CHAPTER II.

INVENTIONS OF THE MARQUIS OF WORCESTER, AND COUNCILLOR ORFFIREUS.

EDWARD SOMERSET, sixth Earl and second Marquis of Worcester, born at Ragland, near Monmouth, author of the "Century of Inventions," was much distinguished in his youth by King Charles I., during several visits he made to Ragland Castle, and who subsequently appointed him Lord-Lieutenant of North Wales, addressing him as Earl of Glamorgan, until he succeeded to his heritable honours. Walpole has been justly censured for describing him as "a fanatic projector," and his "Century" as "an amazing piece of folly." He died in retirement near London, 1667, in reduced circumstances.

The following is the fifty-sixth article transcribed from the manuscript of the "Century of Inventions," dated 1659, and indexed therein as "An advantageous change of centers:"—

56. To prouide and make that all y^e^ weights of y^e^ defcending syde of a wheele shal be perpetually further from y^e^ center, then thofe of y^e^ mounting syde, and yett equall in number and heft of y^e^ one syde as y^e^ other. A most incredible thing if not seene, butt tryed before y^e^ late King of happy and glorious memorye in y^e^ Tower by my directions, two Extra-ordnary Embaffadors accompanying his Ma^tie^ and y^e^ D. of Richmond, D. Hamilton, and most part of y^e^ Court attending him. The wheele was 14 foote ouer, and 40 weights of 50 p^d^ apiece; S^r^ Wm. Belford, then Lieu^t^ of y^e^ Tower, and yet liuing can justify it with seuerall others; They all saw that noe sooner these great weights passed y^e^ Diameter Line of y^e^ vpper syde but they hung a foote further from y^e^ center,

nor no sooner passed the Diameter line of the lower syde, butt they hung a foote nearer; bee pleased to judge y^e^ consequence.*

Note on above, from an edition of the "Century of Inventions," edited by Charles F. Partington. 1825:—

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 inner 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

* See Harleian MS., No. 2,428, in the British Museum.

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.

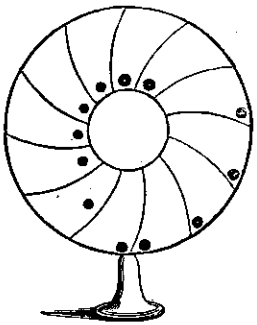
Mr. Partington, in his "Manual of Natural Philosophy," writes as follows on Perpetual Motion:—

Having taken a brief review of the simple machines which are usually considered under the general character of mechanical powers, it may now be advisable to examine how far a combination of these powers can tend towards producing a perpetual motion. There are few subjects, indeed, that have more engaged the attention of the mechanical world in every age, than the solution of this apparently difficult problem; and their repeated failure has been no bar to renewed attempts.

It may, indeed, be demonstrated that a perpetual motion is impossible, at least by the ordinary laws of nature; for to be possible, it is necessary that the effect should become alternately the cause, and the cause the effect. It would be necessary, for example, that a weight raised to a certain height by another weight, should in its turn raise the second weight to the height from which it descended. Now this we know to be impossible.

Amongst the various attempts at a perpetual motion, that of a circular wheel, described by the Marquis of Worcester and Orffyreus, offered at first view the greatest chance of success.

The Marquis of Worcester's account of a perpetual motion occurs in the fifty-sixth article of his "Century of Inventions."*



In this cylindrical wheel, or drum, are formed channels, containing balls of lead, which alternately approach and recede from the centre; and it would seem, upon the principle of the lever, that as the weights are always further from the centre on one side than on the other, a continuous rotatory motion must be produced.

But, notwithstanding the specious appearance of this reason-

* See preceding article.

ing, experience has proved that the machine will not turn perpetually; and it will be seen, on inspection, that, though some of the weights are more distant from the centre than others, yet there is always a proportionably smaller number of them on the side at which they have the greatest power, so that these two circumstances precisely counterbalance each other.*

The Marquis's wheel will be found often referred to in notices occurring in succeeding pages; indeed, the invention and its ingenious author are sufficiently remarkable, no one having been able to reproduce a wheel possessing the precise properties he mentions, or satisfactorily contradict the statement he has made.

