAMORGAN; with whom whatever you shall resolve we shall think ourselves obliged to, and perform it at his return. His great merits oblige us to this confidence, which we repose in him above all, having known him above twenty years; during which time, he hath always signally advanced himself in our good esteem, and by all kind of means carried the prize above all our subjects. This being joined to the consideration of his blood, you may well judge of the passion which we have particularly for him, and that nothing shall be wanting on our part to perfect what he shall oblige himself to in our name, [xxi] in consideration of the favours received by your means. Confide therefore in him: but in the meanwhile, according to the directions we have given him, how important it is that the affair should be kept secret, there is no occasion to persuade you, since you see that the necessity of the thing requires it. This is the first letter which we have ever wrote immediately to any Minister of State of the Pope, hoping it will not be the last; but that after the said earl and you shall have concerted your measures, we shall openly shew ourself, as we have assured him.
>
> Your Friend,
> CHARLES R.
>
> *From our Court at Oxford,*
> *30th April, 1645.*

The earl's negotiation had hitherto gone on prosperously, and there was good reason to suppose that he would shortly have brought the rebels to a complete concurrence with his Majesty's views, when a most unexpected accident disconcerted the whole of his schemes. An [xxii] attempt having been made by the Irish upon Kilkenny about the end of October, 1645, in which the titular Archbishop of Tuam had a command; the rebels were beaten and the prelate killed, in whose baggage was found a copy of the treaty which his Lordship had entered into with the confederate Catholics and the pope's nuncio. Of this discovery immediate information was furnished to the Parliament, then sitting, which had invariably expressed the greatest aversion to any concession being made to the Catholics; and the matter became so public, that the Lords Ormonde and Digby found it necessary to do something towards the vindication of his Majesty's honour, and to preserve appearances with the Parliament.

The council having met on the twenty-sixth, Lord Digby appeared at the board, and accusing the Earl of Glamorgan of high treason, moved that he should be immediately committed to the castle. On the following day he was examined by a committee of the council, when he exonerated [xxiii] his Majesty, and requested that the whole blame of the matter might be attributed to him; as he had consulted with no one on the subject, but the parties with whom he had made the agreement. [3]

When the intelligence of his lordship's imprisonment reached Kilkenny, where the supreme council then held their sittings, the Catholics were thrown into the greatest confusion, and some insisted on an immediate recourse to arms for his enlargement. These proceedings, however, were soon stayed by the friends of the Earl of Ormonde, and his lordship was shortly afterwards released on bail. As soon as this was effected he repaired to Kilkenny, in order to expedite the [xxiv] embarkation of a force amounting to about three thousand men, which had been raised for the relief of Chester; and, had there been a sufficient co-operation on the part of the general council, they might have sailed time enough to have afforded the most essential service to the royal cause; but after repeated delays on their part, intelligence was brought of the loss of that important city; and the Marquis, finding that his further stay in Ireland was attended with considerable hazard to his own life, without any commensurate benefit to his Majesty, resolved on embarking for France, where he was soon after joined by the exiled queen.

Immediately after his lordship's departure for the continent, the parliamentary forces under Sir Thomas Fairfax appeared before Ragland; and being refused admission by the venerable old Marquis, their hostile approaches were carried on with great vigour, in spite of repeated sallies from the fortress. The gallant veteran, however, finding the garrison, which at first consisted of [xxv] only 800 men, reduced to less than half that number, surrendered on honourable terms on the 17th August. Notwithstanding the pledge given by Sir Thomas Fairfax, the conditions of capitulation were most disgracefully violated, and the Marquis was committed to the custody of the Black Rod, where he languished till the December following; when he expired in the eighty-fifth year of his age, and was buried in St. George's Chapel at Windsor.

In the mean time the fortifications of Ragland were destroyed, and all the timber in the parks was cut down, and sold by the committee of sequestrations. The lead alone that covered the castle was sold for 6,000 pounds, and the loss to the family in the house and woods, has been estimated at not less than 100,000 pounds!

From the destruction of Ragland castle by the Parliamentary forces, till the beginning of 1654, the earl's name scarcely occurs in the political history of those times; but about that period, we [xxvi] find him attached to the suit of Charles II., who then resided at the court of France: and in the following year he was dispatched by the exiled monarch to London, for the purpose of procuring private intelligence and supplies of money, of which the king was in the greatest need. He was, however, speedily discovered and committed a close prisoner to the Tower, where he remained in captivity for several years.

Some idea of the state of indigence to which the Marquis was now reduced may be formed from a perusal of the following Letter, directed to the celebrated Colonel Copley, who was, it appears, one of the noble Author's supporters.

"Dear Friend,

"I knowe not with what face to desire a curtesie from you, since I have not yet payed you the five pownds, and the mayne businesse soe long protracted, whereby my reallity and kindnesse should with thankefullnesse appeare; for though the least I intende you is to make up the somme allready promised, to a thousand pownds yearly, or a share ammounting to farr more, (which to nominate before the perfection of the woorke were but an *individuum vagum*, and therefore I deferre it, and vpon noe other score,) yet, in this interim, my disapointments are soe great, as that I am forced to begge, if you could possible, eyther to helpe me with tenne pownds to this bearer, or to make vse of the coache, and to goe to Mr. Clerke, and if he could this daye helpe me to fifty pownds, then to paye yourself the five pownds I owe you out of them. Eyther of these will infinitely oblige me. The alderman has taken three days time to consider of it. Pardon the great troubles I give you, which I doubt not but in time to deserve by really appearing [xxvii]

"Your most thankful friend
WORCESTER.

28th of March, 1656.

"To my honored friend
Collonell Christopher Coppley,
These."

On the king's restoration, the Marquis of Worcester was one of the first to congratulate his Majesty on the happy event, though the situation of the unfortunate nobleman was little bettered by the change; indeed it appeared but as the signal for new persecutions, as one of the earliest public acts of that ungrateful monarch may be characterized as an invidious attempt to set aside the just claims of his earliest and best friend. [xxviii]

In 1660 the House of Lords appointed a committee to consider of the validity of a patent granted to the Marquis of Worcester in prejudice to the Peers, upon the first intimation of which his Lordship sent a messenger to the committee then sitting, stating his willingness to surrender it, and it was shortly afterwards presented to the House by his son Lord Herbert.

In 1663 appeared the first edition of the noble Author's Century of Inventions, and on the 3d of April in the same year, a bill was brought in for granting to him and his successors the whole of the profits that might arise from the use of an engine, described in the last article in the *Century*. [4] [xxix]

Of the merits of the *Century of Inventions* as a literary composition but little can with justice be said; whether, however, as a scientific production, it deserves the character that has been given of it by men more celebrated for their literary attainments, than for scientific knowledge, the reader, after a perusal of the work, will readily determine.[5]

The Marquis likewise published a work entitled "An Exact and true Definition of the most stupendous Water-commanding Engine, invented by the Right Honourable (and deservedly to be praised and admired) Edward Somerset Lord Marquis of Worcester, and by his Lordship himself presented to his most excellent Majesty Charles II., our most gracious Sovereign." This was published in a small quarto volume consisting of only twenty-two pages, and is now become extremely rare. [xxx] [xxxi]

His lordship survived the publication of this work but two years; as he died in retirement near London upon the third of April 1667. His remains were conveyed with funeral solemnity to the cemetery of the Beaufort family in Ragland church; where he was interred on Friday the nineteenth of the same month, near the body of his grandfather, Edward Earl of Worcester. The coffin was placed in an arched stone vault, with the following inscription on a brass plate:

"Depositum Illustrissimi Principis Edwardi Marchionis et Comitis Wigorniæ, Comitis de Glamorgan, Baronis Herbert de Raglan, Chepstow et Gower, nec non serenissimo nuper Domino Regi Carolo primo, Southwalliæ locum tenentis: qui obiit apud Lond. tertio die Aprilis, An. Dom. MDCLXVII."

ORIGINAL LETTERS
AND
OFFICIAL PAPERS,
ILLUSTRATIVE OF THE PRECEDING MEMOIR.

[xxxii] [xxxiii]

The manuscripts from whence the annexed documents have been selected, are now in the possession of his Grace the Duke of Beaufort; and the Editor would be wanting in justice to another distinguished member of the same noble family, did he omit to acknowledge the great kindness which he has received from Lord Granville Somerset, who has materially assisted the Editor in illustrating the labours of his very ingenious ancestor.

GLAMORGAN [xxxiv]

I heerewth send you the rest of my dispatches for Ireland, whether I praye hasten, time beeing most considerable. I am sensible of the dangers y^{u} will undergoe, and y^{e} greate trouble and expences you must be at, not being able to assiste y^{w} who have already spent aboue a Million of Crowns in my service, neither can I saye more then I well rememb^{r} to have spoke and written to you that allready words could not expresse your merits nor my gratitude: and that next to my wife and children I was most bound to take care of you. whereof I have besides others particularly assured yo^{r} Cosin Biron as a person deare unto you. What I can further thinke at this pñt is to send y^{w} the Blue Ribben, and a Warrant for the Title of Duke of Somerset both w^{ch} accept and make vse of at your discretion, and if you should deferre y^{e} publishing of either for a whyle to avoyde envye, and my being importuned by others yet I promise yo^{r} Antiquitie for y^{e} one and your Pattent for y^{e} other shall beare Date with the Warrants. And rest assured, if God should [xxxv] crosse me wth your miscarrying I will treate your Sonne as myne owne, and that y^{u} labour for a deare freind as well as a thankefull Master when tyme shall afforde meanes to acknowledge, how much I am

Yo^{r} most assured reall constant
and thankfull freind
Charles R.

Oxford Feb. 12, 1644.

Oxford this seconde of January 1644 Severall Heades whereupon you our Right trusty and right welbeloved Cosen Edward Earle of Glamorgan may securely proceede in execution of our Commands.

First you may ingage y^{r} estate, interest and creditt that we will most really and punctually performe any our promises to the Irish, and as it is necessary to conclude a Peace suddainely, soe [xxxvi] whatsoever shall be consented unto by our Lieutenant the Marquis of Ormond, We will dye a thousand deaths rather than disannull or breake it, and if vpon necessity any thing be to be condescended unto, and yet the Lord Marquis not willing to be seene therein, as not fitt for us at the present publickely to owne, doe you endeavour to supply the same.

If for the encouragement of the Lord Marquis of Ormond you see it needefull to have the Guarter sent him, or any further favour demonstrated from vs vnto him, we will cause the same to be performed.

If for the advantage of our service you see fitt to promise any titles, even to the Titles of Earles in eyther of our Kingdomes, vpon notice from you we will cause the same to be performed.

For the Maintenance of our Army vnder y^{r} Com~aund we are gratiously pleased to allowe the Delinquentes estates where you overcome, to be disposed by you, as alsoe any our revenues in [xxxvii] the sayd places, Customes or other, our profitts, woods and the like wth the contributions.

Whatever Townes or places of importance you shall thinke fitt to possesse you shall place Com~aunders and Governours therein at y^{r} pleasure.

Whatever Order we shall sende you (w^{ch} you are only to obey) We give you leave to impart the same to y^{r} Counsill at Warr and if they and you approve not thereof We give you leave to replye, and soe farr shall we be from taking it as a disobedience, that we com~aunde the same.

At y^{r} returne we will accept of some officers vpon y^{r} recom~endation, to the ende noe obstacle or delay may be in the execution of y^{r} desires in order to our service, and our com~aunds in that behalfe.

At y^{r} Returne you shall have y^{e} Com~aund of South Wales, Herefordshire, and Glocester-shire of the Welsh-side returned to you in as ample manner as before.

In y^{r} abscence we will not give creditt or countenance to any thing, w^{ch} may be preiudiciall to [xxxviii] y^{r} Father, you, or yours

C. R.

Herbert

I wonder, you are not yet gone for Ireland; but since you have stayed all this time, I hope these will ouertake you, whereby you will the more see the great trust and confidence I repose in your integrity, of which I have had soe long and soe good experience; commanding yow to deale with all ingenuity and freedome with our Lieutenant of Ireland the Marquis of Ormond, and on the word of a King and a Christian I will make good any thing, which our Lieutenant shall be induced unto upon your persuasion: and if you find it fitting, you may privately shew him these, which I intend not as obligatory to him, but to myselfe, and for both your encouragements and warrantise, in whom I repose my cheefest hopes, not having in all my Kingdomes two such

subjects; whose endeauours joining, I am confident to be soone drawen out of the mire, I am now enforced to wallow in; and then shall I shew my thankfullnesse to you both, and as you have neuer failed mee, soe shall I neuer faile you, but in all things shew how much I am [xxxix]

Oxforde the 12th
of March 1644.

HERBERT

I am confident that this honest trusty bearer will give you good satisfaction why I have not in euerie thing done as you desired, the wante of Confidence in you beeing so farre from beeing y^{e} cause thereof that I am euery daye more and more confirmed in the trust that I have of you, for beleeve me it is not in the power of any to make you suffer in my opinion by ill Offices, but of this and diuers other things I have given so full Instructions that I will saye no more, but that I am

Yo^{r} most assured constant freind
CHARLES R.

Oxford 26 Feb. 1645.

GLAMORGAN [xl]

I am glad to heare that you are gone to Ireland and assure y^{u} that as my selfe is nowyse dishartened by our late misfortune so neither this Country; for I could not have expected more from them, then theye have now freely undertaken though I had come hether absolute Victorious w^{ch} makes me hope well of y^{e} neighbouring Sheeres. So that (by y^{e} grace of God) I hope shortly to recover my late losse with aduantage if such succours come to me from that Kingdome w^{ch} I have reason to expect, but the circumstance of time is that of the greatest consequence, beeing that which is cheefliest and earnestliest recommended you by

Your most assured reall constant
freind
CHARLES R.

Hereford 23 June 1645.

GLAMORGAN

I have no time nor do you expect that I should make unnecessary repetitions to you wherefore referring you to Digby for business this is onlie to giue you assurance of my constant freindship to you which considering the generall Defection of common honesty is in a sorte requisite howbeit I knowe y^{u} cannot be but confident of my making good all instructions and promises to you [xli]

Y^{r} most assured constant freind
CHARLES R.

Oxford 5 Aprile 1646

Henriette Marie R

Nous henriette Marie de bourbon Regne de la grande Bretagne auons par l'ordre du Roy notre tres honoré Seigneur et Mary fait deliurer es mains de notre tres cher et bien amé cousin Edouard Somerset Comte et Marquis d Worcester un collier de Rubis contenant dix gros Rubis et cent soixante perles enchassées et confilées en or entre les dits Rubis comme aussy deux gros diamans l'un appellé Sancy et l'autre le Portugal, confessans qu'outre les tres grandes depenses [xlii] faites par luy, pour le dit Roy notre tres honore Seigneur, il nous a encore fourny trois cens soixante et dix mil liures tournois outre les tres grands seruices qu'a ce present mesme il nous fait qui sont au moins d'egale consequence, au regard de quoy nous faisons scauoir que le dit collier et Diamans sont totalement pour en disposer par luy soit par uente on engagement, sans que nous, ou aucun en notre nom puisse en faire aucune demande, Rechercher ou troubler aucune personne qui achetera ou prestera argent sur les dits Joyaux cy dessus nommez en temoignage de quoy nous auons Signé et fait mettre notre Séel Royal a cette presente a notre Cour a St Germain en Laye ce Jourdhuy 20 May mil six cens quarente huiet.

L. S.
(The Royal Arms.)

To the Kinges most Exelent Mai^{tie} The humble Petition of all the Deputy Lieutenants Justices of the Peace the Knights & Burgises for Parliam^t setting for the Countie of Monmouth & indeede of all the Gentry & Comonalty Freehoulders and other inhabitence within the said Countie nemine contradicente but una voce most humbly [xliii]

Sheweth

That whereas y^e^ Right hon^ble^ our very good Lord the now Earle and Marquisse of Worcester after about twenty yeares absence comforteth and honoureth us w^th^ his p^r^sence to y^e^ great sattisfaction of all your Maj^ties^ most loyall & devote^d^ subjects, Wee become most humble petition^rs^ to your Gratious and most sacred Maj^tie^ that you wilbe pleased to incuredge his Exelency to make his cheife residance heer, which by longe and suffitient experience wee well know will much conduce to your Maj^ties^ intherest, and seruice, and to the good and great sattisfaction not onely of this but of all y^e^ adjacent Counties, his Lords^p^ having always been a [xliv] disinterested Governor and freind to us all, as most espetially a most faithfull zealouse and powerfull promoter of seruices to y^e^ Crowne, yett with care and sweetnesse euer shewed towards your Maj^ties^ Loyall subjects, and nowayes partiall to those of his owne perswation and religion, where ever his Excelency hath had command looking but vpon his kings intherest and y^e^ peoples justifiable pretentions neither can his greatest enimies make appeare y^e^ least profe to y^e^ contrary.

May itt therefore please your most Excelent Maj^tie^ vpon this our most humble petition suplycat^g^ to Joyne his Lords^pp^ with his most deseruing sonne, the Lord Herbert, in the Liuetenancie of this Countie, and wee esteeme it wille soe far from derogateing from my Lord his Sonne who we must hon^r^ that it wilbe an adit~on of coumfort and hon^r^ to his Lords^pp^ to have his beloued father Joyned with him, as his Grandfather was with his Father the Lord Privie Seale, that wise and stout Privie counsellor: his Lords^pps^ great grandfather and predecessor neither doe [xlv] wee looke with lesse awfullnesse and respect vpon our now Lord Marquisse of Worcester, if he reside amonghst us in a poore Grange of his then whilst he dwelt in his most sumptuous Castle of Ragland, like a Prince attended, esteemeing his now pouertie in respect of his then opulancie, but as a badge of Loyaltie, and as readilie and cheerfully shall wee obey his commands who our harts attend, as much as then, if Impower^d^ by your Gratious Maj^tie^ to bee our Joynt Lord Lieutenant which hon^r^ and power wee most humbly begg may be againe conferred upon his Excelency.

And wee shall euer pray, &c.

May it please y^r^ Grace

The obiections yow were pleased to make against the owning and subscribing y^e^ Letter to his Ma^tie^ were as I humbly conceaue y^r^ Graces resolution not to trouble y^e^ King for any money [xlvi] businesse euen in your owne behalfe much lesse in an others, and secondly that as for Creations you had absolutely promised his Ma^tie^ you would not importune him againe, to the furst I answeare that this is to save the Kings Coffirs, since certainely if eyther honor or conscience should take place his Ma^tie^ ought to saue me harmelesse from the six thousand pound Confest and proued to be y^e^ Crownes Debt, soe happyly now vpon his Head by your Graces noe lesse prudent and valerous then dutyfull endeauours blest by Devine Prouidence neuer intending the ruine of his best deseruing subiects, and y^e^ only promoting of his ribells, which the child unborne may rue if not timely preuented, and as a wise Privye-Counsillor y^r^ Graces part is to minde his Ma^tie^ soe of, as not totally to disharten I will not say disgust his good subiects well desarueing yet that as far as loyalty and Religion will giue them leaue, and I am sory his Ma^tie^ should bedd a diew to workes of superergation and loue in his subiects and most Certinely they are not his best Councellers who aduise him to it, and y^r^ Grace will be most Commendable in douing the [xlvii] Contrery, and at long running the King will loue you best for it, soe that this obiection of y^r^ Grace I humbly conceave to be totally solued.

As for the seconde y^r^ Graces promise not to speake for any more Creations be pleased to vnderstand it rightly, and you are noe motioner of this, you doe but lay before him my reasonable Petition therein, such as indeed my Lord Chancellor was pleased to thinke soe fitting as he once vndertook it for me, and I am confident will thanke y^r^ Grace for reuiuing of it and in my Conscience soe will y^e^ King too in graunting of it, for I cannot haue soe meane a thought of his Ma^tie^ but that against the hayre he hath binne forced to bistow honoure to the highest degree upon five member men and vpon irth as subscribed to his father of happy memory his death, and that he will thinke mutch to countinance him who only assisted his late Ma'^ie^ to flye from theyr compulsion of him to agree to such acts as would have lefet him selfe our now Gratious King y^e^ [xlviii] sucessior of a title of a King of three Kingdoms but to the substance of noe one of them. It was I furnished his Ma^tie^ with money to goe (to) Theobalds to goe to Yorke when the then Marquis of Hambleton refused to pay three hundered pound for his Ma^tie^ at Theobalds only to deliuer him to the Parliament, as he had donne the Earle of Strafford, and to * * * the * * * Parliament, It was I

carried him money to sett vp his standard at Yorke, and procured my father to giue the then s[r] John Byron five thousand pound to rayse the first Regiment of Horse, and kept a table for aboue twenty Officers at Yorke, which I vnderhand sent thether to keepe them from takeing Conditions from y[e] Parliament, and soe were ready to accept his. It was I vittled the towre of London & gaue fiue and twenty hundred pound to y[e] then Lieutenant s[r] John Byron my Cosin Germain by my first wifes side. It was I raysed most of the Menne at Edgehill fight, and after I was betrayed at when soe many Gentlemen of Quality were taken and of twenty fiue thousand men first & last by me [xlix] raysed Eight thousand men disperssed by the Contriuance of such as called themselues y[e] Kings good subiects, and some of them rewarded for it, they were my men weekely payed without takeing a farthing contribution because the country tottered, who tooke in the forest of Deane, Goodredge Castle, Monmouth, Chepstowe, Carlyon and Cardiff from y[e] Parliament forces, in w[ch] and y[e] Garrison of Ragland I can bring profe of aboue an hundered and fifty thousand pounds expended, and in ready Money first & last to y[e] Kings owne Purse aboue as much more, and of aboue thirty five thousand Pounds Receaued by my father and me Comunely Armes in forty—forty two—and forty three I have not now fiue and twenty hundered and that clogged well, twenty thousand Pounds Crying Debts that keepe me not only from a competent maintenance but euen from sleepe, I speake not heare of aboue three hundered thowsands pounds which it hath cost y[e] Noblemen Knights and Gentlmen which ridd in my Life Guarde for ther comporting they makeing [l] amongst them aboue three-score thousand Pownds yearly of Land of inheretance and I vpon my interest with seauen Countys had begune an Engagement of above three hundered thousand Pounds yearly land of inhiretance against my returne with men from beyonde the sea in which endeauours my charges have beine vast, besides hazard by sea euen of shipwracke and by Land of deadly encounters, I doe not trouble y[r] Lo[p] with, but all this being true to a tittle as vpon my word and honour dearer to me then my life I advouche it, I cannot doubt but y[r] Grace will call for a peane to signe y[e] Letter, and if you please sende this together with it, and rest assured that if the King refuse my request I will neuer importune you more, nor euer sett my foote into his Ma[ties] Court againe vnlesse expressly comanded by him for his seruice, otherwise I will only heartyly pray for him but neuer hereafter shall I or any freind of mine engage for him further, then y[e] simple duty of a Loyall subiect sitting quiettly at home noe ways breake the peace or disobying the wholsom lawes of the land, and god seande him better and more able subiects to [li] searve his Ma[tie] then my selfe, willinger I am sure he cannot, and I beseeche y[r] Grace to pardon me if passion hath a little transported me beyonde good manners, and lay what pennance you please vpon me soe it tende not to lessen y[r] Graces beliefe that I am

Y[r] Graces
Most really deuoted freind
and seruant ever to obey you
WORCESTER.

Dec. 29th, 1665.

My deare Lord, my heart is yet full froughted and I can say much more for myselfe, were I not [lii] ashamed of giueing y[r] Grace soe great a trouble with my scribling, which I will thus ende, promising to smoother as long as may be my deplorable condition, and worse vsage, but it will at last fly ouer the whole world to the disheartining of all zelous and Loyall subiects, vnlesse such a true hearted Englishman and fathful seruant as y[r] Grace doe awaken his Ma[tie] out of the leturgie my enimies have cast him not to be sensible of what I have done or suffered. Cardinall Mazarine presented me to his King, with these woords "S[r] who soeuer hath Loyalty or Religion in recommendation must honour this well Borne Person," and Queene Mother now Dowager hath often sayd to have heard her husband say that next to her and his Children he wass bound to take a care of me of whom it may be now verified qui iacet in terra non habet vnde cadet, I am cast to the Ground I can fall noe lower.[6]

To the Kings most Excellent Majesty, The most humble Petition of Edward Marquis of Worcester.