The only other invention we have here to consider is the celebrated one constructed by Jean Ernest Elie-Bessler ORFFYRE or ORPHYREUS, who is usually named Orffyreus when noticed in English and German† works on mechanics. He was born in 1680, near Zittan, in the department of Alsace, France, and early studied theology and medicine, but his erratic genius was only to be satisfied by engaging himself in the pursuit of a variety of the mechanical arts and painting. He asserts that it was during his search for whatever might prove curious and valuable that he discovered Perpetual Motion, and between the years 1712 and 1719, made two machines on his system; one he desired to exhibit publicly, but broke it up rather than submit to the payment of the licence or tax required by the Government of Cassel; the other he destroyed after its having been unfavourably reported on by M.'S Grævesande. He published, in German and Latin, a book, or pamphlet, entitled "Le Mouvement Perpétuel Triomphant," quarto, dated Cassel, 1719.‡

* A Manual of Natural and Experimental Philosophy. By Charles F. Partington. 8vo.

† Leupold styles him Herr Rath Orffyreus, he being one of the Councillors to the Prince of Hesse Cassel. [See Appendix A.]

‡ See Dezobry and Bachelet's Dictionnaire Générale de Biographie, &c. Paris, 1857. Royal 8vo.

Other accounts differ, as will presently appear, respecting the breaking of the second machine; and, on insufficient authority, Mr. Partington styles him a "German mechanic." Dr. William Kenrick, among his miscellaneous works, wrote "An Account of the Automaton, or Perpetual Motion of Orffyreus, with additional remarks," in editions dated 1770 and 1771. Orffyreus died November, 1745.

We shall now proceed to give notices and attempted refutations of his and supposed like inventions.

The "Annual Register" for 1763 gives the following interesting correspondence about Orffyreus and his wheel:—

On the possibility, and use towards finding the longitude, of a Perpetual Motion.

SIR,—The "Utrecht Gazette" some time since informed us, "that a mechanic of East-Friesland hath invented a machine, which, being once put in motion, keeps perpetually going till such time as the materials of which it is composed are fallen to decay, or the structure of the machine itself is altered." To this account some blundering news-writer, I suppose, has added the following reflection: "If this be true, we have here a discovery of the longitude under all the variations of climes, seasons, weather, &c., an invention which the great Leibnitz and Bernouilli thought as impossible as the squaring of the circle, or the discovery of an universal panacea." Now, Sir, whether the information contained in the above article be true or false, or whether such a discovery be practicable or only chimerical, certain it is we should be no otherwise benefited by, in regard to the longitude, than as it might be productive of a time-keeper, that would not want winding up. It is, however, an equable as well as a constant motion, that is wanted to determine the longitude; so that every such machine must be regulated by a pendulum, and would then, as well as in other respects, be subject to the variations of climes and seasons. Again, the reflector is mistaken in saying that both Leibnitz and Bernouilli thought this discovery impossible. The former, indeed, constantly affirms its impossibility; and yet in his disputes with Papin, published in the "Acta Lipsiensia," he declares, that if the force of a body in motion be in a direct

proportion to its velocity (as it is now universally known to be) a perpetual motion must be possible. And with regard to Bernouilli, you may find in the first volume of his works, page 41 *& seq.*, that he not only declares it to be possible, but also that he had actually conceived a method whereby it might be rendered practicable. De la Hire and other eminent mathematicians pretend, indeed, to have demonstrated the impossibility of such a discovery. But it is certain that others have not thought those demonstrations applicable to all possible machines. Among these may be mentioned the late Professor 'S Gravesande of Leyden, undoubtedly one of the first mathematicians, and as well versed in geometry and mechanics as any man of his time. Yet this gentleman wrote a treatise professedly to prove the possibility in question; nay, it appears that he went so far as to think it had been actually discovered in the machine of Orfyreus, that made such a noise at Hesse Cassel about forty years ago; and which he examined at the desire of the landgrave, with the utmost care and attention. Indeed, I cannot help thinking that the dispute subsisting between the philosophers concerning the momenta of moving bodies, which was at that time at its highest warmth, prevented that machine from being so much attended to as it deserved. In this opinion also I am strongly confirmed by a letter, written by that professor to Sir Isaac Newton on the subject of that machine; which letter, as I know not where it is to be found in the English language, I have translated from the French,* for the information or entertainment of your readers:—

A Letter from Professor 'S Gravesande to Sir Isaac Newton, concerning Orfyreus's Wheel.