Sheweth

That yo[r] petitioner overwhelmed with the very, very much he hath to say, fearefull too long to detaine y[r] sacred Ma[ty] therewith from the more serious affaires humbly prayeth that you wilbe [liii] pleased to refer him to be heard by the Lord high Chancellor of England, The Lord privie seale, The Duke of Alm~erle, the Earle of Lotherdale, the Lord Arlington, the Lord Ashley, and Mr. Secretary Morris, or to such of them, or other persons, as yo[r] Ma[ty] shall thinke fitt, and that vppon their Report yo[r] Ma[ty] will vouchsafe to doe with yo[r] petitioner, or to yo[r] petitioner, what they in the petitioners behalfe, and congruous to yo[r] service shall finde reasonable, and consonant with yo[r] petitioners meritts or demeritts, the petitioner most intirely submitting to your will and pleasure, Casting himselfe vppon yo[r] Ma[tyes] goodnesse, noe wayes standing vppon his deserts, though really found never soe many not thought of, or hetherto kept from yo[r] Ma[tyes] knowledge, your peti[r] doth not say through envy or malice, since perhaps through ignorance such ignorance notwithstanding as the divines call ignorantia crassa, but whatsoever in quality or

number, his services were, they were but due to such a gratious King and Master as yo^{r} Ma^{tyes} [liv]
Father of happy memory was to yo^{r} petitioner, and to yo^{r} incomparable selfe, and therefore acknowledgeth they fall farr shorte of his true loyalty and devotion to either and being once rightly made knowne and p^{r}sented to yo^{r} sacred Maiesty yo^{r} petitioner promiseth himselfe noe lesse incouragement for the future from your Ma^{ty} nor lesse abilities in himselfe to become as useful as formerly, and as disinterresedly to serve you, Neither shall any thing for the future dismaye, or in any kinde deterr, your petitioner, from that his resolution, but from the bottome of his heart

He shall ever pray, &c.
WORCESTER.

Att y^{e} Court att Hampton Court Jan. 29th
1666.

His Ma^{ty} is graciously pleased to referr and recom~end the Peticõner to bee heard by the within named Lords Referrees or to any fower or more of them, and they to give their Report to his Ma^{ty} as soon as conveniently may bee.

ARLINGTON.

MADDAM [lv]

I did not thinke I should have had the occation to have troubled you with an other Letter but I am soe little sattisfyed with yours in what I required conscerninge my monyes that I cannot thinke a survilous paper an equal ballance for soe waighty and iust a debt: I confesse I have hard of a new way to pay ould debts but certainly this is the newest, I belieue your Ladiship is one of the first that euer tryd it: itt may bee *al a mode*, but truely I doe not like the fashion, though itt may bee others doe: To answare your Letter, first for your Religion I medle not with itt It conscerns not mee; if I have, certainely I have done rather an hon^{r} to itt then an iniury: for I belieu'd soe well of your Religion that itt tought noe man to distroy his faith, Hon^{r}, and Christianety; which my Lord hath done in his engagement to mee I onely speake of him—I pray you Maddam lett mee aske, what is hon^{r} if broken? tis easely answared noe hon^{r}, what is itt to pretend a faith in Jesus Christ, to be call'd a Christian, and to breake that faith, and likewise [lvi]
forfitt that Christianety, he's noe Christian and whereas you say I wronge the memory of the late Kinge (I know not upon what grounds) Maddam you doe mee wronge, I serve the memory of that Royall Martyr, equall to any hee that lives: I pray you did his Ma^{tie} euer engage his faith, hon^{r}, and Christianety, to pay any debts, where in he fail'd; Maddam vnder fauour I must say you doe his incomparable ashes iniury. You likewise tell mee noe gallant pearson wilbeleiue but that my Lord will pay mee when hee hath itt, tis a large extent, and for ought I know may reach to Dooms day; tis small sattisfaction to expect a certaine debt att such an vncertaine payment. Maddam you haue the priueledge of a Woeman in speakinge of my Loyalty, noe man can, nor dare tax itt, for my publishinge any thinge that conscernes your Lord, tis his owne actions that causeth mee to report those truths: You say my Lord hath spent more in his Ma^{ties} seruice than any Protestant, I dare say there has beine ten thousand loyall faithfull Protestants hath spent as much: where of I [lvii]
am one, for wee have spent, and lost all wee had to our proportions, tis as much as hee (the widowes mite will make itt good) and in soe doinge wee did but our dutyes, and wee ought not to obraide the King with itt, tis vnhandsome to expect Sallery for a lawfull duty. Your Ladyship saith that I reported my Lord gaue mee counterfitt plates, I confesse hee gaue mee some plates, and forced them upon mee, hee likewise borrowed them of mee againe, resoluinge to returne them within too dayes, but he hath not restored them to this day, I heare since that my Lord hath sould them: I hope hee will confesse that noe man of Hon^{r} did euer such an action before, allthough he was ready to starue, and for his giuinge mee false plate, I must deny itt for I neuer said itt, but this I did say, that when I was at his Lordsp's house he showed mee some plates, that was not the same that hee had formerly giuen mee for the first was beaten, and the latter was cast, if that was counterfitt, I sayd itt, and that ile iustify. for your friuolous paper, I dare say your reconcil'd [lviii]
iudgment doth repent the sendinge of itt, I have shewed it to diuers of your religion, and they condemne you for itt, likewise the paper, nor can the Kinge of Englande giue you thanks for itt. But his royall Mother beinge a Roman Catholique, my hon^{r} and admiration of her doth silence my penn in answeringe that scandalous paper.

Your Ladiships humble Servant
RICH. HASTINGS.

Paris Ape 3

Directed,

Forr the Right Hon^{ble} the Marchioness
of Worcester these

humbly

Jesus + Mi~a September 6 1670

NOBLE MADAM—

The Grace of the Holy-ghost be with you.

The great esteeme and honour w^{ch} I have euer had for your Lady^{sp} hath all waise made mee [lix]
prompt and willing to serve you to the best of my power, without the bias of selfe interest, as your selfe can witnesse; And because I feare that at present, your Honour hath noe one, that in the greate concernes, which you have in hand, will tell you the truth, as it often happens to persons of greate quality: I have thought it the part of my Priestly function, and fidelity towards yo^{r} Ho^{r}: (haveing first in my poore prayers, humbly commended it to Alm: God) to represent unto you, that w^{ch} all your friends know to bee true, as well as myselfe, and would be willing that your Lady^{sp} should know it likewise.

Alm: God hath Madam put you into a happy, and flourishing condition, fitt and able to serue God, and to doe much good to your selfe and others; and your Lady^{sp} makes yourselfe unhappy, by seeming not to be contented with your condition but troubling your spiritts with many thoughts of attayning to greater dignityes and riches.

Madam all those that wish you well, are greeued to see your Lady^{sp} to bee allready soe much [lx]
disturbed & weakened in your iudgment & in danger to loose the right use of your reason, if you doe not tymely endeauour to preuent it, by ceasing to goe on with such high designes, as you are vppon, which I declare to you, in the faith of a Priest to bee true: The cause of your present distemper, and of the aforesayd danger, is doubtlesse, that your thoughts and imagination are very much fixed on the title of Plantagenet, and of disposing yourselfe for that greate dignity by getting of greate sums of money from the king, to pay your deceased Lords debts, and enriching your selfe by the great Machine and the like. Now Madam how vnproper such undertakings are for your L. and how vnpossible for you to effect them, or any one of them, all your friends can tell you if they please to discover the trueth to you.

The ill effects that flow from hence are many: as the danger of looseing your health and iudgment by such violent application of your fancies in such high designes and ambitious desires; the probability of offending Alm: God and preiudising your owne soule thereby: the advantage [lxi]
you may thereby give to those who desire to make a prey of your fortune, and to rayse themselves by ruining of you: the spending greate sums of money in rich and sumptuous things w^{ch} are not suteable to the gravity of your Lady^{sp} and present condition of Widdow-hoode and mourning for your deceased Lord.

Although it bee certine, that it is a greate temptation which you are now vnder, and very dangerous and hurtfull both to your temporall and eternall happynesse; yet I confesse that the Devil, to make his suggestion the more preualent, doth make vse of some motives that seeme plausible, as of paying your Lords debts, of founding of monasterys, and the like, and that your Lady^{sp} hath the Kings favour to carry on your designes. But Madam it is certine that the King is offended with your comeing to the Court, and much more with your pretention to the title of Plantaginet; and it is dangerous to provoke him any farther: And for paying of Debts and founding of Monasteryes, wee all know that your L. can neuer bee in a better condition to doe it, [lxii]
than now you are; and as you are not bound to doe such things, so they are not expected from you; but wee all applaud your pious inclinations herein, of w^{ch} you will not loose the merit with Alm: God but our apprehensions are, least you should by your Lady^{ps} inordinate designes bring your selfe into such a condition, as not to bee able to helpe your friends nor your selfe.

Bee pleased Madam now to give mee leave to suggest some waie how the approaching dangers may bee prevented, by changing the objects of your affections, and insteede of temporall, to seeke after eternall riches, and honors, which your age doth assure you are not far off; for w^{ch} you may dispose yourselfe, before death comes, by retiring into the countrey for some time, from the distractions of the Court, where you may haue the advice and directions of some learned Priest, in whose vertue you may wholey confide, and bee guided by him, for your internall quiet & security. Many places may soone be found out, that are fitt for that purpose: At Hammersmith [lxiii]
Mrs. Bedingfield a very vertuous & discreete person, and of your Lady^{ps} acquaintance, hath lately taken a faire house & garden, & hath but a small family. In some such place your Ho^{r} might likewise haue the aduice of some well experienced Doctor, for the health of your person, and the benefitt of good ayre and of quietnesse, would much conduce to your health: And soe by Alm. Gods blessing, you may recouer from that most pernicious distemper of bodey and mind, vnto w^{ch} every one seese you to bee very neere approching, and may live many yeares with your owne fortune & dignity in greate honour and happynesse & bee the author of many good workes of piety & Charity to the glory of God & eternall saluation of your owne soule. Thus dear Madam I have ventured to declare a great trueth to you, w^{ch} was before a secrett only to your selfe. I know that I run the hazerd of incurring your displeasure, if your Lady^{sp} should not reade the candor of [lxiv]
my intentions, w^{ch} in my Letter I intend towards you: but my assurance of haveing herein performed a duty w^{ch} I owe to my God, and the hope I have that you will take it well as I intend it, have encouraged mee to doe it, and to subscribe myselfe

Honored Madam
Your humb. Ser. in C. J.
WALT. TRAVERS.

The Lord Marquesse of Worcester's ejaculatory and extemporary thanksgiving Prayer, when first with his corporal eyes, he did see finished a perfect trial of his Water-commanding Engine, delightful and useful to whomsoever hath in recommendation either knowledge, profit, or pleasure. [lxv]

Oh! infinitely omnipotent God! whose mercies are fathomlesse, and whose knowledge is immense, and inexhaustible; next to my creation and redemption I render thee most humble thanks from the very bottom of my heart and bowels, for thy vouchsafing me, (the meanest in understanding,) an insight in soe great a secret of nature, beneficent to all mankind, as this my water commanding engine. Suffer me not to be puffed upp, O Lord, by the knowing of it, and many more rare and unheard off, yea unparalleled inventions, tryals, and experiments.—But humble my haughty heart, by the true knowledge of myne own ignorant, weake, and unworthy [lxvi] nature: proane to all euill, O most mercifull Father my creator, most compassionatting Sonne my redeemer, and Holyest of Spiritts, the sanctifier, three diuine persons, and one God, grant me a further concurring grace with fortitude to take hould of thy goodnesse, to the end that whatever I doe, unanimously and courageously to serve my king and country, to disabuse, rectifie, and convert my vndeserved, yet wilfully incredulous enemyes, to reimburse thankfully my creditors, to reimmunerate my benefactors, to reinhearten my distressed family, and with complacence to gratifie my suffering and confiding friends, may, voyde of vanity or selfe ends, be only directed to thy honour and glory everlastingly. Amen.

[lxvii]

A

CENTURY

OF THE

NAMES AND SCANTLINGS

OF SUCH

INVENTIONS,

As at present I can call to mind to have tried and perfected, which (my former Notes being lost) I have, at the instance of a powerful Friend, endeavoured now in the Year 1655, to set these down in such a way, as may sufficiently instruct me to put any of them in practice.

——*Artis et Naturæ proles.*

[lxviii]

TO

[lxix]

THE KING'S

MOST EXCELLENT MAJESTY.

SIR,

"Scire meum nihil est, nisi me scire hoc sciat alter," saith the poet, and I most justly in order to your Majesty, whose satisfaction is my happiness, and whom to serve is my only aim, placing therein my "summum bonum" in this world: be therefore pleased to cast your gracious eye over this summary collection, and then to pick and choose. I confess, I made it but for the superficial satisfaction of a friend's curiosity, according as it is set down; and if it might now serve to give [lxx] aim to your Majesty how to make use of my poor endeavours, it would crown my thoughts, who am neither covetous nor ambitious, but of deserving your Majesty's favour, upon my own cost and charges, yet, according to the old English proverb, "It is a poor dog not worth whistling after." Let but your Majesty approve, and I will effectually perform to the height of my undertaking: vouchsafe but to command, and with my life and fortune I shall cheerfully obey, and maugre envy, ignorance and malice, ever appear

Your Majesty's
Passionately-devoted, or otherwise disinterested
Subject and Servant,
WORCESTER.

[lxxi]

TO
THE RIGHT HONOURABLE
THE
LORDS SPIRITUAL AND TEMPORAL;
AND TO
THE KNIGHTS, CITIZENS, AND BURGESSES
OF THE
HONOURABLE HOUSE OF COMMONS:
NOW ASSEMBLED IN PARLIAMENT.

MY LORDS AND GENTLEMEN,

Be not startled if I address to all, and every of you, this Century of Summary Heads of Wonderful Things, even after the dedication of them to his most excellent Majesty, since it is with his most gracious and particular consent, as well as indeed no ways derogating from my duty to his sacred self, but rather in further order unto it, since your Lordships, who are his great [lxxii] Council, and you, Gentlemen, his whole kingdom's Representatives (most worthily welcome unto him) may fitly receive into your wise and serious considerations, what doth or may publicly concern both his Majesty and his tenderly-beloved people.

Pardon me, if I say, (my Lords and Gentlemen) that it is jointly your parts to digest to his hand, these ensuing particulars, fitting them to his palate, and ordering how to reduce them into practice, in a way useful and beneficial, both to his Majesty and his kingdom.

Neither do I esteem it less proper for me to present them to you in order to his Majesty's service, than it is to give into the hands of a faithful and provident steward, whatsoever dainties and provisions are intended for the master's diet; the knowing and faithful steward being best able to make use thereof to his master's contentment, and greatest profit, keeping for the morrow whatever should be overplus or needless for the present day, or at least to save something else in lieu thereof. In a word, (my Lords and Gentlemen,) I humbly conceive, this [lxxiii] simile not improper, since you are his Majesty's provident stewards, into whose hands I commit myself, with all properties fit to obey you; that is to say, with a heart harbouring no ambition, but an endless aim to serve my King and Country: and if my endeavours prove effectual, (as I am confident they will,) his Majesty shall not only become rich, but his people likewise, as treasurers unto him; and his peerless Majesty, our King, shall become both beloved at home, and feared abroad; deeming the riches of a King to consist in the plenty enjoyed by his people.

And the way to render him to be feared abroad, is to content his people at home, who then with heart and hand are ready to assist him; and whatsoever God blesseth me with to contribute towards the increase of his revenues, in any considerable way, I desire it may be imployed to the use of his people; that is, for the taking off such taxes or burthens from them as they chiefly [lxxiv] groan under, and by a temporary necessity only imposed on them; which being thus supplied, will certainly best content the King, and satisfy his people; which, I dare say, is the continual tend of all your indefatigable pains, and the perfect demonstrations of your zeal to his Majesty, and an evidence that the kingdom's trust is justly and deservedly reposed in you. And if ever Parliament acquitted themselves thereof, it is this of yours, composed of most deserving and qualified persons; qualified, I say, with your affection to your Prince, and with a tenderness to his people; with a bountiful heart towards him, yet a frugality in their behalfs.

Go on therefore chearfully (my Lords and Gentlemen) and not only our gracious King, but the King of Kings will reward you, the prayers of the people will attend you, and his Majesty will with thankful arms embrace you. And be pleased to make use of me and my endeavours to enrich them, not myself; such being my only request unto you, spare me not in what your wisdoms shall [lxxv] find me useful, who do esteem myself not only by the act of the Water-commanding Engine (which so chearfully you have past) sufficiently rewarded, but likewise with courage enabled to do ten times more for the future; and my debts being paid, and a competency to live according to my birth and quality settled, the rest shall I dedicate to the service of our King and Country by your disposals: and esteem me not the more, or rather any more, by what is past, but what's to come; professing really from my heart, that my intentions are to outgo the six or seven hundred thousand pounds already sacrificed, if countenanced and encouraged by you, ingenuously confessing, that the melancholy which hath lately seized upon me (the cause whereof none of you but may easily guess) hath, I dare say, retarded more advantages to the public service than modesty will permit me to utter: and now, revived by your promising favours, I shall infallibly be enabled thereunto in the experiments extant, and comprised under these heads, practicable with [lxxvi] my directions by the unparalleled workman both for trust and skill, Caspar Kaltoff's hand, who hath been these five and thirty years as in a school under me employed, and still at my disposal, in a place by my great expences made fit for public service, yet lately like to be taken from me, and consequently from the service of King and kingdom, without the least regard of above ten thousand pounds expended by me, and through my zeal to the common good; my zeal, I say, a field large enough for you (my Lords and Gentlemen) to work upon.

The treasures buried under these heads, both for war, peace, and pleasure, being inexhaustible; I beseech you pardon me if I say so; it seems a vanity, but comprehends a truth; since no good spring but becomes the more plentiful by how much more it is drawn; and the spinner to weave his web is never stinted, but further inforced.

The more then that you shall be pleased to make use of my Inventions, the more inventive shall [lxxvii] you ever find me, one invention begetting still another, and more and more improving my ability to serve my King and you; and as to my heartiness therein there needs no addition, nor to my

readiness a spur. And therefore (my Lords and Gentlemen) be pleased to begin, and desist not from commanding me, till I flag in my obedience and endeavours to serve my King and Country:

For certainly you'l find me breathless first t'expire,
Before my hands grow weary, or my legs do tire.

Yet abstracting from any interest of my own, but as a fellow-subject and compatriot will I ever labour in the vineyard, most heartily and readily obeying the least summons from you, by putting faithfully in execution, what your judgments shall think fit to pitch upon amongst this Century of Experiments, perhaps dearly purchased by me, but now frankly and gratis offered to you. Since my heart (methinks) cannot be satisfied in serving my King and Country, if it should cost them [lxxviii] any thing: as I confess when I had the honour to be near so obliging a master as his late Majesty of happy memory, who never refused me his ear to any reasonable motion: and as for unreasonable ones, or such as were not fitting for him to grant, I would rather to have died a thousand deaths, than ever to have made any one unto him.

Yet whatever I was so happy as to obtain for any deserving person, my pains, breath and interest imployed therein satisfied me not, unless I likewise satisfied the fees; but that was in my golden age.

And even now, though my ability and means are shortened, the world knows why my heart remains still the same; and be you pleased (my Lords and Gentlemen) to rest most assured, that the very complacency that I shall take in the executing your commands, shall be unto me a sufficient and an abundantly-satisfactory reward.

Vouchsafe therefore to dispose freely of me, and whatever lieth in my power to perform; first, [lxxix] in order to his Majesty's service; secondly, for the good and advantage of the Kingdom; thirdly, to all your satisfactions, for particular profit and pleasure to your individual selves, professing that in all and each of the three respects I will ever demean myself as it best becomes,

My Lords and Gentlemen,

Your most passionately bent fellow subject in his Majesty's service, com-patriot for the public good and advantage, and a most humble Servant to all and every of you,

WORCESTER.

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MARQUIS OF WORCESTER'S
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EXPLAINED AND ILLUSTRATED.

No. I.

Several sorts of seals, some showing by screws, others by gauges, fastening or unfastening all the marks at once: others, by additional points and imaginary places, proportionable to ordinary escutcheons and seals at arms, each way palpably and punctually setting down (yet private from all others, but the owner, and by his assent) the day of the month, the day of the week, the month of the year, the year of our Lord, the names of the witnesses, and the individual place where any [2] thing was sealed, though in ten thousand several places, together with the very number of lines contained in a contract, whereby falsification may be discovered, and manifestly proved, being upon good grounds suspected.

Upon any of these seals a man may keep accounts of receipts and disbursements, from one farthing to an hundred millions, punctually showing each pound, shilling, penny, or farthing.

By these seals, likewise, any letter, though written but in English, may be read and understood in eight several languages; and in English itself, to clear contrary and different sense, unknown to any but the correspondent, and not to be read or understood by him neither, if opened before it arrive unto him; so that neither threats, nor hopes of reward, can make him reveal the secret, the letter having been intercepted, and first opened by the enemy.

NOTE. [3]

The use of *sigili* or "autograph seals" is very ancient, indeed we find them mentioned by the prophet Jeremiah (chap. xxii. v. 10); these, however, were invariably engraved on the collets or stones of rings, and it was not till a much later date that hand stamps were applied to that purpose. In England, the first sealed charter extant is that of Edward the Confessor, upon his founding Westminster Abbey; and many of our English kings used them, from an inability to affix any other kind of signature: this indeed is candidly acknowledged by Caedwalla, a Saxon king, who says, at the conclusion of one of his charters, "*propriâ manu pro ignorantiâ literarum signum sanctæ crucis expressi et subscripsi.*"

The nearest approach to a *corresponding seal* that occurs prior to the sixteenth century, is that described in a decree of Cardinal Otto, who was papal legate in 1237, by which the bishops were to bear on their seals their title, office, dignity, and even their proper names. About this period *mottos* were likewise generally introduced, but none of those before the publication of the noble author's work were at all adapted for secret correspondence; or, in fact, had they any mode of combining moveable characters in the matrix for the purpose of varying the impression. The principle upon which those described by the Marquis must have been formed is simply this: a frame similar to those in which seals are generally mounted having been first prepared, a number of moveable circles may be made to slide within each other on one common centre. If three are employed, they [4] should be engraved with the numerals, the alphabet, and, if intended for secret writing, the third circle may be furnished with any arbitrary signs that may suggest themselves. These, by means of a key, of which both the corresponding parties must possess a duplicate, may be combined to form the day of the week, month, year, &c.

It would be found very useful in preventing and detecting the mistakes which so frequently occur in the delivery of letters, if the seals in common use were provided with at least two of these revolving circles, with the day of the month and hour of the day engraved on their face, parallel to the stone. A particular part of the arms or cipher being used as an index hand, it would then show the precise hour the letter was sent, without the trouble of dating, &c.

In engraved seals where coats of arms are used, it will be obvious that the seal must be larger than those generally in use, as the circles must be made to revolve round the outer extremity of the stone, and their usefulness will be considerably diminished. With regard to the possibility of forming a key by which writing in any language may be deciphered, we have the following curious anecdote, furnished by the late learned and ingenious Mr. Astle, keeper of His Majesty's Records: he states, on the authority of a noble Lord, deceased, that the late Earl Granville, while Secretary of State, told him, that when he came into office he had his doubts respecting the certainty of deciphering. That he wrote down two or three sentences in the Swedish language, and afterwards put them into such arbitrary marks or characters, as his mind suggested to him; that he sent the paper to Dr. Willes, [5] who returned it the next day, and informed his lordship, that the characters he had sent to him formed certain words, which he had written beneath the cipher, but that he did not understand the language; and Lord Granville declared, that the words were exactly those which he had first written, before he put them into cipher.

No. II.

How ten thousand persons may use these seals to all and every of the purposes aforesaid, and yet keep their secrets from any but whom they please.

NOTE.

As the mode of deciphering inscriptions, dates, &c. formed by these seals, depends on a key, the formation of which is arbitrary, and resting entirely upon the fancy or ingenuity of its composer; it follows, that the smallest variation from the one originally intended for that purpose, will entirely destroy the effect of the proposed combination.

No. III.

A cipher and character so contrived, that one line, without returns and circumflexes, stands for each and every one of the twenty-four letters; and as ready to be made for the one letter as the other. [6]

NOTE.

Of this and the following invention, the noble author has left to the curious in the stenographic art, his own definition; a manuscript, in the Marquis's hand-writing, having been preserved in the *Harleian Collection*, appended to an original copy of the Century of Inventions, in which he explains the system upon which these two articles are founded. The MS. alluded to is thus entitled:—"An Explanation of the most exact and most compendious way of Short-hand Writing; and an Example, given by way of Questions and Resolves upon each significant Point, proving how and why it stands for such and such a Letter, in order, alphabetically placed in every page."—*Bibl. Harl.* No. 2428.

The above work is accompanied with engraved brass plates; and his system, which is simple and easy of attainment, may be thus described:—A sheet of paper must first be prepared, with a given number of horizontal rows of small octagons, somewhat resembling the chequers on a draft-board. Straight lines are then to be drawn from the centre towards the sides of these squares, in different positions, and of various lengths, for each letter in the alphabet. Thus, A is a short horizontal stroke, made to the right hand, and not touching the side; E, A, and W, are represented by a similar stroke [7] in the opposite direction, but varying in their lengths. By a similar method the author suggests, in the following article, that we may write with a dot, or single point only, placed in a given situation in the octagon; varying the position for each letter, as is at present done in music, the paper being prepared with ruled lines, or it may be simplified by the use of coloured inks for the vowels and consonants.

No. IV.

This invention refined, and so abbreviated, that a point only showeth distinctly and significantly any of the twenty-four letters; and these very points to be made with two pens, so that no time will be lost, but as one finger riseth, the other may make the following letter, never clogging the memory with several figures for words, and combinations of letters; which, with ease and void of confusion, are thus speedily and punctually, letter for letter, set down by naked and not multiplied points. And nothing can be less than a point, the mathematical definition of it being *cujus pars nulla*. And of a motion, equally as swift as *semiquavers* or *relishes*, yet applicable to [8] this manner of writing.

NOTE.

Vide the preceding article.

No. V.

A way, by a circular motion, either along a rule or ring-wise, to vary any alphabet, even this of points, so that the self same point, individually placed, without the least additional mark or variation of place, shall stand for all the twenty-four letters, and not for the same letter twice in ten sheets writing; yet as easily and certainly read and known, as if it stood but for one and the self same letter constantly signified.

NOTE.

The gauge, in this case, must accompany the letter to be deciphered, and, when circular, made to resemble a *map-meter*. By noticing the number of lines passed over by this instrument, and comparing the index-hand with the dots, a sufficiently intelligible though certainly complex cipher may be formed.

[9]

No. VI.

How, at a window, as far as eye can discover black from white, a man may hold discourse with his correspondent, without noise made or noise taken; being, according to occasion given and means afforded, *ex re natâ*, and no need of provision beforehand; though much better if foreseen, and means prepared for it, and a premeditated course taken by mutual consent of parties.

NOTE.

The *telegraph*, though not generally used in Europe till the commencement of the French revolution, appears to have been well known to the ancients. Polybius describes a method of communication, which was invented by Cleoxenus, which answered both by day and night. Kircher and Scott likewise allude to its use; but the description given by the Marquis is evidently superior to any that had preceded him; and, indeed, must have nearly resembled that in use at the present period.

No. VII.

A way to do it by night as well as by day, though as dark as pitch is black.

NOTE. [10]

The allusion here to a telegraphic communication is likewise sufficiently evident; though it is obvious that, for night signals, it will become necessary to substitute rockets or reflecting lamps for the painted boards.

Among the signs for nightly information at a distance, those by fire are extremely common, and have been used by the Chinese, Persians, and other nations, in the remotest times. This species of communication is affirmed by Diodorus Siculus to have been practised by Medea in her conspiracy with Jason, which carries us back three thousand and seventy years; and although there must be some uncertainty on this question, Pliny, in his "History," lib. vii. cap. 56, says, it originated with Sinon. "Specularem significationem Trojano bello Sinon invenit." This was the signal upon which Sinon agreed to unlock the wooden horse in the siege of Troy, about 1184 years before Christ:

"——Flammas cum regia puppis
Extulerat."

Virgil. Æn. lib. ii. 256.

And, after the taking of Troy, Æschylus relates, that Agamemnon immediately apprized his queen, Clytemnestra, of that event by a similar method; which, we suppose, must have been done either by men placed at certain distances with lighted torches, which they held up in succession, or by a considerable number of fires on the tops of hills, denoting the simple fact previously agreed on between the parties. See Onosander's Strategicus, cap. 25, where this practice is described. [11]

The fire-signals of the Greeks and Romans are also slightly mentioned by Quintus Curtius, Livy, Cæsar, Herodotus, Homer, and Thucydides; likewise by Vegetius and Frontinus; but still more in detail by Polybius and Æneas Tacticus; the latter of whom was contemporary with Aristotle, and has left a valuable fragment on the duties of a general, (translated into Latin by Casaubon,) wherein are many curious remarks on the subject of secret correspondence. The Greek signals were much improved by Polybius, who, in his history, (lib. x. cap. 45. p. 296. tom. iii. Lips. 1790. edit. Joh. Schweighaeuser,) attributes the invention to Cleomenes and Democritus, or (more correctly) to Cleoxenus and Democlitus, in words thus rendered: "Postrema ratio, cujus auctores sunt Cleoxenus et Democlitus, sed quam nos correximus, certa definitaque est, adeo ut quidquid exortum fuerit negotii, id possis certo facere notum." Prior to that period, the information communicated by torches, flags, smoke, or otherwise, was very limited, and it was requisite to settle beforehand what each signal should mean; whereas Polybius showed how to correspond alphabetically, and to give or receive any species of intelligence, without this previous concert. The plans of Æneas Tacticus had never arrived at such perfection, and were therefore of comparatively small use; though, without doubt, he at least equalled any of his predecessors in the facility of his telegraphic communications.

[12]

No. VIII.

A way how to level and shoot cannon by night as well as by day, and as directly, without a platform or measures taken by day, yet by a plain and infallible rule.

No. IX.

An engine, portable in one's pocket, which may be carried and fastened on the inside of the greatest ship, *tanquam aliud agens*, and, at any appointed minute, though a week after, either of day or night, it shall irrecoverably sink that ship.

NOTE.

To prepare this dangerous instrument, it is merely necessary to connect a gun-lock with a common bomb shell, filled in the usual manner, and a small clock attached; which will at any given time discharge the lock, and cause the shell to explode: the tremendous effects of which in the cabin or hold of a vessel may easier be conceived than described.

[13]

No. X.

A way, from a mile off, to dive and fasten a like engine to any ship, so as it may punctually work the same effect, either for time or execution.

NOTE.

Mr. Fulton, of the United States, the inventor of the *Torpedo*, recommends the use of a gun-harpoon for fixing this destructive engine on the side of a ship; but this plan appears liable to two objections: the resistance that would be offered by the water, should the harpoon be fired from a considerable distance; and the certainty of discovery from the report of the cannon, on a near approach to the hull of the vessel. The methods most eligible for this object appear to be, either to let the machine float with the tide, and by striking against the side of the vessel discharge a gun-lock; or else, by employing a *diving-bell*, pass beneath the surface of the water. In proof of the practicability of the latter plan, about the time of the attack made by the English at Boulogne, Buonaparte caused a small diving vessel to be made, which, at a preconcerted signal, lowered its masts, yards, &c.; and by admitting a certain quantity of water sunk it to the required depth; it was then impelled forward by means of a circular paddle or wheel turned within the vessel, and upon the air becoming foul or exhausted, the vessel was raised to the surface by means of pumps or dropping of ballast. It appears more than probable, that this is the species of vessel to which the Marquis

alludes. Hook, in his *Philosophical Collections*, No. 2, describes an air-vessel possessing similar properties with the above.

No. XI.

[14]

How to prevent and safeguard any ship from such an attempt by day or night.

NOTE.

A safe and easy method of preventing the dreadful consequences attendant on the explosion of this tremendous machine, may be found in the use of a strong net, resembling that used in the salmon fishery; which must be kept at the required distance from the vessel by floating buoys placed for that purpose. It will also be necessary to fix a bell upon the upper extremity of each buoy, which will, by its ringing on a calm night, discover the approach of any hydrostatic vessel; and should the weather be stormy, the attempt must end in the destruction of the sub-marine voyagers.

No. XII.

A way to make a ship not possible to be sunk, though shot at an hundred times between wind and water by cannon, and should she lose a whole plank, yet, in half an hour's time, should be made as fit to sail as before.

NOTE.

[15]

Provided the hull of the vessel be composed of number of small divisions, similar to the life preservers constructed by Mr. Daniel, it will scarcely be possible to sink it, especially if a large sheet, well prepared with oakum, be drawn under the vessel in the event of a fracture occurring, as the pressure of the water on the surface of the vessel will force the canvass into the chasm, and allow of the necessary reparation. The latter method has been adopted in the navy for several years.

No. XIII.

How to make such false decks, as in a moment should kill and take prisoners as many as should board the ship, without blowing the real decks up, or destroying them from being reducible; and, in a quarter of an hour's time, should recover their former shape, and to be made fit for any employment without discovering the secret.

NOTE.

At about six inches from the fixed deck, and supported by cross beams, it will be necessary to raise an artificial one of thin planks, under which must be previously placed a number of small iron boxes, open at the top, and filled with powder, connected with each other by a train. The instant this is fired, the upper, or false deck, will blow up *en masse*, without affecting in the slightest degree the permanent deck beneath.

No. XIV.

[16]

How to bring a force to weigh up an anchor, or to do any forcible exploit in the narrowest or lowest room in any ship, where few hands shall do the work of many; and many hands applicable to the same force, some standing, others sitting, and, by virtue of their several helps, a great force augmented in little room, as effectual as if there were sufficient space to go about with an axle-tree, and work far from the centre.

NOTE.

The application of an endless screw, or worm, appears the most advantageous mode of increasing power in a small space; and it possesses the additional advantage of remaining stationary at any point without the assistance of the ratchet and click.

No. XV.

A way how to make a boat work itself against wind and tide, yea, both without the help of man or beast; yet so, that the wind or tide, though directly opposite, shall force the ship or boat against itself; and in no point of the compass, but it shall be as effectual as if the wind were in the poop, or the stream actually with the course it is to steer, according to which the oars shall row, and necessary motions work and move towards the desired port, or point of the compass.

[17]

NOTE.

A *Panemore*, or globular wind-mill, erected in the centre of a ship, has been proposed for the turning of two wheels or paddles, placed on the bows, which would thus impel the vessel forward in any required direction. The panemore, which was invented by M. Desquinemare, consists of a kind of globe placed on the top of a mast, on which it always turns round with the wind. In consequence of the ingenious adjustment of the curves which it presents in all its points, the rotary motion is always in the same direction, be that of the wind as it may; and their utmost violence, instead of being detrimental to its action, only augments its power. The means of the instrument increasing in a cubical ratio when the wind doubles its velocity; and by doubling the surface its power is increased eight-fold.

No. XVI.

How to make a sea-castle, or fortification, cannon-proof, capable of a thousand men, yet sailable at pleasure to defend a passage, or, in an hour's time, to divide itself into three ships, as fit and trimmed to sail as before; and even whilst it is a fort or castle, they shall be unanimously steered, and effectually be driven by an indifferent strong wind. [18]

NOTE.

Scheffer, in his treatise entitled *De Militiâ Navali*, describes a vessel of a somewhat similar construction: it was composed of four floating tanks, or parts of vessels, which could at pleasure be joined together by means of bolts. Bomb-proof batteries of prodigious force were used by the Spaniards in their attack on Gibraltar, in 1782. Their upper decks were at an angle of about forty-five degrees, and composed of successive layers of oak-planking and raw hides. These offered an irresistible barrier to the shot and shells commonly used, till General Elliot decided on the application of red-hot balls, which, by burning a passage through the outer layers, quickly communicated to that part of the hold used as a depository for powder, &c., and the consequence was, the entire destruction of this immense flotilla.

No. XVII.

How to make upon the Thames a floating garden of pleasure, with trees, flowers, banqueting-houses, and fountains, stews for all kind of fishes, a reserve for snow to keep wine in, delicate bathing places, and the like; with music made by mills; and all in the midst of the stream, where it is most rapid. [19]

NOTE.

The most celebrated gardens of this description were those made by the Mexicans on the great lake which surrounds the capital; here they planted trees, and cultivated maize, pepper, and other plants necessary for their support. In progress of time, as these floating fields grew numerous from the industry of the people, they formed among them gardens for flowers and other odoriferous plants, which were employed in the worship of their gods, and which served also for the recreation of the nobles. Every day of the year, at sun-rise, innumerable vessels, laden with various kinds of flowers and herbs, cultivated on the water, arrived by the canal, at the great market-place of the capital.

To form their floats, they first plait or twist willows, with roots of marsh plants, and upon this foundation they place the mud and dirt which they draw from the bed of the lake. When the owner of a garden wishes to change his situation, to remove from a disagreeable neighbour, or to come nearer his own family, he gets into his little vessel and tows the plantation after him.—Vide *Nov. His. de Mexico par le Abbé Francesco Saverio Clavigero*. [20]

The floating pleasure bath moored in the River Thames, near Westminster Bridge, is supported by empty casks; and this plan, if assisted by mooring-chains, may be applied to gardens of any reasonable extent, even in the broadest and most rapid rivers.

No. XVIII.

An artificial fountain, to be turned like an hour-glass, by a child, in the twinkling of an eye, it yet holding great quantities of water, and of force sufficient to make snow, ice, and thunder; with the chirping and singing of birds, and showing of several shapes and effects, usual to fountains of pleasure.

NOTE.

That a fountain may be made upon the principle of an hour-glass, and that when the upper division is exhausted, the lower may be elevated by a crank and lever, the fluid passing through the centre of its axis, we may easily conceive; but how a fountain of water can produce snow, ice, thunder, and the singing of birds, is a circumstance not easy to be comprehended.

[21]

No. XIX.

A little engine, within a coach, whereby a child may stop it, and secure all persons within it, and the coachman himself, though the horses be never so unruly, in full career; a child being sufficiently capable to unloose them, in what posture soever they should have put themselves, turning never so short; for a child can do it in the twinkling of an eye.

NOTE.

There are but few persons who will disallow the utility of an invention, whose object is to prevent, as much as possible, the frequent and terrible accidents which occur from the present mode of attaching horses to carriages, and other vehicles; that these might in a great measure be avoided, by the application of the Marquis's invention, and a legislative enactment to secure its adoption, there can be no doubt.

To accomplish this very desirable object, a bar, of equal length with the axle-tree, to which is fixed the pole and traces; must be furnished with three iron bolts made to fit a like number of sockets in the axle-tree; and from which, the additional bar may be readily raised, by the application of a common lever: either by the pressure of the driver's foot, or by a string made to communicate with the body of the vehicle. For a chaise the apparatus will be no less simple, with the exception of a

[22]

small resting bar, or foot, which it will be necessary to discharge by the same lever which sets at liberty the horse, and by this means prevent the sudden jerk, that must otherwise occur in a two wheeled carriage.

No. XX.

How to bring up water balance-wise, so that as little weight or force as will turn a balance, will be only needful, more than the weight of the water within the buckets, which counterpoise and empty themselves one into the other, the uppermost yielding its water (how great a quantity soever it holds) at the same time when the lowermost taketh it in, though it be an hundred fathom high.

NOTE.

An engine answering the above description may be composed of a series of ladles or buckets, the handles of which being hollow will admit a passage for the water by elevating the bucket end. A number of these, sufficient for the required height, must be fastened in a frame; each ladle being suspended by a fulcrum so balanced that when filled with water, they may remain in equilibrio. The whole of the buckets thus constructed may be connected by rods passing from the top of the [23] machine to the lowest handle, and the continued series so placed, that the handle of the one bucket will empty itself into the reservoir of the succeeding one, so that by alternately raising and depressing the rods the water is raised to the top of the machine.

No. XXI.

How to raise water constantly with two buckets only, day and night, without any other force than its own motion, using not so much as any force, wheel, or sucker, nor more pullies than one, on which the cord or chain rolleth, with a bucket at each end. This, I confess, I have seen and learned of the great mathematician Clavius's *Studies at Rome*, he having made a present thereof unto a cardinal; and I desire not to own any other man's inventions; but if I set down any, to nominate likewise the inventor.

NOTE.

The construction of an hydraulic engine with powers nearly similar to this, may be thus described: two buckets of unequal size must be first suspended by a flexible chain turning on a double roller or [24] pulley; so that one bucket will be elevated to the required height, while the other reaches the level of the water to be raised; a small stream of water must then be made to communicate with the largest bucket, which will speedily be depressed and descend to the lower level, while the opposite bucket will discharge its contents into a cistern or reservoir at the top of the machine: the larger bucket being likewise emptied by striking against a projecting beam placed there for that purpose.

Mr. Sarjeant has described a very simple and powerful machine for raising water, nearly similar in point of principle to the above. An engraving of Mr. S.'s engine, together with an account of its construction, is inserted in the Trans. of the Soc. of Arts, vol. xix. p. 255.

No. XXII.

To make a river in a garden ebb and flow constantly, though twenty foot over, with a child's force, in some private room, or place out of sight, and a competent distance from it.

NOTE.

The very ingenious canal lock lately invented by Peter Bogaerts, Esq., appears fully calculated for effecting this object. In this lock, which from its simplicity is no less useful than economical, a small portion of water is made to assist in displacing several tons of that element, and there is no doubt [25] but a *child's force* would raise double the quantity of water described by the Marquis. In the model lately exhibited, a weight of seven pounds was made to raise 10 *cwt.* of water more than four feet in a few seconds.

No. XXIII.

To set a clock as within a castle, the water filling the trenches about it; which shall show, by ebbing and flowing, the hours, minutes, and seconds, and all the comprehensible motions of the heavens, and counterlibration of the earth, according to Copernicus.

NOTE.

A tide-mill was several years back exhibited in the Museum of that very ingenious mechanic, Mr. G. J. Hawkins; and a similar prime mover has been suggested for the purpose of winding a clock for a bell signal station on the Northern coast of England. An astronomical machine as described by the Marquis, must be provided with two barrels, each possessing a maintaining power sufficient for the correct performance of the whole. In addition to the line that supports the weight, or maintaining power, each barrel must be provided with a revolving pulley resembling those used for old thirty-hour clocks; with chains passing over their axis; and the chains being attached to large floats of [26] wood will be alternately raised or depressed by the ebbing and flowing of the tide; and thus in succession wind up the weights which form the maintaining power of the clock. The clepsydræ, or hydraulic clock, was in general use among the ancients, and a stream of water was frequently employed to give motion to planetary machines.

No. XXIV.

How to increase the strength of a spring to such a degree as to shoot bombasses and bullets of an hundred pound weight a steeple height, and a quarter of a mile off and more, stone bow-wise, admirable for fire-works and astonishing of besieged cities, when, without warning given by noise, they find themselves so forcibly and dangerously surprised.

NOTE.

The strength of a compound spring formed of two metals may, by the application of heat, be increased to any given power. *Rationale.*—Iron possessing an expansive power of 1/95, and brass being only 1/60, the weaker metal will be bent by that whose power of expansion is greater, and the impulse of the spring increased in an equal ratio.

[27]

No. XXV.

How to make a weight, that cannot take up an hundred pound, and yet shall take up two hundred pounds, and at the self same distance from the centre; and so, proportionally, to millions of pounds.

NOTE.

This is indeed paradoxical, and so completely contrary to every established principle or rule in science, that we may fairly set it down among the number of those inventions which, by partaking so highly of the marvellous, have contributed to bring the whole *Century* into disrepute.

No. XXVI.

To raise a weight so well and as forcibly with the drawing back of the lever, as with the thrusting it forwards; and by that means to lose no time in motion or strength. This I saw in the arsenal at Venice.

NOTE.

The mere application of a crank, such as is used for the *foot-lathe*, acting upon a drum and fly-wheel, with a chain attached to move a second lever or upright sliding bar, will fully effect the object here described. [28]

No. XXVII.

A way to remove to and fro huge weights, with a most inconsiderable strength, from place to place. For example: ten ton with ten pounds, and less; the said ten pounds not to fall lower than it makes the ten ton to advance or retreat upon a level.

NOTE.

A weight attached to an ordinary crane may be moved with the utmost facility; and it is well known that the employment of friction wheels furnishes a ready medium of conveyance for masses of iron and stone of the greatest magnitude.

No. XXVIII.

A bridge, portable upon a cart, with six horses, which, in a few hours' time, may be placed over a river half a mile broad, whereon, with much expedition, may be transported, horse, foot, and cannon.

NOTE. [29]

A portable bridge, or rather ferry boat, calculated for crossing wide and deep rivers, was frequently employed in ancient warfare, and is still used for the conveyance of horses and passengers in many parts of Europe. The apparatus for this purpose may readily be attached to the banks of the most rapid river, as it merely consists in the employment of two ropes or wires, tightened by means of a winch, on which slide pullies connected with a large floating tank or waggon, that is afterwards intended to be employed as a medium of conveyance. The apparatus being thus prepared, a communication may readily be opened by means of two cords between the opposite banks of the river.

No. XXIX.

A portable fortification, able to contain five hundred fighting men, and yet, in six hours' time, may be set up and made cannon proof, upon the side of a river or pass, with cannon mounted upon it, and as complete as a regular fortification, with half-moons and counterscarps.

NOTE. [30]

It is difficult to attempt an elucidation of this or the following articles; but the annexed extract from the *General Evening Post* for 1747 appears to throw some light on No. XXX.

"On the 11th instant, Mr. James Allis was presented to the Royal Society, with a new invented

cannon, which charges and discharges both at one time, and twenty times in a minute: he had their thanks, and a handsome present."

No. XXX.

A way, in one night's time, to raise a bulwark, twenty or thirty foot high, cannon proof, and cannon mounted upon it; with men to overlook, command and batter a town; for, though it contain but four pieces, they shall be able to discharge two hundred bullets each hour.

NOTE.

Vide the preceding Article.

Since writing the above, the Editor has been called to witness the effects of highly elastic vapour applied to the propelling of leaden bullets, in an apparatus contrived by Mr. Perkins; and these destructive missile engines are capable of discharging nearly two hundred bullets, in one sixtieth part of the time described by our author in the present Article. [31]

No. XXXI.

A way how safely and speedily to make an approach to a castle or town-wall, and over the very ditch, at noon-day.

NOTE.

A wheel carriage, of sufficient strength to support an heavy iron tower, must first be provided. It may be constructed of thick wrought iron, with door, &c., of the same material, and hung round with sand-bags, through the interstices of which may project from six to eight small guns to protect it from musquetry. The most eligible method of moving the tower appears to be by fixing small handles to the axles of the wheels, which may be turned at pleasure by those within the walls. To prevent any attempt of the enemy who may sally forth to drag the machine within the walls of the town, &c., it will be adviseable to arm the wheels with long steel studs, which, when the handles are fastened within, will render it immoveable.

This tower, though but of little use in modern warfare, appears well adapted for reconnoitring the walls of a fortified town, and, if fixed upon a hollow iron vessel, will possess the further advantage of crossing rivers and moats. Nearly similar machines are described by Vitruvius, and other authors who treat on military engineering.

[32]

No. XXXII.

How to compose an universal character, methodical and easy to be written, yet intelligible in any language; so that if an Englishman write it in English, a Frenchman, Italian, Spaniard, Irish or Welchman, being scholars, yea, Grecian or Hebritian, shall as perfectly understand it in their own tongue as if they were English, distinguishing the verbs from the nouns, the numbers, tenses, and cases, as properly expressed in their own language as it was written in English.

NOTE.

The great difficulty which the various contrivers of a universal character or philosophical language have hitherto had to encounter, from the Marquis of Worcester and Bishop Wilkins down to M. Lodowick, appears to have arisen rather from the difficulty attendant on engaging the several nations to use it, than in inventing the most convenient character.

The *real character* of Bishop Wilkins, which there is every reason to suppose strongly resembled that of his contemporary the Marquis, was repeatedly recommended by Dr. Hook, who, to engage the world in the study of it, published some curious inventions of his own, tending to its illustration. [33] But the most accurate notice on the history of *pasigraphy* yet published appeared in the *Spect. du Nord* for May, 1798. The anonymous author of this interesting memoir commences by a brief inquiry into the nature and utility of the universal character, and then proceeds with this very just eulogium on our immortal countryman Bacon.

It is generally allowed that Lord Bacon of Verulam comprehended nearly the whole circle of human knowledge at the period in which he lived, and foresaw most of the discoveries which have since been made. He laid the foundation of an Encyclopædia, and was very near discovering various important philosophical results, such as the weight of the air, &c. If we open his book on the progress of the sciences, we shall find the notion of a pasigraphy in the chapter entitled *The Instrument of Discourse*. "It is possible to invent such signs," says he, "for the communication of our thoughts, that people of different languages may, by this means, understand each other; and that each may read immediately in his own language, a book which shall be written in another." But Bacon did not think of confining this to twelve characters: on the contrary, he requires a great number, at least as many as the number of radical words; on which head he quotes the example of the Chinese; "and although," adds he, "our alphabet may appear more commodious than this method of writing, the thing itself nevertheless is well deserving of attention. The problem relates to the signs by which thoughts may be rendered current; and, as money may be struck of other materials [34] as well as gold and silver, it is possible likewise to discover other signs of things as well as letters and words."

Des Cartes, in his third letter to father Mercennus, discusses the invention of a Frenchman, whom he does not name, but who, by means of a certain language and an artificial writing, pretended to understand all the different idioms. He remarks on this subject, that it would be very possible to compose a short and convenient grammar, with general signs, which should render all foreign languages intelligible.

In the year 1661, John Joachim Becher published a Latin folio, the title of which was "Characters for the Universal Knowledge of Languages: a Stenographic Invention hitherto unheard of." This unheard of invention consists of a method by which a native of any country may make himself understood by all foreigners by writing in his own language, and be enabled also to comprehend what they write in theirs. It was truly at that time a thing unheard of; for Becher, being the first who had given a complete treatise on this art, may be considered as the inventor.

He begins his work by a series of highly interesting observations upon general grammar, and the fundamental relations of all languages with regard to each other. He gives a learned comparative table of the relations and harmony of the Latin, the Greek, the Hebrew, the Arabian, the Sclavonian, the French, and the German. This work cannot be too highly esteemed, and assuredly was not unknown to the author of the work *Du Monde Primitif*. A Latin dictionary then follows, in which every word corresponds with one or more Arabic numeral figures arbitrarily taken. Every number is [35]
assumed as distinctive, or denoting the same word in all languages; and consequently nothing more is required than to compose a dictionary for each, similar to that which he has given for the Latin.

There is likewise a table of declensions and conjugations, which presents certain determinate numbers for all the cases, moods, tenses, or persons. By means of this general disposition, when a Frenchman is desirous of writing to a German the following phrase, *La guerre est un grand mal* (war is a great evil), he seeks in his index, *guerre*, *être*, *grand*, *mal*; and he writes the correspondent numbers,

13, 33, 67, 68.

The sentence might be understood by these four characteristic numbers; but, to leave no room for ambiguity, he says, *Guerre* is the nominative case, and finds, as the characteristic of the nominative, the Arabic figure 1. *Est* is the third person singular of the indicative mood, present tense, of which the characteristic is 15. To *grand*, and to *mal*, belong likewise the figure 1, for the nominative case; he will therefore write

13.1 | 33.15 | 67.1 | 68.1 |

where the numbers are separated by small vertical bars to prevent confusion. It may easily be conceived how, by the inverse method, the German will find in his tables the words denoted by the ciphers, which will form *Der krieg ist ein grosses uebel*.

This invention of Becher, which is the same thing nearly with regard to language, as algebra is to [36]
arithmetic, is possessed of considerable simplicity, and even a few hours practice will render it easy. A great variety of attempts on this principle may be found in Sturmius, *Essais d'Expériences Curieuses*.

In the same year, George Dalgaru, an Englishman, published in London a work of which the prolix title is sufficient to show its object. It runs thus, "The Art of Signs, or an Universal Character and Philosophical Language, by Means of which, Men of the most different Idioms may, in the Space of two Weeks, learn to communicate, whether by Word of Mouth or by Writing, all their Thoughts, as clearly as in their Mother Tongue. Besides which, young Persons may therein learn the Principles of Philosophy, and the Practice of true Logic, more speedily and more readily than in the ordinary philosophic Writings." The book of Dalgaru is written in Latin, and Beckman accuses him of extreme pedantry. His characters likewise were ciphers.

Joachim Frisichius, professor at the Gymnasium at Riga, was employed on a similar attempt, his object being to introduce a natural, rational, and universal language, of which some sheets printed at Thorn in 1681 contain the only specimen extant. The death of the author interrupted his labours. He purposed to call his new language Ludovicean, in honour of Louis XIV., under whose patronage he pursued his labours; a prince whose generosity was extended to the learned of all countries.

Athanasius Kircher also published a work on this subject, entitled "A New and Universal Polygraphia, deduced from the Art of Combination," and by means of which, says Morhoff, [37]
(Polyhistor, l. ii. c. 5.) he who understands one language only may correspond in writing with all the nations of the earth.

It would perhaps be unjust to pass in silence the little-known work of father Besnier, a Jesuit, who, in a book entitled *La Réunion des Langues, ou l'Art de les apprendre toutes par une seule*, printed at Paris in 1674, has furnished many important hints for the cultivation of this branch of language.

The most remarkable work, however, which has been written on this subject, is that for which we are indebted to Bishop Wilkins, the brother-in-law of Cromwell: it is entitled, "An Essay towards a Real Character and a Philosophical Language, London, 1668." It is divided into four parts: 1st, Considerations on the various languages, their defects and imperfections, from which a philosophic language ought to be exempt. 2dly, Philosophical inquiries respecting all the things and notions to which proper names ought to be assigned. 3dly, The organic science of native grammar considered as the necessary means of representing simple ideas in discourse. 4thly, The application of the general rules to every character and language. Examples, &c. This concise outline sufficiently shows the importance of the work.

In his appendix, the author explains the utility of a method of writing without alphabetic characters, by means of signs, which are to be used to denote all the principal ideas, the relative attributes being designated by small strokes added at right, acute, or obtuse angles, to the right or left; &c. Of principal or chief ideas he admits but forty, under which he ranges all the others, by that [38]
means forming a series of categories. His new language is calculated to afford great facility of comprehension, and new openings to the various processes of science.

After so many attempts, more or less philosophical, and of different degrees of perfection, with others probably of which we know nothing, we must not overlook the efforts of the celebrated Leibnitz. His History and Development of a Characteristic Universal Language is very generally known. Leibnitz considered his universal characteristic as the art of inventing and judging. He stated his conviction that an alphabet might be formed, and of this alphabet such words as would afford a language capable of giving mathematical precision to all the sciences. "Men may thus acquire," says he, "as it were, a new organ, which would add energy to their moral faculties, as the microscopic lens increases the power of the eye. The compass is not more highly valuable to the navigator, than this philosophical language would be to him who embarks on the sea of reason and

experiments, which is now so full of danger."

In concluding this brief sketch, it may be enough to notice the ingenious method of the Abbé de l'Epée, who, by means of various gestures, dictated to his various deaf and dumb pupils certain discourses, which they wrote with equal readiness in four languages.

No. XXXIII.

To write with a needle and thread, white, or any other colour, upon white, or any other colour, so that one stitch shall significantly show any letter, and as readily and as easily show the one letter as the other, and fit for any language. [39]

NOTE.

Vide Article LXXV.

No. XXXIV.

To write by a knotted silk string, so that every knot shall signify any letter, with comma, full-point, or interrogation; and as legible as with pen and ink upon white paper.

NOTE.

This very ingenious mode of secret writing is the most simple of any suggested by our author. A silk string of considerable length having been provided, it will be necessary to furnish the persons corresponding with a key or graduated gauge, by means of which the writing will be rendered intelligible. Having procured a duplicate or corresponding gauge it may then be commenced, 1/16 of an inch being allowed for the first letter, 1/4 for the second, 3/8 for the third, and so on, in equal proportions, through the whole alphabet. Should this arrangement be found to extend the line to an [40] inconvenient length, it may be advisable to form a certain number of changes on three different lengths, as in No. LII.; though the former way is the least difficult.

No. XXXV.

The like by the fringe of gloves.

NOTE.

The principle of this and the four following Articles is the same as the preceding, with this difference, that in the first, the letters, or words, are formed by knotting the fringe, to which the gauge is afterwards applied; in the second, and most desirable way, the beads are set to the required distance; by the third, the gloves are pierced or pricked in rows, according to the divisions on the gauge; and by the fourth and fifth, the rows of parallel holes in a sieve or lantern are stopped at the required distances, and the gauge applied as before.

No. XXXVI.

By stringing of bracelets.

No. XXXVII.

By pinked gloves.

[41]

No. XXXVIII.

By holes in the bottom of a sieve.

No. XXXIX.

By a lattin or candlestick lantern.

No. XL.

By the *smell*.

NOTE.

Pegs of sandal, cedar, and rose woods, may be so varied, that a person writing in the dark will, by the smell, readily distinguish the formation of words and sentences.

No. XLI.

By the *taste*.

NOTE.

For writing by the *taste*, it will be necessary to immerse an equal number of the pegs or beads in weak solutions of alum, aloes, common salt, or any other liquid whose taste is sufficiently pungent or aromatic, to be distinguished when dry, on applying the tongue to them for that purpose. [42]

No. XLII.

By the *touch*.

By these three senses, as perfectly, distinctly, and unconfusedly, yea, as readily as by the sight.

NOTE.

This object may be readily attained by the use of raised moveable types and the heavy pressure of an iron pen or mallet.

A mode of corresponding by the touch has been suggested by M. Haüy, and by this means the blind have been fully instructed, not only in the rudiments of language, but also in the liberal arts and sciences. M. Haüy's method of preparing the books, &c., which is simple and easy of attainment, is as follows: when the types have been arranged and fixed, a page of very strong paper is moistened, so as to be capable of receiving and retaining impressions, and laid upon the types; and then by the operation of a press or hammer, frequently repeated over the surface, the impression of the type is made to rise on the opposite side of the paper; and it continues, when dry, not only "obvious to the sight," but to the touch, and is not easily effaced. On the upper side of the paper, the letters appear in their proper position; and by their sensible elevation above the common surface, the blind may easily read them with their fingers. For epistolary correspondence it will be necessary to moisten the paper and use a metal pen. [43]

No. XLIII.

How to vary each of these, so that ten thousand may know them, and yet keep the understanding part from any but their correspondent.

NOTE.

This may be effected by changing the order of their arrangement, which can only be ascertained by a previous examination of a key chosen for that purpose.

No. XLIV.

To make a key of a chamber door, which to your sight hath its wards and rose-pipe but paper thick, and yet at pleasure, in a minute of an hour, shall become a perfect pistol, capable to shoot through a breastplate, commonly of carabine proof, with prime, powder, and fire-lock, undiscoverable in a stranger's hand.

NOTE. [44]

The *rose-pipe* must in this case be formed like the sliding tubes of a telescope; that next the wards being furnished with a screw at the inner and capable of holding the whole of them together. A small quantity of detonating powder being first placed within, the pipe may be readily discharged by tightening of the screw.

No. XLV.

How to light a fire and a candle, at what hour of the night one awaketh, without rising or putting one's hand out of bed. And the same thing to be a serviceable pistol at pleasure; yet, by a stranger, not knowing the secret, seemeth but a dexterous tinder-box.

NOTE.

The pistol tinder-box may readily be made to perform the whole of what is here described. A bell rope attached to the trigger will suffice to elicit fire, which, communicating with a quick-match or fusee, will quickly ignite and produce the required light. If the fire is previously prepared with wood or some other combustible material, and a small quantity of inflammable spirits sprinkled over it, the slightest spark will throw the whole into a blaze. For the latter qualification mentioned by the noble author, a pistol barrel may easily be secreted under the tinder. [45]

The inflammable air-lamp contrived by Volta possesses similar properties: a stream of hydrogen gas being inflamed by the spark from an electrophorus.—Vide *Brande's Manual of Chemistry*, vol. i. p. 240.

No. XLVI.

How to make an artificial bird to fly which way and as long as one pleaseth, by or against the wind, sometimes chirping, other times hovering, still tending the way it is designed for.

NOTE.

In the year 1810, two birds were exhibited at the museum of the late Mr. Merlin; these performed nearly all the evolutions described by the Author: with this exception, however, that they were supported by fine wires; and a similar bird was exhibited in London in the year 1786.—Vide *77th Art. in the Century*.

No. XLVII.

To make a ball of any metal, which, thrown into a pool or pail of water, shall presently rise from the bottom, and constantly show, by the superficies of the water, the hour of the day or night, never rising more out of the water than just to the minute it showeth of each quarter of the hour; and if by force kept under water, yet the time is not lost, but recovered as soon as it is permitted to rise to the surface of the water. [46]

NOTE.

A metal ball graduated on the surface, in the same manner as the index stem to an hydrometer, with a balance to preserve its equilibrium, must first be exhausted of air, which being effected, the water may be allowed to enter by a small aperture, and it will gradually sink till the vessel is filled: this, if the ball is about 12 inches in diameter and the aperture of a proportionate size, will not take place in less than twelve hours.

No. XLVIII.

A screwed ascent, instead of stairs, with fit landing places to the best chambers of each story, with back stairs within the *noel* of it, convenient for servants to pass up and down to the inward rooms of them, unseen and private.

NOTE. [47]

It is most probable that the Marquis here alludes to the geometrical staircase now in such general use, with the addition of a small flight of stairs in the centre, in lieu of the common handrail, which being surrounded by a partition of boards, would readily serve as a private communication with the upper stories: sufficient space being left between the ceiling and under side of the principal staircase to admit of a passage to the inner rooms. Since writing the above, the Editor has seen a more explicit account of this species of staircase. It occurs in "Evelin's Memoirs," vol. i. page 59, and forms part of that learned and amusing author's tour through France in 1644. The following is an extract. "Quitting our barke, we hired horses to Blois, by way of Chambourg, a famous house of y^{e} King's, built by Francis I. in the middle of a solitary parke, full of deere; the enclosure is a wall. I was particularly desirous of seeing this palace, from the extravagance of the design, especially the *stayrecase*, mentioned by Palladio. It is said that 1800 workmen were constantly employed in this fabric for twelve yeares; if so, it is wonderfull that it was not finish'd, it being no greater than divers gentlemen's houses in England, both for roome or circuit. The carvings are very rich and full. The stayrecase is devised wth four entries or ascents, which cross one another, so that though four persons meete, they never come in sight, but by small loope-holes, till they land. It consists of 274 steps (as I remember), and is an extraordinary worke, but of far greater expense than use or beauty." [48]

No. XLIX.

A portable engine, in way of a tobacco-tongs, whereby a man may get over a wall, or get up again, being come down, finding the coast proveth insecure for him.

NOTE.

It is not very easy to discover to what the noble author here alludes: if by *tobacco-tongs*, he means a combination of levers such as is used by gardeners, to gather choice fruit or lop the upper boughs of trees, the mode of applying them is extremely easy. A number of short pieces of brass, jointed together, and made to resemble a row of *trellis* work, may, by distending the joints in an horizontal direction, be made to go in the smallest compass; and again, by closing the arms, the machine will be elevated. An ingenious mechanic has constructed a *fire-escape* upon this principle, of which a model is preserved in the Museum of the Society for the Encouragement of Arts, &c.

No. L.

A complete light portable ladder, which taken out of one's pocket, may be by himself fastened an hundred feet high to get up by from the ground. [49]

NOTE.

A number of light brass tubes, each having a socket to receive the end of the preceding joint, may be raised to any given height, and with the assistance of small loops of cord will fully answer the purpose here described. It will be necessary to have a small stud at one end of each joint, with a narrow slit at the end of the following tube to receive it, which being carried on in a right angle for about twice its width, will on being turned round serve as a key to prevent the joints separating.

No. LI.

A rule of gradation, which, with ease and method, reduceth all things to a private correspondence, most useful for secret intelligence.

NOTE.

Vide Article V.

No. LII.

How to signify words, and a perfect discourse, by jangling of bells of any parish church, or by any musical instrument within hearing, in a seeming way of tuning it, or of an unskilful beginner. [50]

NOTE.

By varying the order of arrangement, the whole alphabet may readily be rung on three bells; and these, being formed into sentences by short pauses between each word, will fully serve for distant conversation. For musical instruments, it is merely changing keys for bells, and the same purpose may be answered without the trouble of forming changes upon so small a number of fixed tones. A table is subjoined, by the use of which a combination of three bells is made to express the whole alphabet:

A represented by	111
B	112
C	113
D	121
E	122
F	123
G	131
H	132
I	133
K	211
L	212
M	213
N	221
O	222
P	223
Q	231
R	232
S	233
T	311
V	312
U	313
W	321
X	322
Y	323
Z	333

[51]

No. LIII.

A way how to make hollow and cover a water-screw, as big and as long as one pleaseth, in an easy and cheap way.

NOTE.

A leathern water-pipe, such as is used by the firemen, being nailed in a spiral form round a long circular pole, is the cheapest and most simple method yet discovered of making the Archimedean screw.

No. LIV.

How to make a water-screw tight, and yet transparent, and free from breaking; but so clear, that one may palpably see the water, or any heavy thing, how and why it is mounted by turning.

NOTE.

This may be readily effected either by making a coarse screw in the usual manner, and covering it with horn, or by fitting a spiral tube of glass on a wooden cylinder, and filling up the interstices with wax or any hard cement so as to project beyond the glass tube: this appears the most eligible method, though the former is the most economical. [52]

M. A. Rochon has likewise proposed a most ingenious substitute for the use of horn in the construction of the Archimedean screw, and other hydraulic instruments. It is formed (like the safety lamp of Sir H. Davy) of a coarse wire gauze which, on being immersed in pure fish-glue or size, forms when varnished a cheap and durable substitute for the use of glass.

No. LV.

A double water-screw, the innermost to mount the water, and the outermost for it to descend more in number of threads, and consequently in quantity of water, though much shorter than the innermost screw, by which the water ascendeth, a most extraordinary help for the turning of the screw to make the water rise.

NOTE.

This appears one of those extraordinary slight of hand discoveries in which the noble author is too apt to indulge; and though we may readily admit that two water-screws may be most advantageously employed in turning of any water-wheel, where an abundant supply is found at the top of the machine, it yet requires a greater share of penetration than we choose to take credit for, to discover how a larger quantity of water can descend than has been previously raised, or, if so, how the machine could be at all applied to the *raising* of water. [53]

No. LVI.

To provide and make, that all the weights of the descending side of a wheel shall be perpetually farther from the centre than those of the mounting side, and yet equal in number and heft of the one side as the other. A most incredible thing, if not seen, but tried before the late king of happy and glorious memory, in the Tower, by my directions; two extraordinary ambassadors accompanying his Majesty, and the Duke of Richmond, and Duke Hamilton, with most of the court attending him. The wheel was fourteen feet over, and forty weights of fifty pounds a-piece. Sir William Belford, then Lieutenant of the Tower, can testify it, with several others. They all saw, that no sooner these great weights passed the diameter line of the upper side, but they hung a foot farther from the centre; nor no sooner passed the diameter line of the lower side, but they hung a foot nearer. Be pleased to judge the consequence. [54]

NOTE.

The celebrated problem of a self-impelling power, though denied by Huygens and de la Hire, who have attempted to demonstrate its fallacy, has yet been supported by some of the most celebrated among the ancient as well as modern philosophers. Innumerable have been the machines to which the idea of *the perpetual motion* has given birth; but the most celebrated among the moderns is the *Orffyrean wheel*. This machine, according to the description given of it by M. Grævesande, in his *Œuvres Philosophiques*, consisted of a large circular wheel or drum, twelve feet in diameter, and fourteen inches in depth. It was composed of a number of thin deals, the spaces between which were covered with wax cloth, in order to conceal the interior parts of it. On giving the wheel, which rested on the two extremities of an iron axis, a slight impulse in either direction, its motion was gradually accelerated; so that after two or three revolutions it is said to have acquired so great a velocity as to make twenty-five or more turns in a minute: and it appears to have preserved this rapid motion for the space of two months, during which time the Landgrave of Hesse, in whose chamber it was placed to prevent a possibility of collusion, kept his own seal on the outer door. At the end of that time it was stopped to prevent the wear of the materials. Grævesande, who had been an eye-witness to the performance of this machine, examined all the external parts of it, and was convinced that there could not be any communication between it and the adjacent rooms. Orffyreus, however, having been informed of the ill-timed curiosity of the professor, and incensed at the refusal of a premium of *twenty thousand pounds*, which he had made a *sine quâ non* for disclosing the mechanism of its construction, broke the whole apparatus into atoms, and his life was soon after sacrificed to chagrin at his disappointment. The analogy between the Marquis's description and the Orffyrean wheel is sufficiently evident; and the experiment having been made in the Tower, more than fifty years prior to the attempt of the German mechanic, it is more than probable that the idea was derived from the noble author's work. [55]

No. LVII.

An ebbing and flowing water-work in two vessels, into either of which, the water standing at a level, if a globe be cast in, instead of rising, it presently ebbeth, and so remaineth, until a like globe be cast into the other vessel, which the water is no sooner sensible of, but that the vessel presently ebbeth, and the other floweth, and so continueth ebbing and flowing, until one or both the globes be taken out, working some little effect besides its own motion, without the help of any man within sight or hearing: but if either of the globes be taken out, with ever so swift or easy a motion, at that instant the ebbing and flowing ceaseth; for if, during the ebbing, you take out the globe, the water of that vessel presently returneth to flow, and never ebbeth after, until the globe be returned into it, and then the motion beginneth as before. [56]

NOTE.

This invention, which is evidently more a matter of curiosity than of real utility, is no doubt effected upon the principle of an ebbing and flowing spring; the throwing in of the ball, by causing a commensurate rise of the water, fills a syphon, and sets the water-work in motion, but as the effect of this would cease after the two vessels attained an equilibrium, the machine must be assisted by a moving power attached to one or both of the vessels, as the Marquis merely says, that it may be performed "without the help of any man *within sight or hearing*."

[57]

No. LVIII.

How to make a pistol to discharge a dozen times with one loading, and without so much as once new priming requisite; or to change it out of one hand into the other, or stop one's horse.

NOTE.

An attentive examination of this and the subsequent articles has suggested what appears an improvement of considerable importance in the principle of modern fire-arms. The expense attendant on the manufacture of double barrelled guns, and the inconvenience which arises from

their additional weight, have hitherto prevented their coming into general use, though their utility in the field is very generally allowed. An economical gun uniting all the advantages of the one, with the lightness and portability of the other, must therefore be considered as a desideratum of the first importance. To effect this, a common gun barrel must be pierced with the required number of touchholes, at a sufficient distance to allow of an equal number of charges. A detonating magazine gunlock may then be made to slide on the lower part of the barrel, with a parallel ratchet and click to fix precisely opposite the touchhole to be inflamed. The gun must then be loaded by a graduated [58] ramrod, the powder of each charge being brought opposite its proper touchhole. After the first discharge, the cock must be moved back one tooth of the ratchet, and this motion continued till the whole are exploded, each hole being covered successively by a plate attached to the lock.

No. 60 is evidently performed by filling a cylindrical flask, made the same size as the barrel, with the required number of charges and afterwards forcing the whole of them into the barrel.

Nos. 61 and 67 may be performed by filling a flask previously made to fit the breech of the musket, and forcing forward each successive charge by a screw or lever, in the same manner as the charging is effected in a magazine air-gun.

No. LIX.

Another way, as fast and effectual, but more proper for carabines.

Vide Article LVIII.

No. LX.

A way, with a flask appropriated unto it, which will furnish either pistol or carabine with a dozen charges in three minutes' time, to do the whole execution of a dozen shots, as soon as one pleaseth, proportionably.

Vide Article LVIII.

[59]

No. LXI.

A third way, and particularly for muskets, without taking them from their rests to charge or prime, to a like execution, and as fast as the flask, the musket containing but one charge at a time.

Vide Article LVIII.

No. LXII.

A way for a harquebuss, a crock, or ship musket, six upon a carriage, shooting with such expedition, as, without danger, one may charge, level, and discharge them sixty times in a minute of an hour, two or three together.

Vide Article LVIII.

No. LXIII.

A sixth way, most excellent for *sakers*, differing from the other, yet as swift.

Vide Article LVIII.

[60]

No. LXIV.

A seventh, tried and approved before the late king (of ever blessed memory), and an hundred lords and commons, in a cannon of eight inches and half a quarter, to shoot bullets of sixty-four pounds weight, and twenty-four pounds of powder, twenty times in six minutes; so clear from danger, that, after all were discharged, a pound of butter did not melt, being laid upon the cannon britch, nor the green oil discoloured that was first anointed and used between the barrel thereof, and the engine having never in it, nor within six foot, but one charge at a time.

Vide Article XXIX.

No. LXV.

A way that one man, in the cabin, may govern a whole side of ship muskets, to the number (if need require) of two or three thousand shots.

NOTE. [61]

The plan of this and the following Articles, though not of much practical utility, may yet be acted upon with a certainty of success. The powder may be ignited by the means of a powerful electrifying machine made to communicate with each separate piece, and the charging must be performed by conducting wires or rods made to act upon the magazine lever described in Article LVIII.

Since writing the above, an article has appeared on the subject in one of the French Journals, of which the following is a translation: At two o'clock in the afternoon M. Bouche made an experiment in the *Jardin des Plantes* at Paris, to try the effect of electricity applied to gun batteries. Instead of guns he had fixed about one hundred rockets on long sticks, disposed in the garden. The rockets were all connected by an iron wire, and the same spark produced a spontaneous explosion. The concourse of people was very great, the weather being remarkably fine. This new invention is not intended to increase the destructive powers of those formidable weapons; but it is expected to afford the means of using them without exposing gunners to the fire of the enemy.

No. LXVI.

A way, that against the several avenues to a fort or castle, one man may charge fifty cannons, playing and stopping when he pleaseth, though out of sight of the cannon. [62]

Vide last Article.

No. LXVII.

A rare way likewise for muskettoons, fastened to the pommel of the saddle, so that a common trooper cannot miss to charge them, with twenty or thirty bullets at a time, even in full career.

NOTE BY THE AUTHOR.

When first I gave my thoughts to make guns shoot often, I thought there had been but one only exquisite way inventible; yet, by several trials, and much charge, I have perfectly tried all these.

No. LXVIII.

An admirable and most forcible way to drive up water by fire, not by drawing or sucking it upwards, for that must be, as the philosopher calleth it, *infra sphæram activitatis*, which is but at such a distance. But this way hath no bounder, if the vessels be strong enough; for, I have taken [63] a piece of a whole cannon, whereof the end was burst, and filled it three-quarters full, stopping and screwing up the broken end, as also the touchhole; and making a constant fire under it, within twenty-four hours it burst and made a great crack: so that having found a way to make my vessels, so that they are strengthened by the force within them, and the one to fill after the other, have seen the water run like a constant fountain stream, forty feet high; one vessel of water, rarefied by fire, driveth up forty of cold water: and a man that tends the work is but to turn two cocks, that one vessel of water being consumed, another begins to force and refill with cold water, and so successively, the fire being tended and kept constant, which the self-same person may likewise abundantly perform in the interim between the necessity of turning the said cocks.

NOTE.

Vide Article C., to which is prefixed a brief historical and descriptive account of that stupendous machine, the Steam-engine. [64]

No. LXIX.

A way how a little triangle and screwed key shall be capable and strong enough to bolt and unbolt, round about a great chest, an hundred bolts through fifty staples, two in each, with a direct contrary motion, and as many more from both sides and ends, and at the self-same time shall fasten it to the place, beyond a man's natural strength to take it away; and, in one and the same turn, both locketh and openeth it.

NOTE.

This invention, with its two following modifications, is evidently intended to operate on the principle of applying a screw for the purpose of forcing the *lock bolt*, in lieu of using the handle of the key as a lever for that purpose. That this plan might be applied to locks generally, there can be no doubt, and by a similar contrivance the large keys at present in use for outer doors, iron chests, &c. might be advantageously reduced to the size described by the noble author. By employing the escutcheon mentioned in No. LXXII. these locks would be equally safe and much more simple than [65] those in common use. For the latter part of the Article, any ingenious smith may make a lock with an hundred bolts; and to fasten it to the place, the power of a screw key is abundantly sufficient to force an iron bar through a staple previously fixed in the floor.

No. LXX.

A key, with a rose-turning pipe, and two roses pierced through endwise; together with several handsomely contrived wards, which may likewise do the same effects.

No. LXXI.

A key, perfectly square, with a screw turning within it, and more conceited than either of the rest, and no heavier than the triangle screwed key, and doth the same effects.

No. LXXII.

An escutcheon, to be placed before any of these locks with these properties.

1. The owner (though a woman) may, with her delicate hand, vary the ways of coming to open the lock ten millions of times, beyond the knowledge of the smith that made it, or of me who invented it. [66]

2. If a stranger open it, it setteth an alarm a going, which the stranger cannot stop from running out; and, besides, though none should be within hearing, yet it catcheth his hand, as a trap doth a fox; and though far from maiming him, yet it leaveth such a mark behind it, as will discover him if suspected; the escutcheon, or lock, plainly shewing what money he hath taken out of the box, to a farthing, and how many times opened since the owner had been at it.

NOTE.

The two principal properties of this escutcheon may be readily contrived; and the first of them has, in fact, been already applied to a very ingenious padlock, invented by Mr. Marshall, and for which the Society of Arts voted him a reward of ten guineas. In Mr. M.'s escutcheon the letters or figures commonly used in the ring padlock allow an almost endless variety of changes, and the owner may in one minute alter the arrangement in such a manner that even the maker would experience as much difficulty to open it, as an entire stranger to its construction. To render the [67] combination of letters variable, the characters must not be engraved upon the outside of the rollers themselves, but upon a thin brass hoop made to fit on its outer surface; and a spring fastened to the roller, and pressing upon the inside of the hoop, will cause a sufficient degree of friction to make them move together.

The other part of this invention is equally simple with the preceding. An alarum, such as is attached to a clock, may easily be wound up prior to closing the box; and the lid provided with a chamfered bolt or staple, capable of effecting its discharge when the box is opened.

To register the amount of money taken from the box, it will be necessary either to place each distinct piece of money in separate divisions, or to put a number together in one deep recess capable of admitting but one piece to pass at a time. As the pieces are shaken out, they will in their passage raise a lever capable of moving a wheel one division in the passage of each piece.

The Bank of England have a method somewhat similar for registering the number of notes worked from the printing press of that establishment.

No. LXXIII.

A transmittable gallery over any ditch or breach in a town-wall, with a blind and parapet, cannon proof.

[68]

No. LXXIV.

A door, whereof the turning of a key, with the help and motion of the handle, makes the hinges to be of either side, and to open either inward or outward, as one is to enter or to go out, or to open in half.

NOTE.

By making the handle act on a lever communicating with the hinges, they may be raised from their sockets on the required side; and to open in half, it is merely necessary to joint them in the centre.

No. LXXV.

How a tape or riband-weaver may set down a whole discourse, without knowing a letter, or interweaving any thing suspicious of other secret than a new-fashioned riband.

NOTE.

The evident analogy between this Article and No. XXXIII. will be apparent on the slightest view, and in general principle it is similar to Nos. XXXIV. XXXV., &c. It may be performed either by making the stitches of a given length, varying the distance to distinguish the different letters of the [69] alphabet; or, by any arbitrary shape which may be previously agreed upon by the parties corresponding. These arrangements being made, the silk weaver will have nothing more to do, than set his loom to the required pattern.

No. LXXVI.

How to write in the dark, as straight as by day or candle-light.

NOTE.

Two planes of ebony of equal length and breadth, similar to the parallel ruler, and joined at each end by racks, the side of which being graduated to the width of the line intended will serve as a certain guide, and by the use of this instrument a blind person may write with the greatest accuracy. If ivory tablets or a slate is used, a fine wire drawn with a steel point may be readily felt by the point of the pencil.

No. LXXVII.

How to make a man to fly: which I have tried with a little boy of ten years old, in a barn, from one end to the other, on a hay-mow.

NOTE. [70]

Innumerable are the schemes that have been proposed by the learned at different periods, to enable man to support himself in the air by the means of artificial wings, &c. and some, indeed, of these ingenious contrivances have formed the labours of the most distinguished mechanical geniuses, which are recorded in the early annals of science.

Bacon, and an Italian priest named Francisco Lana, endeavoured to accomplish it by means of two thin hollow globes, exhausted of air, which being considerably lighter than that fluid, were intended to sustain a chair suspended to their lower extremity, and on which the aeronaut might be seated. But Dr. Hook, in a work published some time after the *Prodromo* of Lana, plainly showed the fallacy of the attempt, though without in the least attempting to deny the possibility of eventually effecting this object.

Bishop Wilkins, who was also a disciple of the flying system, describes a species of land-sailing vessels or chariots, which were then commonly used in China: and it is rather a curious fact that a German Count, possessing as much of modesty as the generality of foreign mechanics, has lately given to the public, as his own, an invention which has been known in Europe, and occasionally employed in Asia, for the last four hundred years.

But of all the plans that have hitherto been devised, those only which have mechanic power as their basis appear to have any chance of success. This may be considered as an unerring *datum* to guide the future experimentalist, the certainty of which is fully demonstrated by a comparison of the [71]
powers of the human frame with those of the feathered tribe: for it has been calculated by an ingenious anatomist, that the muscles which move the wings downwards in a bird in many instances, constitute not less than the sixth part of the weight of the whole body; while those of a man are not one hundredth part so large. By the use of springs, however, wound to a certain degree of tension, prior to embarking upon the intended expedition, and acting upon cranks working the wings, the same power as that possessed by the feathered race may be obtained, and the springs may be readily made to draw more than fifty times their weight. By this means a whalebone, or other light carriage, may be raised, though it would be but for a short time, as it would not be in the power of the aëronaut to wind the springs so quick as the machine would require.

From this, then, it will be seen that, to produce the effect necessary for this species of navigation, it is only requisite to have a first mover, which will produce more power, in a given time, in proportion to its weight, than the animal system of muscles.

High pressure steam-engines have been made to operate by expansion only, and they, it appears, might be constructed so as to be light enough for this purpose. In that case, however, it will be evident that the usual plan of a large boiler must be given up, and the principle of injecting a proper charge of water into a series of tubes, forming the cavity of the fire, must be adopted in lieu of it.

The following estimate will show the probable weight of such an engine with its charge for one [72]
hour.

	lbs.
The engine itself, from 90 to	100
Weight of inflamed coals in a cavity presenting about 4 feet surface of tube	25
Supply of coal for 1 hour	6
Water for ditto, allowing steam of one atmosphere to be 1/1800 the specific gravity of water	32
	163

It may at first view appear superfluous to inquire further relative to a first mover for aërial navigation; but lightness is of so much value in this instance, that it is proper to notice the probability that exists of using the expansion of air by the sudden combustion of inflammable powders or fluids with great advantage. The French have experimentally shown the great power produced by igniting inflammable fluids in close vessels; and several years ago, an engine was made in this country to work in a similar manner, by the inflammation of spirit of tar.

It appears that eighty drops of this fluid raised eight hundred weight to the height of 22 inches; hence a one-horse power may consume from 10 to 12 pounds per hour, and the engine itself need not exceed 50 pounds weight.

Probably a much cheaper engine of this sort might be produced by gas-light apparatus, and by firing the inflammable air generated, with a due portion of common air, under a piston. Upon some [73]
of these principles it is perfectly clear that force can be obtained by a much lighter apparatus than the muscles of animals or birds, and therefore in such proportion may aërial vehicles be loaded with inactive matter. Even the high pressure steam-engine doing the work of six men, and only weighing equal to one, will readily raise five men into the air, but by increasing the magnitude of the engine ten, fifty; or even five hundred men may equally well be conveyed.

Having rendered the accomplishment of this object probable upon the general view of the subject, it will now be necessary to point out the principles of the art itself. The whole problem is confined within these limits, viz. To make a surface support a given weight by the application of power to the resistance of the surrounding atmosphere.

Many experiments have been made upon the direct resistance of air by Mr. Robins, Mr. Rouse, Mr. Edgeworth, Mr. Smeaton, and others. The result of Mr. Smeaton's experiments and observations was, that a surface of one square foot met with a resistance of one pound, when it

travelled perpendicularly to itself through air at a velocity of 21 feet per second.

Having ascertained this point, had our tables of angular resistance been complete, the size of the surface necessary for any given weight would easily have been determined. Theory, which gives the resistance of a surface opposed to the same current in different angles, to be as the squares of the sine of the angle of incidence, is of no use in this case; as it appears, from the experiments of the [74] French Academy, that in acute angles, the resistance varies much more nearly to the direct ratio of the sines, than as the squares of the sines of the angles of incidence. The flight of birds will prove to an attentive observer, that, with a concave wing apparently parallel to the horizontal path of the bird, the same support, and of course resistance, is obtained. And hence it appears that, under extremely acute angles with concave surfaces, the resistance is nearly similar in them all.

Six degrees was the most acute angle, the resistance of which was determined by the valuable experiments of the French Academy; and it gave 4/10 of the resistance, which the same surface would have received from the same current when perpendicular to itself. Hence then a superficial foot, forming an angle of six degrees with the horizon, would, if carried forward horizontally (as a bird in the act of skimming) with a velocity of 23·6 feet per second, receive a pressure of 4/10 of a pound perpendicular to itself. And if we allow the resistance to increase as the square of the velocity, at 27·3 feet per second it would receive a pressure of one pound.

The flight of the *corvus frugilegus*, or rook, during any part of which it can skim at pleasure, is (from an average of many observations) about 34·5 feet per second. The concavity of the wing may account for the greater resistance here received, than the experiments upon plain surfaces would indicate.

The angle made use of in the crow's wing is much more acute than six degrees: but in the [75] observations that will be grounded upon these data, it may safely be stated that every foot of such curved surface, as will be used in aërial navigation, will receive a resistance of one pound, perpendicular to itself, when carried through the air in an angle of six degrees with the line of its path, at a velocity of about 34 or 35 feet per second.

The next object is to apply what has been advanced to the theory of aërial navigation; and the following description will convey a just idea of the best method of effecting it. Suppose a sail to be made of thin cloth, of a firm texture, containing two hundred square feet; and that the weight of the man and the apparatus is 200 pounds. Then if the wind blow with a velocity of 35 feet per second, in a certain direction, at the same time that a cord in that direction sustains a tension of 21 lbs. from being fixed to the machine, the whole apparatus will be suspended in the air. But it is perfectly indifferent whether the wind blow against the plane, or the plane be propelled by any means against the air with an unequal velocity. Hence, if this machine were drawn forward by the cord under a tension of 21 lbs. and with a velocity of 35 feet per second, the whole would be suspended in an horizontal path. Now, if, instead of this cord, any other propelling power were generated in the same direction, and with the same intensity, an equivalent effect would be produced, and aërial navigation accomplished. *Vide Bishop Wilkins's Math. Magic.—Hook's Philosophical Collections.—Sir G. Cayley on Aërial Navigation.*

[76]

No. LXXVIII.

A watch to go constantly, and yet needs no other winding from the first setting on the cord or chain, unless it be broken, requiring no other care from one than to be now and then consulted with, concerning the hour of the day or night; and if it be laid by a week together, it will not err much; but the oftener looked upon, the more exact it showeth the time of the day or night.

NOTE.

For a pocket watch it will be necessary to employ a small balance, with a nut attached to its axis and communicating with the fusee, the continued vibration of which will, by winding the watch, give it nearly all the advantages of a perpetual prime mover. Should the time-piece be placed in a fixed case it will require a communication between the joint of the door and the fusee, and this may likewise be readily applied to the case of a hunting watch.

Mr. Gout's *pedometer* not only marks the time, but the number of paces passed over from one place to another: this is accomplished by means of a chain or string passing to the leg of the wearer, or to the wheel of a chariot, which is made to advance the index hand one division at each elevation [77] of the foot: thus, on the same dial, exhibiting, at one view, both time and distance. The same pedometer will, by a proper application to the saddle, ascertain every pace a horse takes, and it may be made to change its performance in a second, should the horse in the course of measuring go from one pace to another.

No. LXXIX.

A way to lock all the boxes of a cabinet (though never so many) at one time, which were, by particular keys appropriated to each lock, opened severally, and independent the one of the other, as much as concerneth the opening of them, and by these means cannot be left open unawares.

NOTE.

This suggestion, which is both ingenious and useful, might be advantageously adopted in every description of cabinet or chest now in use; it may be performed either by cranks and wires, or by sliding bolts and levers communicating with each lock: the latter way, though attended with greater expense, is by far the most durable.

Another and more simple mode offers itself in the use of a series of spring locks, which may be [78] closed by the pressure of the lid, unconnected with any other mechanism.

No. LXXX.

How to make a pistol barrel no thicker than a shilling, and yet able to endure a musket proof of powder and bullet.

NOTE.

It requires no great share of ingenuity to accomplish this object, as an examination of modern fire-arms will fully testify; many pocket pistols that are manufactured at the present period, being at least as thin as those described by the noble author.

No. LXXXI.

A comb-conveyance carrying of letters without suspicion, the head being opened with a needle screw, drawing a spring towards one; the comb being made but after an usual form, carried in one's pocket.

NOTE.

A pocket comb and portable spoon, as described in this and the following article, with double sides to conceal any letter, paper, &c. are too simple to need a particular description. [79]

No. LXXXII.

A knife, spoon, or fork, in an usual portable case, may have the like conveyances in their handles.

No. LXXXIII.

A rasping-mill for hartshorn, whereby a child may do the work of half-a-dozen men, commonly taken up with that work.

NOTE.

A variety of engines have been invented for this purpose, many of which are capable of effecting the saving of labour described by the Marquis, as at that period (1663) the process was usually effected by rubbing the horn or ivory over a common iron grater.

No. LXXXIV.

An instrument whereby persons, ignorant in arithmetic, may perfectly observe numeration and subtraction of all sums and fractions. [80]

NOTE.

Sir Samuel Morland has published a detailed account of two instruments of this kind in a tract entitled, *The Description and Use of two Arithmetic Instruments*, &c.—London, 1673. The Roman *Abacus* and Chinese *Swan-pan* are also instruments of a like description.

The *Abacus* was variously contrived; that chiefly used in European countries was made by drawing any number of parallel lines at pleasure, at a distance from each other, equal to twice the diameter of a *calculus* or counter. This placed on the lowest line, signified 1; on the second, 10; on the third, 100; on the fourth, 1000; on the fifth, 10,000; and so on. In the spaces between the lines, the same counters signified half of what they represented on the next superior line; viz. in the space between the first and second lines, 5; between the second and third, 50; between the third and fourth, 500; and so on. The abacus was also divided cross-wise into *areolæ*, and by this means subtractions were performed. The calculating instrument of Mr. Babbage is however much superior to any other contrivance yet suggested.

No. LXXXV.

A little ball, made in the shape of a plum or pear, which, being dexterously conveyed or forced into a body's mouth, shall presently shoot forth such, and so many bolts of each side and at both ends as, without the owner's key, can neither be opened nor filed off, being made of tempered steel, and as effectually locked as an iron chest. [81]

NOTE.

The steel fangs with which this instrument is furnished must, like the bolt of a common latch, be chamfered from the point, so that, on its being inserted within the teeth, the bolts will instantaneously spring out; and no power short of the key previously made to fit the wards of the lock will suffice to free those who are thus ensnared. This is evidently one of those discoveries which, though practicable in itself, appears better calculated for swelling the catalogue of the noble Author's inventions, than for any beneficial result likely to accrue to the public from its discovery.

No. LXXXVI.

A chair made *à-la-mode*, and yet a stranger, being persuaded to sit down in it, shall have

immediately his arms and thighs locked up, beyond his own power to loosen them.

NOTE.

[82] Chairs of this description are stated to have been employed by the monks in the darker ages of Christianity; and were originally designed for the purpose of entrapping those who, possessing more courage, or less of prudence than their neighbours, ventured to penetrate the mysteries of papal seclusion. They were formed like a common arm-chair, and provided with two levers at the extremity of the arms; and the same number were fixed immediately below the seat. These, on pressing the cushion, were immediately discharged like a man-trap: four powerful springs acting on the levers for that purpose; and so firmly will the occupant of a chair of this description be fixed, that it will take the united force of four or five persons to free the prisoner. A similar chair was exhibited at the *Villa Borghese*, Rome, in 1644—"They shew'd us also a chayre w^{ch} catches any who sitts downe in it so as not to be able to stir out, by certaine springs concealed in the armes and back thereoff which at sitting downe surprizes a man on the suddaine, locking him in by the armes or thighs, after a true tretcherous Italian guise."—Vide *Evelyn's Memoirs*, vol. i. p. 107.

No. LXXXVII.

A brass mould to cast candles, in which a man may make five hundred dozen in a day, and add an ingredient to the tallow, which will make it cheaper, and yet so that the candles shall look whiter and last longer.

NOTE. [83]

The usual method of dipping *store candles* is subject to many objections, though the expense attendant on casting those called *moulds* has hitherto been an impediment to their general manufacture. A more simple method now offers itself, which is equally advantageous and economical. A quantity of drawn tubes being first cut into the given lengths, metal collars must then be soldered on the extremity of each length, with an orifice of sufficient size to allow the tallow and wick to pass through the whole series of tubes. They must then be connected together by a screw cut in each alternate end, and the whole, thus formed, passed through a steam pipe of sufficient size to prevent the tallow chilling in its passage through the moulds. When cold, each joint of the mould must be separately unscrewed and the candles separated by a sharp knife.

A means of purifying the tallow, and as such, of rendering the candles whiter and more durable, likewise suggests itself in the following simple process. The vat, or copper, containing the melted tallow, must be provided with a shower bath placed immediately over the surface, to which must be attached a reservoir of cold water: this, by the action of a lever, may be thrown through the grating of the bath, and falling upon the tallow, will, in its passage, carry to the bottom of the vat the whole of the carbonised animal matter and other impurities with which it is charged. After allowing a few [84] minutes for the lighter fluid to rise, the water may then be drawn off, by a cock placed at the bottom of the vat for that purpose, and the same process repeated till the tallow is fit for use.

No. LXXXVIII.

An engine, without the least noise, knock, or use of fire, to coin and stamp 100lbs. in an hour, by one man.

NOTE.

Antoine Boucher appears to have been the first engraver who used the fly-press for the multiplying of metallic impressions from an engraved matrix. This ingenious mechanic was employed by Henry the Second of France, and the first money was struck with it in that kingdom about the middle of the sixteenth century; it was soon however laid aside on account of the great expense attendant on its use, and the old method of striking with the hammer was again resorted to. Queen Elizabeth also had milled money coined in England about the same period; but it did not continue for more than ten years; and it was not till 1662, that the screw press was finally established in the mint of this kingdom. The accelerated motion of a screw, although possessing many advantages over the old method, does not appear fully to answer the above description, as the noise attendant on its use is certainly very considerable; it is probable therefore, that the [85] hydrostatic press, or a powerful lever worked by a crank, was intended by the noble author as a substitute for this useful machine.

It appears probable that the insertion of this Article originated in an ignorance of the plan formerly proposed by Boucher, which appears of all others best adapted for the purpose of coining with rapidity, and which was not at that period acted upon in England; on the discovery of which the following Article was substituted by the noble author; and appeared in the first printed edition of the *Century*.

No. LXXXVIII.

How to make a brazen or stone head, in the midst of a great field or garden, so artificial and natural, that though a man speak never so softly, and even whispers into the ear thereof, it will presently open its mouth, and resolve the question in French, Latin, Welsh, Irish, or English, in good terms, uttering it out of his mouth, and then shut it until the next question be asked.

NOTE. [86]

Albertus Magnus, a celebrated philosopher of the thirteenth century, is said to have constructed an *automaton* which not only performed all the apparent motions of life, but absolutely answered questions. It is recorded of Thomas Aquinas, that, having accidentally seen the head, he was so

terrified that he broke it in pieces, upon which Albert exclaimed: *Periit opus triginta annorum*! Though this appears one of the earliest instances of a speaking automaton constructed by one of the laity, there is no doubt but that the method of conveying answers to various interrogatories, by the agency of concealed pipes or a speaking trumpet, was practised at a very early period. That the impostor Alexander, however, caused his Æsculapius to speak in this manner is expressly related by Lucan. He took, says this author, instead of a pipe, the gullet of a crane, and transmitted the voice through it to the mouth of the statue. But the invention of the *invisible girl*, which may be considered as an improvement on the oracular responses of the darker ages, infinitely surpassed any of those hitherto recorded.

This very ingenious apparatus was publicly exhibited both at Bristol and in London for a considerable period, during which time no discovery was made of its internal mechanism; and it is probable that its construction would have remained a secret to all but the exhibitors, but for the ingenuity of Mr. (now Professor) Millington, who, in a course of Lectures delivered in the winter of 1806, explained the manner in which it was performed.

The *visible* part of the apparatus connected with the *invisible girl* was thus constructed: first a [87]
mahogany frame resembling a bedstead, having at the corners four upright posts about five feet high, was united by a cross-rail near the top, and two or more cross-rails near the bottom, to strengthen the frame, which was about four feet square. The frame thus constructed was placed upon the floor, and to the top of each of the four pillars were attached as many strong bent brass wires converging towards the top, where they were secured by a crown and other ornaments. From these wires a hollow copper ball was suspended by slight ribbons, so as to cut off all possible communication with the frame. The globe thus supported was supposed to contain the invisible being, as the voice apparently proceeded from the interior of it: and for this purpose, it was equipped with four trumpets, placed round it in a horizontal direction, and at right angles to each other; the trumpet mouths coming to within about half an inch of the respective cross-rails of the frame surrounding them.

When a question was proposed, it was asked from any side of the frame, and spoken into one of the trumpets, and an answer immediately proceeded from the whole of them, so loud as to be distinctly heard by the inquirer, and yet so distant and feeble, that it appeared as if coming from a very diminutive being. In this the whole of the artifice consisted; and the variations were so contrived that the answer might be returned in several languages, a kiss might be returned, the
breath producing the voice was felt, and songs were sung, accompanied by the piano-forte, &c. To [88]
produce this illusion, the sound was conveyed by a tube, in a manner similar to the old and well known contrivance of the *speaking bust*; the invisible girl only differing in one circumstance; that an artificial echo was produced by means of the trumpets and hollow globe, in consequence of which the sound was completely reversed.

In the invisible girl the orifice of the tube was in one of the handrails just opposite the mouth of one of the trumpets, the opening being concealed by reeds and other mouldings; the tube itself, which was about half an inch in diameter, ran through half the handrail, then down one of the corner posts, and from thence under the floor till it reached a large deal case almost similar to an inverted funnel, along the side of which it rose till it came nearly into contact with the ear of the confederate, who with a piano-forte, &c. was concealed in this case. Any question asked by a voice directed into one of the trumpets was immediately reflected back from the concave interior surface of the globe to the orifice of the tube, along which it was conveyed so as to be distinctly heard by the person in the deal case, who returned the requisite answer, which appeared to come precisely from the interior of the globe. A small hole closed with glass was likewise left through the deal case and side wall of the apartment, by means of which the concealed person had an opportunity of observing and commenting upon any circumstance which occurred in the room.

[89]

No. LXXXIX.

White silk, knotted in the fingers of a pair of white gloves, and so contrived without suspicion, that, playing at *primero* at cards, one may, without clogging his memory, keep reckoning of all sixes, sevens, and aces, which he hath discarded, and without foul play.

NOTE.

That sliding knots or rings may be formed on the fringe of silk or other gloves, by which means a reckoning can be kept, may easily be conceived; but it is scarcely too much to aver that an undue advantage taken of an opponent, even at cards, savours very much of foul play, if not absolute cheating.

No. XC.

A most dexterous dicing-box, with holes transparent, after the usual fashion, with a device so dexterous, that with a knock of it against the table, the four good dice are fastened, and it looseneth four false dice, made fit for this purpose.

NOTE. [90]

There are few who profess the science of cheating at cards or dice, or to be encouragers of those who do; and it may fairly be conceded that there are not two periods in our regal annals, in which this detestable meanness had become fashionable enough to sanction a nobleman in inscribing to the King and his Parliament a method by which it might be advantageously effected.

No. XCI.

An artificial horse, with saddle and caparisons fit for running at the ring, on which a man being mounted, with his lance in his hand, he can at pleasure make him start, and swiftly to run his

career, using the decent posture with *bon grace*, may take the ring as handsomely, and running as swiftly as if he rode upon a barbe.

NOTE.

Any person who is acquainted with the various automaton figures that have been constructed by those celebrated mechanics, Vaucanson, Kempelen, and Maelzel, will readily admit the possibility of making a horse of this description; nor should we too readily undervalue those mechanical pursuits, which, though not of any immediate national advantage, have formed the employment of one of the greatest potentates of modern Europe.[7] [91]

The most celebrated of the modern automata were those made by Vaucanson, and which are thus described by Beckman:—

"One of them, which represented a flute-player sitting, performed twelve tunes, and, as we are assured, by wind issuing from its mouth into a German flute, the holes of which it opened and shut with its fingers."

"The second was a standing figure, which in like manner played on the Provençal shepherd's pipe, which it held in its left hand, and with the right beat upon a drum."

"The third was a duck, of the natural size, which moved its wings, exhibited all the gestures of that animal, quacked like a duck, drank water, ate corn, and then, after a little time, let drop behind it something that resembled the excrement of a duck."[8]

Of these automata, or rather *androides*, the flute-player of Vaucanson is the only one of which a correct description has been preserved; a particular account of its mechanism having been published in the Memoirs of the French Academy. The figure was about five feet six inches high, and was placed upon an elevated square pedestal. The air entered the body by three separate pipes, into which it was conveyed by nine pairs of bellows, which expanded and contracted in regular succession, by means of an axis of steel turned by the machine. The three tubes, which conveyed the air from the bellows, after passing through the lower extremities of the figure, united at the chest; and ascending from thence to the mouth, passed through two artificial lips. Within the cavity of the mouth was a small moveable tongue, which by its motion at proper intervals, admitted or intercepted the air in its passage to the flute. The fingers, lips, and tongue derived their specific movements from a steel cylinder turned by clockwork. The cylinder was divided into fifteen equal parts, which by means of pegs, pressing upon a like number of levers, caused the other extremities to ascend. Seven of these levers directed the fingers, having rods and chains fixed to their ascending extremities; which, being attached to the fingers, made them to ascend in proportion as the other extremity was pressed down by the motion of the cylinders, and *vice versa*. Three of the levers served to regulate the ingress of the air, being so contrived as to open and shut, by means of valves, the communication between the lips and reservoir, so that more or less strength might be given, and a higher or lower note produced as occasion required. [92]

The lips were directed by four similar levers; one of which opened them to give the air a freer passage; another contracted them; a third drew them backward, and the fourth pushed them forward. The remaining lever was employed in the direction of the tongue, which by its motion shut or opened the mouth of the flute. The varied and successive motions performed by this ingenious androides, were regulated by a contrivance no less simple than efficacious. The axis of the steel cylinder or barrel was terminated by an endless screw composed of twelve threads, above which was placed a small arm of copper, with a steel stud made to fit the threads of the worm, which, by its vertical motion, was continually pushed forward. Hence, if a lever was moved, by a peg placed on the cylinder, in any one revolution, it could not be moved by the same peg in the succeeding revolution in consequence of the lateral motion communicated by the worm. By this means the size of the barrel was considerably reduced; and the statue not only poured forth a varied selection of instrumental harmony, but exhibited all the evolutions of the most graceful performer. [93]

No. XCII.

A screw, made like a water-screw, but the bottom made of iron-plate spadewise, which, at the side of a boat, emptieth the mud of a pond, or raiseth gravel.

NOTE.

The Archimedean screw, though hitherto only applied to the raising of water, appears to be equally applicable to many other purposes; as the procuring of sand from pits, taking dry goods of small dimensions from carts or barges, clearing rivers, &c. though in that case it will be necessary to make the lower end of the machine in a conical form, gradually increasing the size of the orifice from the point to its upper extremity, in order to prevent the materials from clogging the screw, which would otherwise occur. [94]

The *dredging machine* worked by a steam-engine, and employed in the Thames for a similar purpose, is well known.

No. XCIII.

An engine, whereby one man may take out of the water a ship of five hundred tons, so that it may be caulked, trimmed, and repaired, without need of the usual way of stocks, and as easily let it down again.

NOTE.

Beckman, in his History of Inventions, says, that a machine of this description was invented by a citizen of Amsterdam, in the year 1690, and was by him called the *water camel*. It consisted of two half ships, and on the deck of each were placed horizontal windlasses from which proceeded ropes made to pass under the keel of the vessel intended to be raised. The two sides of the camel having

been sunk by the admission of water, the ropes were drawn tight, and the pumps being put in motion, the vessel was gradually raised to the surface. It appears to have been principally employed in crossing the bar of the Zuyderzee. [95]

No. XCIV.

A little engine, portable in one's pocket, which placed to any door, without any noise, but on crack, openeth any door or gate.

NOTE.

The simple engine called a *Jack*, used for the purpose of raising great weights, with small manual exertion, appears to be admirably calculated for this purpose; and its even uniform motion is evidently described by the noble author.

Ramelli has also given a description of several very curious instruments for the same purpose. Vide *Artificiose Machini*, p. 255, &c.

No. XCV.

A double cross-bow, neat, handsome, and strong, to shoot two arrows, either together, or one after the other so immediately, that a deer cannot run two steps, but, if he miss of one arrow, he may be reached with the other, whether the deer run forward, sideward, or start backward. [96]

NOTE.

The cross-bow, though long since superseded in point of general utility by the invention of fire-arms, might still be found a useful auxiliary in the sports of the field, and as such, it has been thought advisable to notice what appears to be the plan on which this instrument must be constructed. To fire two arrows in immediate succession, it will be necessary either to attach a second bow to the under side of the stock, which, after discharging one arrow, may immediately be reversed, and the second fired. Or, where a bow of sufficient length is used, the string may communicate the required degree of impetus to two arrows in succession, a stud being previously prepared for its reception, about half-way down the stock, from which it may readily be liberated for the second discharge.

No. XCVI.

A way to make a sea-bank so firm and geometrically strong, that a stream can have no power over it; excellent likewise to save the pillar of a bridge, being far cheaper and stronger than stone walls.

NOTE. [97]

The *break-water* erected by Mr. Rennie at Plymouth is, in its results, precisely what the noble author has here described. The plan of its construction is this: a mass of stone in blocks, of about three feet in diameter, is thrown promiscuously into the sea, and left to find their own base, the extremity of which is generally about seventy yards. This sea-wall has been carried about eight hundred fathoms in length, and the total expense attendant on its erection is estimated at £1,150,000. In 1766, Mr. Smeaton also applied loose stones to strengthen the middle piers of London bridge, which was the means of preserving that venerable structure from the almost certain ruin which threatened it.

But the most economical sea-bank yet constructed was executed at Rye, in 1804, under the superintendence of the Rev. Daniel Pape, curate of that place.

The dam or bank was formed in its lower part in two parallel ridges close to each other, like the double roof of a house, which were covered over, first with straw, and then with hazel faggots about thirteen feet long; and the whole was then pinned down with piles, which were united to each other at their heads by pieces put across the direction of the faggots. When this bank was completed, Mr. Pape formed another bank, on the top of the preceding, by filling up the interval between the two ridges, and covering the whole in the manner above described. All this was accomplished in one tide, and when completed it fully answered the purpose for which it was intended.

[98]

No. XCVII.

An instrument, whereby an ignorant person may take any thing in perspective, as justly, and more so than the most skilful painter can do by the eye.

NOTE.

Vitruvius is the first author who directly treats on this branch of the fine arts, though there can be no doubt but the ancients fully understood its most essential rules, which they must have practised at a very early period in the decoration of their theatres. Vitruvius, in the *proem* to his seventh book, informs us, that Agatharchus of Athens noticed the subject, when preparing a tragic scene for a play exhibited by Æschylus: but the principles of the art were more distinctly taught by Democritus and Anaxagoras, the disciples of the former painter.

Pietro del Borgo, early in the fourteenth century, constructed a very ingenious machine, which was afterwards employed by Albert Durer for the above purpose. It consisted of a transparent tablet, through which the object being viewed from a small aperture, the artist contrived to trace the images which the various rays of light emitted from them would make upon it.

Mr. Ferguson has also described a machine for this purpose, the invention of which he ascribes to Dr. Bevis. But the most simple and efficient instrument yet discovered for large objects is the camera obscura and camera lucida; both of which fully answer the description given by the noble author. [99]

No. XCVIII.

An engine, so contrived, that working the *primum mobile* forward or backward, upward or downward, circularly or cornerwise, to and fro, straight, upright or downright, yet the pretended operation continueth and advanceth; none of the motions above mentioned, hindering, much less stopping the other; but unanimously, and with harmony agreeing, they all augment and contribute strength unto the intended work and operation; and therefore I call this a *semi-omnipotent engine*, and do intend that a model thereof be buried with me.

No. XCIX.

How to make one pound weight to raise an hundred as high as one pound falleth, and yet the hundred pounds descending doth what nothing less than one hundred pounds can effect.

[100]

No. C.

Upon so potent a help as these two last mentioned inventions, a water-work is, by many years' experience and labour, so advantageously by me contrived, that a child's force bringeth up, an hundred feet high, an incredible quantity of water, even two feet diameter. And I may boldly call it, *the most stupendous work in the whole world*: not only with little charge to drain all sorts of mines, and furnish cities with water, though never so high seated, as well to keep them sweet, running through several streets, and so performing the work of scavengers, as well as furnishing the inhabitants with sufficient water for their private occasions: but likewise supplying the rivers with sufficient to maintain and make navigable from town to town, and for the bettering of lands all the way it runs; with many more advantageous, and yet greater effects of profit, admiration, and consequence: so that deservedly I deem this invention to crown my labours, to reward my [101] expenses, and make my thoughts acquiesce in way of further inventions. This making up the whole Century, and preventing any further trouble to the reader for the present, meaning to leave to posterity a book, wherein, under each of these heads, the means to put in execution and visible trial all and every of these inventions, with the shape and form of all things belonging to them, shall be printed by brass plates.—Besides many omitted, and some of three sorts willingly not set down, as not fit to be divulged, lest ill use may be made thereof, but to show that such things are also within my knowledge, I will here in myne owne cypher sett down one of each, not to be concealed when duty and affection obligeth me.

In bonum publicum, et ad majorem Dei gloriam.

NOTE.

The three last inventions may justly be considered as the most important of the whole "Century," and when united with the 68th article, they appear to suggest nearly all the data essential for the [102] construction of a modern steam-engine. The noble author has furnished us with what he calls a "definition" of this engine; and although it is written in the same vague and empirical style, which characterises a large portion of his Inventions, it may yet be considered as affording additional proofs of the above important fact.

The Marquis's "definition" is exceedingly rare, as the only copy known to be extant is preserved in the British Museum.—It is printed on a single sheet without date, and appears to have been written for the purpose of procuring subscriptions in aid of a Water Company, then about to be established.

"A stupendous, or a water-commanding engine, boundless for height, or quantity, requiring no external, nor even additional help or force to be set, or continued in motion, but what intrinsically is afforded from its own operation, nor yet the twentieth part thereof. And the engine consisteth of the following particulars:—

'A perfect counterpoise, for what quantity soever of water.

'A perfect countervail, for what height soever it is to be brought unto.

'A *primum mobile*, commanding both height and quantity, regulator-wise.

'A vicegerent or countervail, supplying the place, and performing the full force of man, wind, beast, or mill.

'A helm or stern, with bit and reins, wherewith any child may guide, order, and control the whole operation.

'A particular magazine for water, according to the intended quantity, or height of water.

'An aqueduct, capable of any intended quantity or height of water. [103]

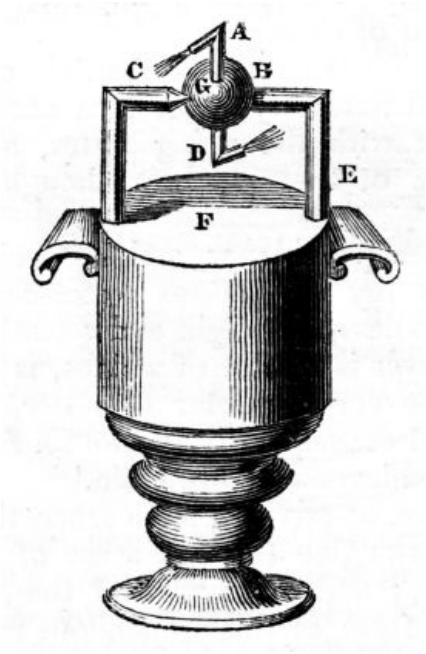
'A place for the original fountain or river to run into, and naturally of its own accord incorporate itself with the rising water, and at the very bottom of the aqueduct, though never so big or high.

'By divine providence, and heavenly inspiration, this is my stupendous water-commanding engine, boundless for height and quantity.

'Whosoever is master of weight, is master of force; whosoever is master of water, is master of both: and consequently to him all forcible actions and atchievements are easie.'"

It may now be adviseable to trace the history of the steam-engine through some of its earlier modifications; and we shall find that, although the present form of this stupendous machine almost deserves the title of an invention, yet that many steps have been taken, and much labour and much ingenuity expended, before it was brought to that point from which the more modern improvements may be said to have begun. And whilst we admire the genius of those who have perfected the application of a mighty power, let us not refuse the tribute of praise to those, who first pointed out that such a power existed.

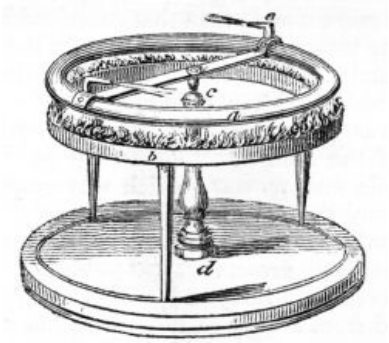
[104]

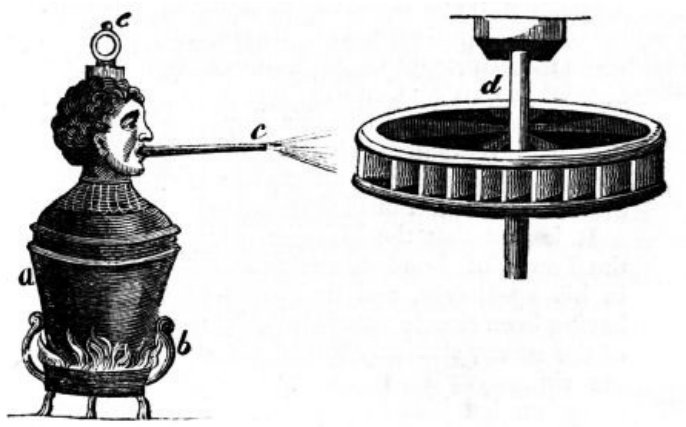


The first apparatus of this description, of which any authentic account has been preserved, was suggested by Hero of Alexandria, and consisted of a vessel F in which steam was generated by the application of external heat. The ball G was supplied with the elastic vapour thus procured, by means of the bent pipe E B, a steam tight joint being provided for that purpose. Two tubes bent to a right angle at A and D, are the only parts open to the air, and as the steam rushes out from very minute apertures, a rotatory motion is produced. An account of this apparatus is preserved in Hero's *Spiritalia*, published by the Jesuits in 1693; and a copy of this highly curious work, with a Latin translation prefixed, is now in the Library of the London Institution.

A modification of Hero's apparatus is represented beneath: It was constructed by Mr. Styles for the use of the Editor in his public lectures. The circular tube *a* is in this case supported by the upright pillar *c d*; and the flame of alcohol in the trough *b*, by generating high pressure steam, which rushes from the apertures *e*, produces a rotatory motion.

[105]





Brancas's revolving apparatus, as will be seen by reference to the diagram in the preceding page, was still more simple than that contrived by Hero. A copper vessel filled with water, (in the original figure made in the form of an ornamental head,) was furnished with a pipe *c*, through which the steam was propelled, and striking against the vanes of the float wheel *d*, readily gave

[106]

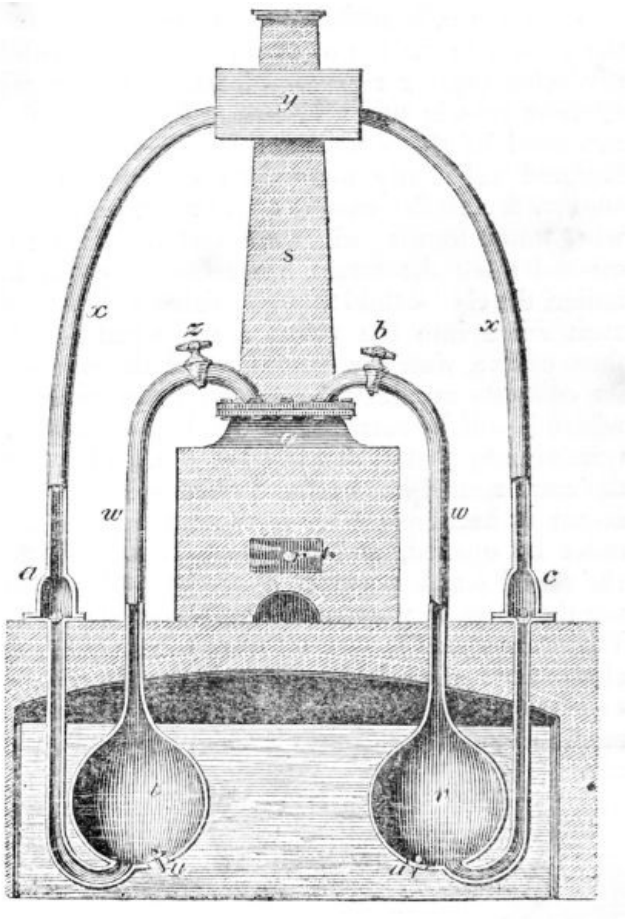
motion to a pestle and mortar, which was employed in the alchemist's laboratory.

The only work in which a description of this engine has been preserved, was published in 1629; it is exceedingly rare, and the above diagram is engraved from a copy in the possession of Major Colby.

A slight examination of the principle upon which this simple apparatus is constructed, will shew that no very considerable force could have been obtained; as the steam passing through the atmosphere in its passage to the wheel, must, to a certain extent at least, be converted into water.

After the publication of the work by Brancas, more than thirty years elapsed ere the publication of the Marquis's "Century" recalled the attention of the scientific world to this important subject; and this invention, which he states as having been completely carried into effect, was evidently very different from that of his predecessors.

It is said that the Marquis, while confined in the Tower of London, was preparing some food in his apartment, and the cover of the vessel, having been closely fitted, was, by the expansion of the steam, suddenly forced off and driven up the chimney. This circumstance attracting his attention, led him to a train of thought, which terminated in the completion of his "water-commanding engine."[9] Of the Marquis's invention no record has been preserved beyond the [107]
articles to which we have already alluded in the present work: and in the absence of other data, the Editor readily introduces Professor Millington's design for an engine on similar principles; and which, with a few alterations, might be made available for the purposes recommended by our author.

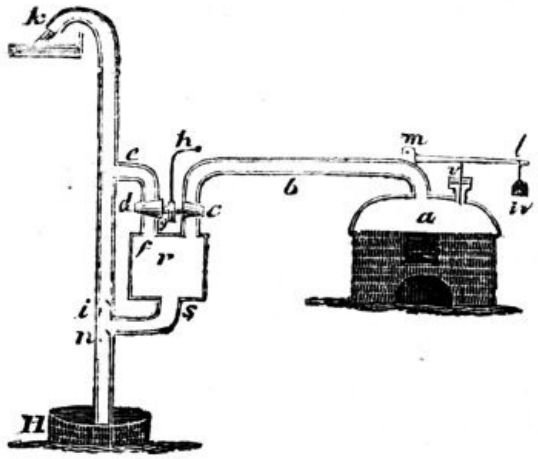


In this diagram, *q* represents a strong and close vessel or boiler to contain water, set in brick [108]
work like a common copper, with a fire-place *r* underneath it, having a chimney *s*. The boiler thus constructed, is intended to afford the means of producing steam: and if we conceive two casks or strong hollow vessels of any form to be placed under the surface of the water, near the boiler, as at *t* and *v*, and that each of these vessels has a valve opening into it in its lower part as *u u*, and two pipes *w w*, proceeding from the upper part of the vessels to the top of the steam boiler *q*, while two other pipes *x x* proceed from the lower parts of these vessels into a cistern *y*, forty feet above the level of the water; an apparatus thus constructed will nearly form the water-commanding engine, for if the vessels *t* and *v* are both filled with water by the valves *u u*, and the cock *z* be opened after the steam has accumulated in the boiler, the elastic fluid thus generated will instantly rush down into the vessel *t*, and when the surface of the water is heated expel the whole of its contents up the pipe *a x*, into the cistern *y*, where it will be retained by a valve opening upwards in any part of that pipe, as at *a*. This done, the cock *z* must be shut, and after permitting the steam to accumulate for a short time, that at *b* must be opened, and the steam will rush into the vessel *v* and perform a similar office, *c* being the valve to prevent the return of the water. When the steam is shut off from the vessel *t*, the elastic fluid which had previously been introduced to expel the water, will be condensed by the cold media round it, and thus a vacuum will be produced in the vessel *t*, consequently a part of the water in which it is immersed will [109]
rush into it by the valve *u*, and occupy the whole internal cavity, thus putting it in a state of

preparation for a second opening of the cock *z*, by which its contents will be again discharged into the cistern *y*, and so of the two vessels alternately; for while *v* is emptying, *t* will be filling, and vice versâ, which agrees with the Marquis's account when he says, "that the man is but to turn two cocks, that one vessel of water being consumed, another begins to force," &c.

The above suggestion for an engine capable of raising water may be still further improved by adding a suction pipe to the valves *u u*, and the pressure of the atmosphere will increase the working power of the engine more than thirty feet: and should a less height be required, the forcing pipe may be shortened in a proportionate degree: indeed this fact was attended to by the next person who claims the honour of having invented the steam-engine, to which it may now be adviseable to direct the reader's attention.

[110]

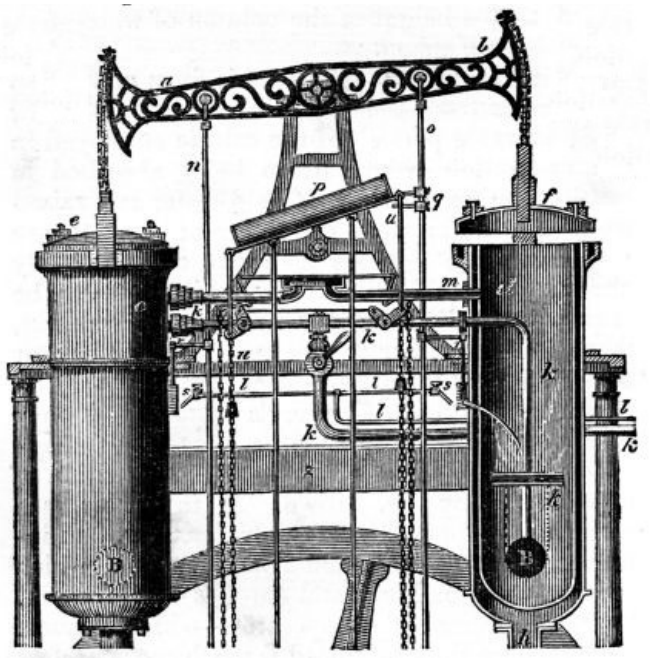


The engine suggested by Savery for the purpose of raising water, consisted of a boiler *a* furnished with a safety valve *v*. The steam-vessel *r* was connected with the well H, by a suction pipe *n*; and when water was to be raised the vessel *r* was filled with steam, which rushing in, soon expelled the air: when that was completely effected, the communication with the boiler was closed, and the steam condensed, which diminishing its bulk, formed a vacuous space within the vessel; the pressure of atmosphere then operating upon the surface of the water in the well, drove it up the pipe. In this form of the apparatus, the inventor was seldom able to raise water more than thirty feet: and when a greater altitude was required, it was effected by the impellent force of high pressure steam. This was accomplished by the ascending pipe *k*, which was sometimes carried sixty feet higher than the steam-vessel *s*; and a reference to the great expansive force of steam will show that this operation must be attended with considerable danger. After condensing the steam and filling the vessel *r* with water, a new supply of steam was [111] then introduced, which pressing on the surface of the water, drove it up the pipe *k*; and it will be evident that the pressure on the internal surface of the boiler must be proportioned to the height of the column of water thus raised by the steam.

The principal objection to this form of the engine arises from the great consumption of fuel, a considerable portion of the caloric employed in the generation of the steam being absorbed in heating the new surface of cold water last raised from the well; and where great heights are required, there appears no mode of completely obviating this objection. Should it, however, be required merely to raise water about thirty feet, there are few contrivances more economical or better adapted for general use.

While speaking of Savery's apparatus it may be adviseable to notice the very ingenious adaptation of the same principle to the construction of a *gas engine*, by Mr. Brown. In the latter case a vacuum is formed by the introduction of an inflamed jet of carburetted hydrogen gas, which consumes the oxygen, and rarefies the nitrogen, by the increase of temperature which ensues. The vacuum thus produced is much more perfect than would at first view have been supposed, from the nature of the process resorted to by the patentee; but the economy of employing carburetted hydrogen gas as a substitute for condensible vapour is still somewhat problematic.[10]

To more fully understand the nature of Mr. Brown's engine, it may be better to revert to a [112] diagram, which will sufficiently explain its general principles.

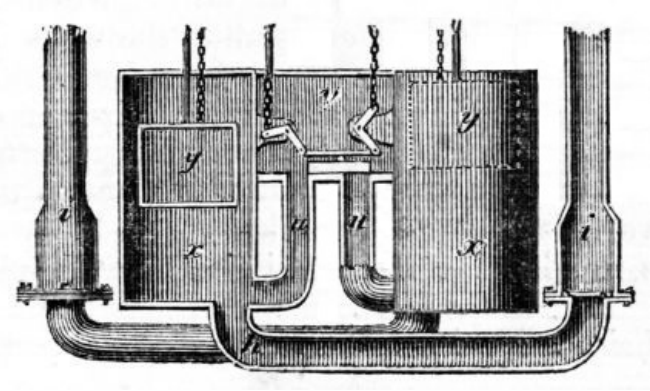


In the above view, the cylinders *c* and *d*, are the vessels in which a vacuum is alternately effected; *g i g* and *h j h* are two pipes, leading into the lower cylinders *x x*, shewn in the next page, from which the water rises along those pipes to fill the vacuum cylinders alternately. The water thus supplied is discharged through the pipes B into the tank or trough *z*, where it falls upon the overshot water-wheel, and, by the rotatory motion thus produced, gives power to such machinery as may be connected to it. The water runs from the wheel along a case surrounding [113] the lower half, into a reservoir *v*, from which the lower cylinders *x x*, are alternately supplied.

The gas is supplied to the cylinders by the pipes *k k k*, which must be, of course, attached to a gasometer, or some other reservoir of gas. The gas also passes along the small pipe *l l* (which communicates also with the gasometer), and being lighted at both ends of that pipe, is kept constantly burning in order to ignite the gas within the cylinders.

The gas being admitted along the pipe *k*, the flame from the pipe *l* is now freely communicated to the gas in the cylinder, through the orifice, by the opening of the sliding valve *s*, which is raised by the arm *r*, lifted by the rod *o* by means of the beam.

The water in the reservoir *v* passing down one of the pipes *w*, into one of the lower cylinders *x*, causes the float *y* in that cylinder to rise, and, pushing up the rod *o*, raises the end *b* of the beam, which, of course, draws up with it the cap *f*, and forces down the cap *e* of the other cylinder *c*.



The *alternate* action of each cylinder is produced by chains and rods, attached to a glass or iron [114] vessel *p*, more than half filled with mercury, and turning upon a pivot; each end receives its movements of elevation and depression from the rise and fall of the projecting arms *q*, by the action of the beam above; the mercury within flowing to the lower end, giving an impetus, and thus regulating the supply of gas to the cylinders, and the movement of the slide in the trough *v*. By this action the water from the reservoir flows down the pipe *w*, into the vessel *x*, and produces the elevation of the float *y* and the rod *n*, and raises the cap *e* by the ascent of the beam at *a*.

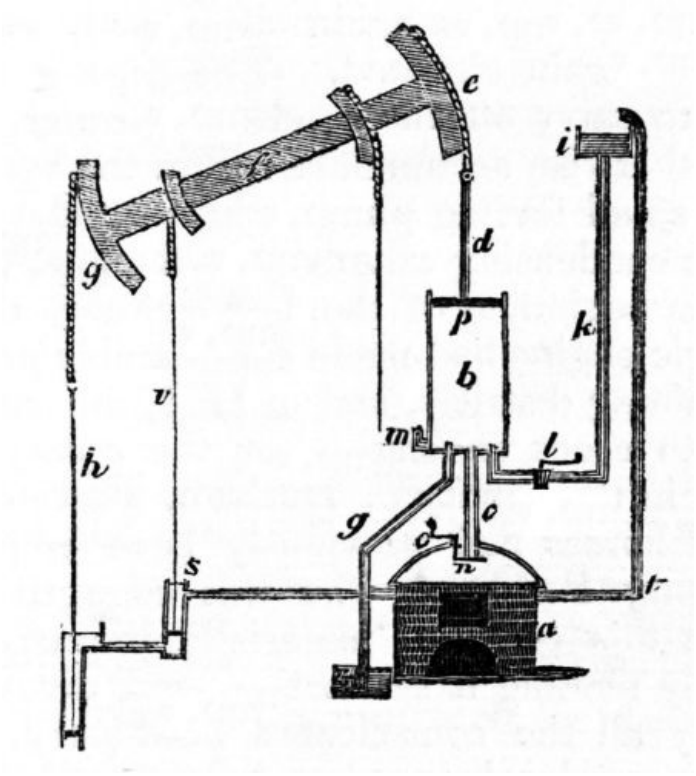
The motion thus produced in one part of the machinery, operates upon the corresponding parts on the other side, and hence a corresponding motion is obtained: the slider in the trough *v*, moved by the action of the mercurial tube *p*, being removed from its position, allows the water to fall into the other pipe *w*; and, as it ascends, suffers the float *y* to descend, and rising into the main cylinder, then lifts again the beam at *b*, and its connexions, and forces down the cap *e* on the top of the other cylinder.

When the vacuum is produced in the cylinders, the air must be admitted to allow the water to be discharged, and the caps to be raised: this is effected by a sliding valve in the air-pipe *m m*, acted upon by chains *t t*, attached to the floats in the reservoir, and as motion is given to them, the valve is made to fly backwards and forwards, so as to allow the free admission of atmospheric air.

Chains *u u*, with suspended weights, open the cocks in the pipe *k k*, and produce the alternate flow of the gas, and regulate and modify its supply. In the pipes *g i g*, and *h j h*, are clacks to prevent the return of the water, when the air is admitted into the cylinders. [115]

A piston may be worked as is above described, with the machinery attached; but it may also be worked in a distinct vessel so as to communicate with several cylinders, and, consequently, several pistons may work at the same time, the air and vacuum valves being opened and closed by similar means to those adapted to work the induction and eduction valves of steam-engines.

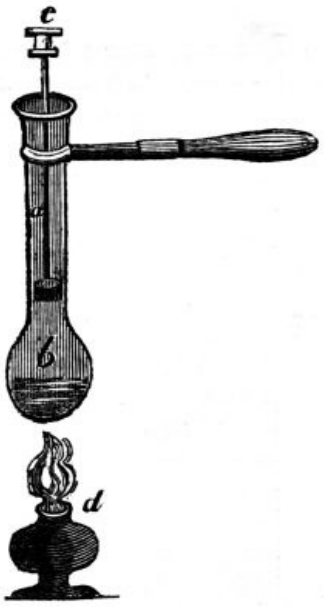
The atmospheric engine comes next in order, and its claim to practical utility is of a very early date.



The cylinder *b*, is in this engine placed over a boiler *n*, and if we suppose the piston *p* made to fit air-tight, it will be evident, that it must be driven up by the action of the steam beneath, should a sufficient supply of heat be applied; when this is effected, the condensible vapour may be reduced to its original bulk, by the introduction of water from the cistern *i*. In the working engine however, the ascent of the piston is effected by the action of the lever *e g*, acting on the fulcrum *f*. To the end *g* of this lever or working beam is attached the pump-rod *h*, and it will be evident that whenever that preponderates over the piston *p*, that the latter must be drawn up. On the readmission of the steam, a new supply of condensing water is introduced by turning the cock *l*, and the pressure of the atmosphere above the piston being unbalanced by any resistance beneath, the end *e* is again depressed, and the pump-rod again elevated. The pipe *g* is employed to carry off the condensing water, which would otherwise accumulate within the cylinder; and the small forcing pump, with its rod *v s*, supplies the condensing cistern *i*, by the pipe *t*. [116]

At the beginning of the last century, the atmospheric engine had made considerable progress in the mining districts, and in 1718, the patentees agreed to erect an engine for the owners of a colliery, in the county of Durham, where several hundred horses had previously been employed. Mr. Henry Beighton, who was engaged as an agent in this concern, materially improved the engine by making it self-acting, and divesting it of nearly all the complicated machinery, which had been previously employed for that purpose.

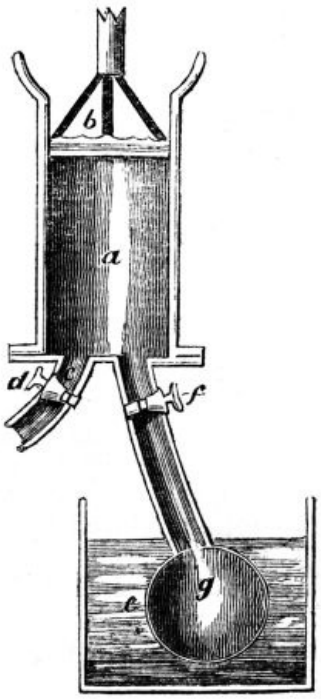
A very simple and at the same time ingenious mode of illustrating the operations of an atmospheric steam-engine will be found in the annexed apparatus, suggested by Professor Brande, and employed in his lectures at the London Institution. [117]



The glass tube and bulb *b* is shewn with its piston *a*, the rod being hollow and closed by a screw *c*. If steam be generated by the spirit lamp *d*, the air will speedily be expelled, and after this is effected, the screw *c* may be closed, and a working stroke produced by artificial condensation.

We come now to a new and distinct era in the history of this important invention, and in noticing the labours of Mr. Watt, we may almost speak of his engine as the gigantic offspring of a [118] hand giving birth to an automaton, no less powerful than that of the fabled enchanters of the olden time.

Mr. Watt's first great improvement in the engine of Newcomen may be best understood by reference to the annexed diagram, in which *a* represents the cylinder, and *b* its plug or piston made to fit air-tight. The pipe *d* is furnished with a stop-cock, by means of which the elastic vapour is occasionally admitted.—A similar pipe, furnished with a stop-cock at *f*, passes from the other side of the cylinder, and enters the vessel *g*; *e* being the reservoir to contain water.



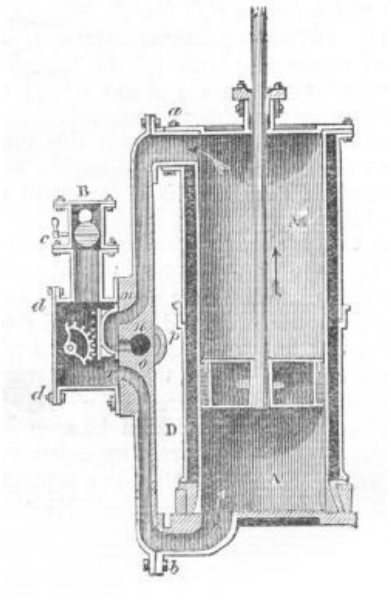
If we now suppose the piston at the bottom of the cylinder, and steam admitted by the pipe *d*, [119] its expansive force will elevate the piston, and when the air is expelled, the whole internal cavity of the tube will be filled with condensible vapour. On closing the steam-cock, and opening that connected with the vessel *g*, a portion of the vapour will immediately expand itself, and coming in contact with the cold sides of the vessel, a portion of its heat must be absorbed by the water at *e*. A new portion of steam then descends, and is also condensed, and indeed the same process continues till the whole of the steam is drawn from the tube. A vacuum being thus formed, the pressure of the atmosphere will preponderate, and the piston rod be depressed to the bottom of the tube. On closing the stop-cock *f*, a new supply of steam may be admitted by the other pipe, and after raising the piston, the process of condensation may be readily repeated.

The advantages that arise from this mode of forming a vacuum are very considerable, not the least important of which, is a saving of nearly half the fuel.

In the old engine, the condensing water must reduce the temperature of the internal surface of the cylinder to that of the atmosphere, before a vacuum could be produced, and when the condensing water was applied more sparingly, the elastic vapour remaining in the cylinder was found to materially reduce the pressure of the air operating above. From this it will be seen that the great advantage of Mr. Watt's apparatus consists in performing the condensation in a separate vessel, so that the cylinder is always preserved at the temperature of boiling water. [120]

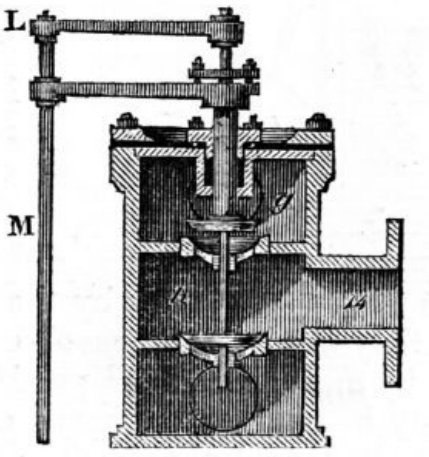
Having thus produced a vacuum without the intervention of condensing water beneath the piston, Mr. Watt's next improvement consisted in closing the top of the cylinder, so that the piston-rod worked through an air-tight hole in the centre of the cap; and to ensure the necessary pressure within the cylinder, steam with an elastic force greater than that of the atmosphere was admitted above the piston. The atmospheric engine of Newcomen was thus converted into a steam-engine, and its power was easily regulated.

A cylinder and piston constructed on the most improved principles may now be examined.



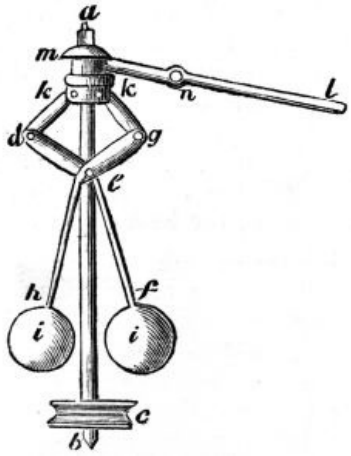
In the annexed diagram, the cylinder A is furnished with a steam-tight piston, the rod of which is supposed to be connected with the working beam. B represents the pipe which admits the steam from the boiler, the quantity being regulated by the throttle valve *c*, and the elastic vapour is now passing through the box *d d*, so that it enters beneath the piston. At the same instant of time, a communication is formed through the aperture *m n* to the pipe *p*, which leads to the condenser. When the piston reaches the top of the cylinder, the sliding bridge or valve has its direction changed, so that the pipe *r*, and consequently the bottom of the cylinder, is connected with the condenser, while a passage is opened from the pipe *m n* to the steam box. Thus a communication is alternately made between the top and bottom of the piston. [121]

The slide-valve represented above is not invariably employed in the double-acting engines, and we frequently find the annexed contrivance resorted to, in some of the best engines.



The pipe 14 represents the passage to the cylinder, and a communication is now opened with the steam chamber *g*. The raised valve is perforated and a similar valve beneath closed by the rod which passes through it. On closing the valve *g*, the lower valve *h* is opened, and a free passage between the condensing pipe beneath and the upper part of the cylinder is the result. If we now suppose a similar double valve placed at the bottom of the cylinder, it will easily be seen that an effect similar to that described in the sliding valve will be produced. [122]

The speed of the engine is regulated by a very ingenious contrivance introduced by Mr. Watt, called the *governor*, and represented beneath.



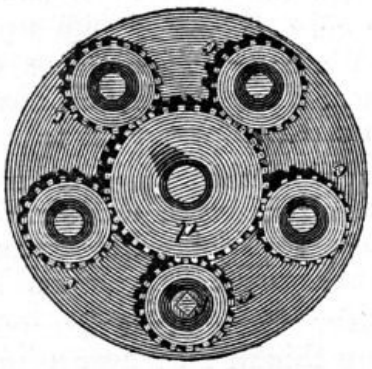
The balls *i i* are supported by the bent levers *h f*, and as they are made to revolve with the fly wheel axis, by means of a band passing round the pulley *c*, any increase in the speed of the engine will cause the balls to diverge. The moment this takes place, the shorter arm of the lever *n* [123] is depressed, and as the extremity *l* is connected with the steam-pipe by the throttle valve, the supply of steam must of necessity be diminished, and the speed of the engine reduced.

As the working power of the engine depends very materially on the accurate fitting of the piston, it may be adviseable to examine some of the modes of effecting this important object.

Mr. Smeaton, who greatly improved the atmospheric engine, coated the under side of the piston with elm or beech planks about two inches thick; the wooden bottom being screwed to the iron with a double thickness of flannel and tar, to exclude the air between the iron and the wood. By the adoption of this improvement, its property of conducting heat was reduced, and the wood having been previously jointed, with the grain radiating in all directions from the centre, was not liable to expand by the heated steam. This piston was kept air-tight by a small stream of water continually falling on its upper surface; but in Mr. Watt's engine he was compelled to make the piston fit tight without any other media than the oil that was employed to lubricate it.

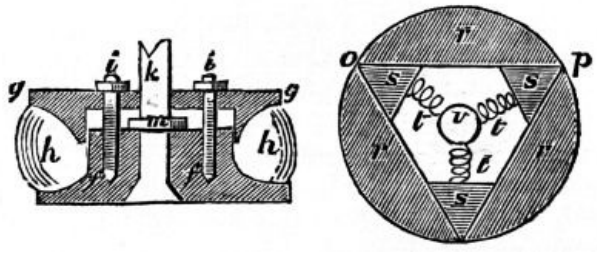
The piston is now cast with a projecting rim at bottom, which is fitted as accurately as possible; the part above the rim being about four inches less than the cylinder, thus leaving a circular groove for the hemp which forms the packing. To keep this in its place, a lid or cover is put over the top of the piston, with a projection which enters into the circular groove for the packing, and pressing upon it, the plate is forced down by screws, which work into the body of the piston. By [124] this means the packing is made to fill the internal part of the cylinder with tolerable accuracy, and thus prevents for a time any steam passing between the piston and the cylinder. When, however, by continued working, the packing ceases to fit, it occasions a waste of steam, to remedy which, the cylinder cap must be removed, and as this is attended with a considerable degree of trouble to the engine-man, it is seldom attended to till a considerable loss of power has arisen. There are two improvements on the piston, by which this inconvenience is to a certain extent obviated.

In the first, by Mr. Woolfs, each of the screws is furnished with a wheel or nut, and these are all connected together by means of a central wheel, working loose upon the piston-rod in such a manner, that if any one of the screws be turned, a similar motion is given to the remainder.



In a piston thus constructed, there is little difficulty in drawing down the packing, by applying a key to the square head of the projecting screw, employed to communicate with the rest: the key- [125] hole being afterwards closed by a cap.

The second contrivance is by Mr. Barton, a diagram of which, accompanied by a piston as it is usually constructed, is shewn beneath.

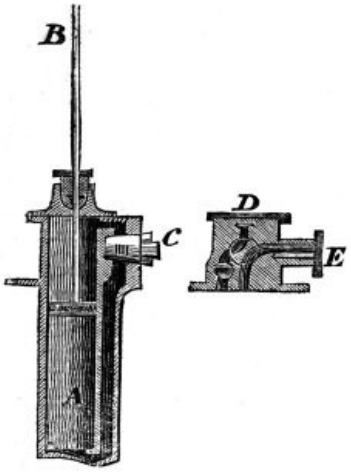


In the first piston, the screws *i i* are made to compress the packing *h h*, by acting upon the plate *n n*, the piston-rod *r* being firmly attached by the nut *c*.

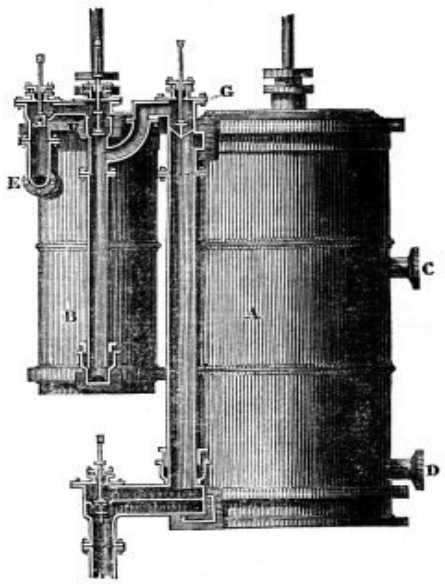
In one of the modifications of *Barton's piston*, on the contrary, the packing is dispensed with, as the flexible springs *t t t* press upon the wedges *c c c*, and expand the intermediate plates. A break-joint is readily formed, by making the series of plates double; the second set of plates falling upon the spaces which occur between the first row.

The action of the *high pressure* engine depends upon the great elastic force acquired by steam, when exposed to the action of heat at very high temperatures.—It may indeed be considered as a return to the principle of Brancas and the Marquis of Worcester, as in this engine no condensing water is necessary; and it acts merely by the elastic or repellant force of steam. In the high [126] pressure engine, the condenser is taken away; and the steam, instead of being converted into water by artificial cold in a close vessel, is allowed to escape into the atmosphere from one side of the piston, while it is acting forcibly on the other.

The advantages of the high pressure engine over that used with a condenser, are cheapness in construction, and a saving of the whole expense attendant on procuring a sufficient supply of condensing water, which in some cases is an object of considerable importance.



In the annexed section, the piston *B* passes through an air-tight stuffing box, and the steam is entering beneath it, by the four-way cock *E*. If we now suppose the piston at the top of the cylinder, a new arrangement of the communicating pipe takes place, as the steam which was [127] beneath escapes, while a fresh supply enters above. The four-way cock may be best explained by a section in the opposite direction. Two pipes are seen at the lower extremity of the cock, which communicate with the upper and under sides of the piston. The aperture *D* opens to the air, while the pipe *C* serves for the admission of steam from the boiler.

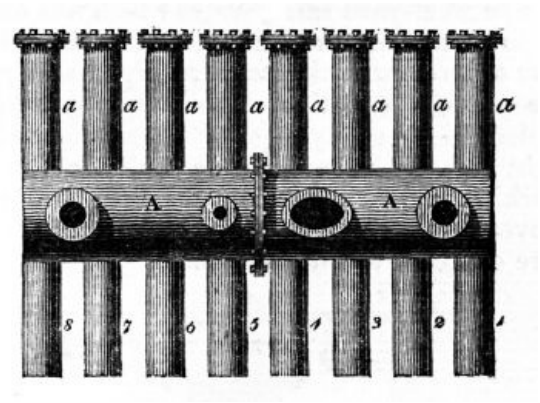


We have now to notice the double cylinder engine constructed by Woolfs, which will be found, [128]

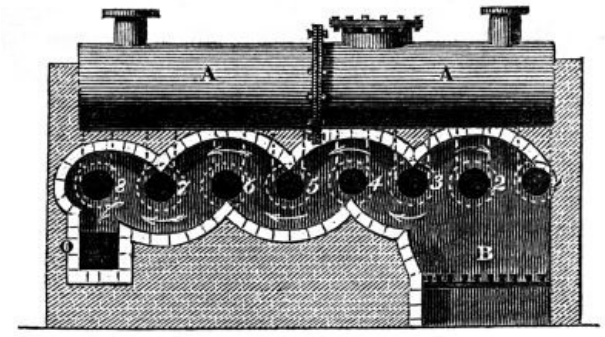
by reference to the diagram in the preceding page, to consist of a high pressure cylinder, connected with a condensing apparatus.

A and B represent the two cylinders, in the larger of which the steam is allowed to expand itself, after passing from the high pressure cylinder B. The steam, which in the first instance is of considerable elasticity, is admitted to the cylinder B, by the tube and valve E, and entering the cylinder above its piston, impels it to the bottom. When this is effected, a communication is opened between the upper part of the cylinder B, and the under side of the cylinder A. The communication between the cylinder B and the steam-pipe E, is now reversed, and the steam is made to press on the under side of the piston B, a communication being at the same time formed between the upper part of the cylinder A, and the pipe leading to the condenser which is seen beneath. So that if we suppose the two pistons connected by means of their rods with one end of an ordinary working beam, the upward and downward strokes of each will be performed at the same time. We have hitherto considered the steam as passing direct from the boiler to the cylinder B; this, however, is in reality effected by a more circuitous route, as it is in the first instance admitted to the steam-case of the larger cylinder by the pipe C, and passing round a similar case, encircling the cylinder B, it is then made to enter at E. The pipe at D is merely intended to form a communication for carrying back to the boiler any water that may be [129] produced by condensation in the steam-case, before the engine arrives at a proper temperature for working.

Having thus briefly examined the nature of Mr. Woolf's engine, it may now be advisable to revert to the boiler, by which he proposes to generate steam of sufficient elasticity for the use of the small cylinder, which requires elastic vapour of great expansive force. The boiler, represented by the diagram beneath, consists of a series of tubes, of cast-iron, connected by screw-bolts with the under side of a larger vessel A A, communicating with the engine. The upper boiler is furnished with four, and in some cases, with five apertures; the first of which is intended for the admission of water, to supply the waste which continually arises from evaporation. The safety valves, man-hole, and water-pipe are also shewn.

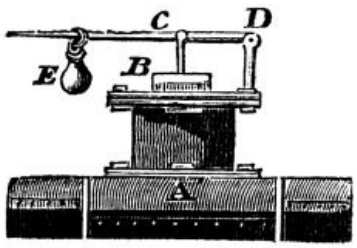


The mode of setting this boiler is also of considerable importance, as it is advisable to give a [130] long and waving course to the chimney.



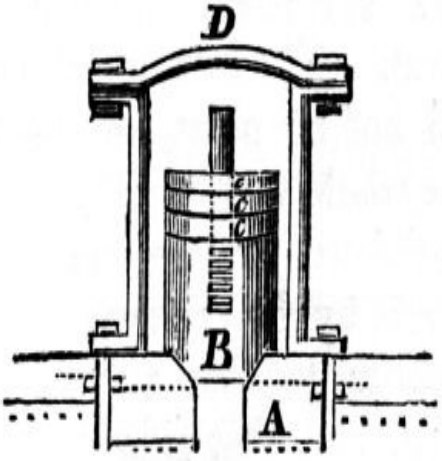
A A still represents the principal boiler, while the figures 1, 2, 3, &c. indicate the passage of the flame and heated air; a section of the chimney being shewn at O.

The steel-yard safety-valve which was employed in all the early engines is simple, and the nature of its construction may readily be understood. A represents a portion of the upper part of the boiler; B the safety-valve or plug made to fit air-tight on the valve-seat beneath; C the lever working on its axis at D, and furnished with a moveable weight E, adjusted to balance the pressure of steam within the boiler.



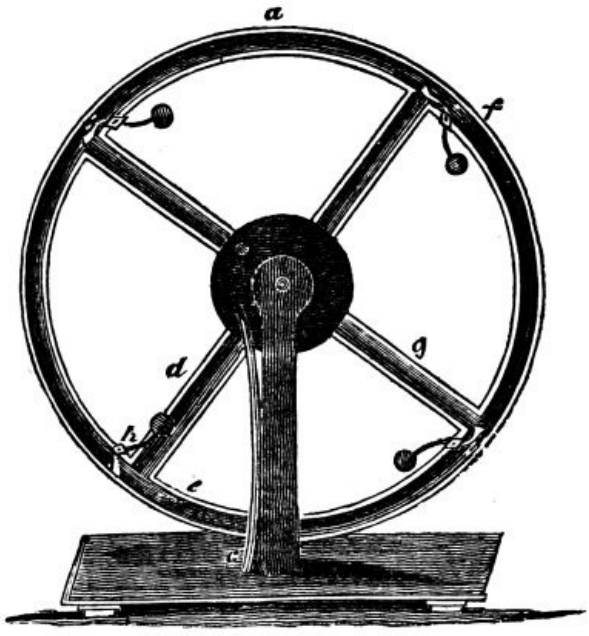
When steam of great elasticity is required, the weight is placed at the extremity of the lever, and as such, acts with greater force on the safety-valve, than when removed to a point nearer to the axis on which it revolves: so that should *low* pressure steam, or that which has a less expansive force, be required, it will only be necessary to remove it nearer towards the axis on which it turns. [131]

The lever and balance-ball safety valve already described, appear but little calculated for those engines in which high pressure steam is employed, as the engine-man, in an over anxious zeal for the full performance of the machinery confided to his care, has been frequently known to increase the internal pressure of a large boiler many thousand pounds beyond the resistance to which it was originally proved. To prevent a recurrence of those accidents, which first drew the attention of the legislature to this important part of the engine, it appears advisable to inclose the safety-valve in an iron case, of which a section is annexed.



The valve *B* in this case rests upon a conical seat in the boiler *A*, and is furnished with a series of small moveable plates lettered *c*, which are employed to increase or diminish the entire weight of the safety-valve, the whole being covered by the box *D*; and as this is pierced with a number of small holes, the steam readily escapes when the expansive force exceeds the resistance offered by the loaded valve. [132]

The patent *revolving wheel* invented by Mr. Masterman, appears to promise the best results of any rotatory engine yet invented, the friction being much less than in any other apparatus in which steam is employed as a prime mover. In this engine, Mr. Masterman proposes to employ water, or the fluid metal mercury as the immediate agent, which he effects by inclosing it in the tubular rim of a large wheel, furnished with valves opening in one direction. This wheel, as is shewn in the opposite diagram, is made to revolve on a hollow axis connected with the steam boiler. The arms or spokes which radiate from the axis are also hollow; and on the admission of steam from the boiler, it is conducted through the arm immediately opposite, and entering the rim of the wheel, comes in contact with, and presses against the column of water beneath and the closed valve above the arm. The water being previously heated to the boiling point, no condensation ensues, but the whole weight of water, which was previously balanced in two columns of equal height, is driven, by the pressure of the steam, to the side opposite to that at which the elastic vapour entered, and that side of the wheel will necessarily preponderate. If this process be repeated, the steam being allowed to blow through each radiating arm in succession, a continuous rotatory motion will be produced. Should it be advisable to employ steam of less elasticity, a condenser may be added, and that too without materially increasing the expense. [133]



The application of steam-engines to the *propelling* of *carriages* on the public road, has hitherto been considered as a refinement in mechanics, rather to be wished for than a matter of reasonable expectation. The *locomotive* engine was first employed for this purpose by Messrs. Trevithick and Vivian, in 1802; and it found a ready introduction to the mining districts where rail-roads are general. In some cases, five, six, and even ten waggons laden with coal are dragged up an inclined plane by means of these vehicles; and of course impelled by a high pressure [134]
engine, from the utter impossibility of carrying condensing water in a moveable vehicle.

An engine of four horses' power, employed by Mr. Blenkinsop, impelled a carriage lightly loaded on a rail-road at the rate of ten miles an hour, and when connected with thirty coal waggons, each weighing more than three tons, its average rate was about one-third of that pace.

When the locomotive engine was first tried, it was found difficult to produce a sufficient degree of re-action between the wheels and the tract road; so that the wheels turned round without propelling the vehicle. This inconvenience was, however, obviated by Mr. Blenkinsop, who, when he adopted the locomotive engine, took up the common rails, on one side of the whole length of the road, and replaced them by a series of racks, or rails, furnished with large teeth. The impelling wheel of the engine was made to act in these teeth, so that it continued to work in a rack which insured a sufficient degree of re-action.

From the great weight of an ordinary *locomotive engine* as well as the construction of its impelling wheel, it must be evident that the employment of this species of prime mover on the public roads would be in the highest degree destructive; and as such that its use will for some years to come be partially confined to the mining districts, in which the greatest facilities are offered for its general adoption. Indeed, we find in one neighbourhood alone, and within a space of less than thirty square miles, more than twenty miles of road admirably adapted for this species of conveyance; and it is a well known fact, that there are many situations in which iron [135]
rail-roads might be advantageously employed, in which it would be quite impossible to open a navigable canal. In illustration of the above fact, it may be proper to state, that a company, with a large capital, is now forming for the express purpose of facilitating the conveyance of goods by locomotive engines.

The mode of applying the steam-engine to the purposes of navigation is equally simple with its employment in our manufactures.

It is generally supposed that the *steam-boat* is of very recent invention; on the contrary, however, the possibility of employing steam as a prime mover in the propelling of vessels was suggested as far back as the reign of Charles I.

In one of the old tracts preserved in the library of the London Institution there is a very curious representation of a steam-boat, constructed by an engineer of the name of Hulls. And this individual, now so little known, was undoubtedly the first who applied a steam-engine to the purpose of navigation.

To impel a vessel by this means, two paddle wheels, like those used in an under-shot water-wheel, are connected by means of a long axis and crank, with the working beam of the steam-engine; and if this motion is not found sufficiently rapid, a wheel and pinion are added, which, although it *decreases* the effective power of the engine, yet *increases* the velocity of the paddle wheels.

To illustrate the great advantages possessed by the steam-engine, even in its rudest state, over [136]
every other species of prime mover yet enumerated, it may now be advisable to examine its effective force when employed in the working of pumps. It has been found that one hundred weight of coals burned in an engine on the old construction, would raise at least *twenty thousand cubic feet* of water twenty-four feet high; an engine with a twenty-four inch cylinder doing the work of *seventy four horses*. An engine on Capt. Savery's plan, constructed by Mr. Keir, has been found to raise nearly *three millions* of pounds of water, and Mr. Watt's engine, upwards of *thirty millions* of pounds the same height.

To the mining interests this valuable present of science to the arts has been peculiarly acceptable; as a large portion of our now most productive mineral districts must long ere this have been abandoned, had not the steam-engine been employed as an active auxiliary in those stupendous works. In the draining of fens and marsh lands, this machine is in the highest degree valuable; and in England, particularly, it might be rendered still more generally useful. In practice it has been ascertained that an engine of six-horse power will drain more than eight thousand acres, raising the water six feet in height; whilst the cost of an engine for this species of work, including the pumps, will not exceed seven hundred pounds. This is more than ten windmills could perform, at an annual expenditure of several hundred pounds; while, in the former case, the outgoings will not exceed one hundred and fifty pounds per annum. To the mariner also, the steam-engine offers advantages of a no less important and novel nature than [137]
those which have already been described. By its use he is enabled to traverse the waters both against wind and tide, with nearly as much certainty, and, as the machinery is now constructed, with much less danger, than by the most eligible road conveyance. It too frequently, however, happens that the faults of any new invention are unjustly magnified, while its real advantages are seldom duly appreciated; and this axiom has been fully verified, in the clamour so unjustly raised against the application of the steam-engine to nautical purposes. Accidents are now, however, but of rare occurrence; and it is more than probable, that the great improvements which have been made in the boiler and safety-valve will effectually secure these parts of the engine from a recurrence of such tremendous explosions as characterised the first introduction of steam navigation. And, lastly, the political economist must hail with the most heartfelt gratification, the

introduction of so able and efficient a substitute for animal labour as the steam-engine. For it has been calculated that there are at least ten thousand of these machines at the present time at work in Great Britain, performing a labour more than equal to that of two hundred thousand horses, which, if fed in the ordinary way, would require above one million acres of land for subsistence; and this is capable of supplying the necessaries of life to more than fifteen hundred thousand human beings.[11]

An ingenious foreigner, who lately visited England, has published an estimate of the mechanical force set in action by the steam-engines of this country. [138]

He supposes that the *great pyramid* of Egypt required for its erection the labour of more than 10,000 men for 20 years:—but if it were required again to raise the stones from the quarries, and place them at their present height, the action of the steam-engines of England, which are managed at most by 36,000 men, would be sufficient to produce the same effect in 18 hours.

THE END.

LONDON:
PRINTED BY C. ROWORTH, BELL YARD,
TEMPLE BAR.

FOOTNOTES:

[1] Some idea of the almost REGAL splendour of the noble possessor of Ragland castle at this period, and an interesting picture of baronial manners in the early part of the seventeenth century, may be found in the following authentic document, which has been accurately copied from the original MS.

LIST OF THE HOUSEHOLD, &C.

At eleven o'clock in the forenoon the castle gates were shut, and the tables laid, viz. two in the dining-room, three in the hall, one in Mrs. Watson's apartment, where the chaplains eat, (Sir Toby Matthews being the first,) and two in the house-keeper's room, for the ladies women.

The EARL entered the dining-room attended by his gentlemen.

As soon as he was seated, Sir Ralph Blackstone, steward of the house, retired.

The comptroller, Mr. Holland, attended with his staff, as did the sewer, the daily waiters, and many gentlemen's sons, with estates from two to seven hundred pounds a year, who were bred up in the castle: and my lady's gentlemen of the chamber.

At the first table, sat

The noble family, and such of the nobility as came there.

At the second table, in the dining-room, sat

Knights and honourable gentlemen, attended by footmen.

In the hall, at the first table, sat

Sir Ralph Blackstone, Steward—The Comptroller. The Secretary—The Master of the Horse—The Master of the Fish Ponds, my Lord Herbert's preceptor, with such gentlemen as came there under the degree of a knight, attended by footmen, and plentifully served with wine.

At the second table in the hall, served from my Lord's table, and with other hot meats, sat

The Sewer, with the gentlemen waiters, and pages, to the number of twenty-four.

At the third table in the hall, sat

The Clerk of the Kitchen, with the yeomen, officers of the house, two grooms of the chamber, &c.

The other officers of the household, were

Chief Auditor—Clerk of the Accounts—Purveyor of the Castle—Ushers of the Hall—Closet Keeper—Gentlemen of the Chapel—Keeper of the Records—Master of the Wardrobe—Master of the Armoury—Twelve master Grooms of the Stables, for the War horses—Master of the Hounds—Master Falconer—Porter and his man—two keepers of the Home Park—two keepers of the Red deer Park—and footmen, grooms, and other menial servants, to the number of *one hundred and fifty*!

[2] His lordship was created Earl of Glamorgan a few days prior to his departure for Ireland, and Carte, who in every point in which Charles was concerned, invariably concealed whatever tended to cast a stain on the king's character, and whose gross partiality in this particular instance we shall hereafter more fully notice, has even questioned the propriety of the Marquis's assuming the title of Earl of Glamorgan. To support this argument, it is said that his Majesty ordered Secretary Nicholas to acquaint the Earl of Ormonde, "that, the patent for making Lord Herbert Earl of Glamorgan had never passed the great seal;" and the apologist for Charles, anxious to make the most of this equivocation in the king, adduces it as an objection to the authenticity of the Irish

commission. Sandford, however, who in an intimate acquaintance with the history of the royal grants was surpassed by none, says, "that there now remains in the signet office a bill, under the royal sign manual at Oxford, if a patent did not thereupon pass the great seal, in order to his creation into the honour of Earl of Glamorgan."

[3] There is scarcely to be found on record, a more enthusiastic instance of loyalty and self-devotion than was exhibited by his lordship on this occasion; for with the damning proofs which he then possessed of his Majesty's complete concurrence and participation in the whole matter, there could not for an instant have been a doubt of his own honourable acquittal. There was also a certain assurance of procuring the favour of the Parliament: who required nothing more than these documents to colour the proceedings they were then meditating, and which, indeed, afterwards formed one of the principal charges against this ill-fated monarch.

[4] Lord Orford describes this bill to have passed on the "simple affirmation of the discovery that he (the Marquis) had made;" but his lordship's palpable want of candour in this statement will be apparent when it is known that there were no less than seven meetings of committees on the subject, composed of some of the most learned men in the house, who, after considerable amendments, finally passed it on the 12th of May.—Vide, *Journals of the Lords and Commons for 1663-4*.

[5] A popular author, to one of whose mistatements we alluded in a preceding note, describes the Marquis as "a fantastic projector," and his "Century as an amazing piece of folly." Having however, in the notes appended to this work, fully demonstrated not only the practicability of applying the major part of the inventions there described, but the absolute application of many of them, though under other names, to some of the most useful purposes of life; we shall leave it to the public to judge, whether the man who first discovered a mode of applying steam as a mechanical agent, an invention alone sufficient to immortalize the age in which he lived, deserves the name of a fantastic projector.

The second edition of the "Century" was published in 1746; the third in 1767: while the fourth, which may be considered as the best edition, is a reprint from the first, and is furnished with an appendix "containing an Historical Account of the Fire Engine for Raising Water." It is dated Kyo, near Lancaster, June 18, 1778. The fifth is a reprint from the Glasgow copy, "by W. Bailey, Proprietor of the Speaking Figure, now showing, by permission of the Right Hon. the Lord Mayor, at No. 42, within Bishopsgate," 1786. The sixth edition was confined to 100 copies, and dated London 1813.

[6] The above Letter, as appears by the envelope, was directed to his Grace the Duke of Albermarle.

[7] CHARLES V., after his abdication, retired to the monastery of St. Justus, in Estramadura, where he amused himself, during the latter period of his life, in the making of automatons, in which he was assisted by a very ingenious artist named Turriano.

[8] History of Inventions, vol. iii. p. 326.

[9] *Vide* Historical and Descriptive Account of the Steam-engine, by C. F. Partington, p. 6.

[10] Since writing the above, the Editor has seen a report on Mr. Brown's engine by Professor Millington, in which it is distinctly stated that the apparatus is fully adapted to the purpose for which it is intended.

[11] *Vide* Historical Account of the Steam-engine, by C. F. Partington.

Transcriber's note:

Minor typographical and punctuation errors have been corrected without note. Irregularities and inconsistencies in the text have been retained as printed.

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On pages 84 and 85 there are two items both of which are numbered LXXXVIII. The table of contents reflects the same.

In the table of contents the following page numbers have been changed to match the book:

Page lxxxii:
33. A Needle Alphabet—39 changed to 38
38. A Sieve Alphabet—ibid. changed to 41

Page lxxxiv:
79. A total locking of Cabinet Boxes—78 changed to 77
80. Light Pistol Barrels—ibid. changed to 78

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