Sir,—Doctor Desaguliers has doubtless shown you the letter that Baron Fischer wrote to him some time ago, about the wheel of Orfyreus; which the inventor affirms to be a perpetual motion. The landgrave, who is a lover of the sciences and fine arts, and neglects no opportunity to encourage the several discoveries and improvements that are presented him, was desirous of having this machine made known to the world, for the sake of public utility. To this end he engaged me to examine it; wishing that, if it should be

* Printed in the "Mercure Historique et Politique," September, 1721.

found to answer the pretensions of the inventor, it might be made known to persons of greater abilities, who might deduce from it those services which are naturally to be expected from so singular an invention. You will not be displeased, I presume, with a circumstantial account of this examination; I transmit you therefore a detail of the most particular circumstances observable on an exterior view of a machine, concerning which the sentiments of most people are greatly divided, while almost all the mathematicians are against it. The majority maintain the impossibility of a perpetual motion, and hence it is that so little attention hath been paid to Orfyreus and his invention.

For my part, however, though I confess my abilities inferior to those of many who have given their demonstrations of this impossibility; yet I will communicate to you the real sentiments with which I entered on the examination of this machine. It is now more than seven years since I conceived I discovered the paralogism of those demonstrations, in that, though true in themselves, they were not applicable to all possible machines; and have ever since remained perfectly persuaded, it might be demonstrated that a perpetual motion involved no contradiction; it appearing to me that Leibnitz was wrong in laying down the impossibility of the perpetual motion as an axiom. Notwithstanding this persuasion, however, I was far from believing Orfyreus capable of making such a discovery, looking upon it as an invention not to be made (if ever) till after many other previous discoveries. But since I have examined the machine, it is impossible for me to express my surprise.

The inventor has a turn for mechanics, but is far from being a profound mathematician, and yet his machine hath something in it prodigiously astonishing, even tho' it should be an imposition. The following is a description of the external parts of the machine, the inside of which the inventor will not permit to be seen, lest any one should rob him of his secret. It is an hollow wheel, or kind of drum, about fourteen inches thick, and twelve feet diameter; being very light, as it consists of several cross pieces of wood framed together; the whole of which is covered over with canvas, to prevent the inside from being seen. Through the centre of this wheel or drum runs an axis of about six inches diameter, terminated at both ends by iron axes of about three-

quarters of an inch diameter upon which the machine turns. I have examined these axes, and am firmly persuaded that nothing from without the wheel in the least contributes to its motion. When I turned it but gently, it always stood still as soon as I took away my hand; but when I gave it any tolerable degree of velocity, I was always obliged to stop it again by force; for when I let it go, it acquired in two or three turns its greatest velocity, after which it revolved for twenty-five or twenty-six times in a minute. This motion it preserved some time ago for two months, in an apartment of the castle: the door and windows of which were locked and sealed, so that there was no possibility of fraud. At the expiration of that term indeed his serene highness ordered the apartment to be opened, and the machine to be stopped, lest, as it was only a model, the parts might suffer by so much agitation. The landgrave being himself present on my examination of this machine, I took the liberty to ask him, as he had seen the inside of it, whether, after being in motion for a certain time, no alteration was made in the component parts; or whether none of those parts might be suspected of concealing some fraud: on which his serene highness assured me to the contrary, and that the machine was very simple.

You see, Sir, I have not had any absolute demonstration, that the principle of motion which is certainly within the wheel, is really a principle of perpetual motion; but at the same time it cannot be denied me that I have received very good reasons to think so, which is a strong presumption in favour of the inventor. The landgrave hath made Orfyreus a very handsome present, to be let into the secret of the machine, under an engagement nevertheless not to discover, or to make any use of it, before the inventor may procure a sufficient reward for making his discovery public.

I am very sensible, Sir, that it is in England only the arts and sciences are so generally cultivated as to afford any prospect of the inventor's acquiring a reward adequate to this discovery. He requires nothing more than the assurance of having it paid him in case his machine is found to be really a perpetual motion; and as he desires nothing more than this assurance till the construction of the machine be displayed and fairly examined, it cannot be expected he should submit to such examination before such assurance be given him. Now, Sir, as it would conduce to public utility, as well as to

the advancement of science, to discover the reality or the fraud of this invention, I conceive the relation of the above circumstances could not fail of being acceptable. I am, &c.

Nothing can be more in favour of Orfyreus than this testimony of Mr. 'S Gravesande; so that, on a supposition that the Gazette-writer of Utrecht hath not imposed upon us, the East-Frieslander hath probably done no more than Orfyreus did before him; the world having been so long deprived of the advantages that must necessarily attend the publication of such a discovery, from the effects of a mistaken prejudice, equally destructive to the improvement of the arts and sciences, as to the happiness of mankind.*

The following remarks of Dr. Desaguliers on Perpetual Motion, in the thirty-first volume of the "Philosophical Transactions," are repeated in the first volume of his "Course of Experimental Philosophy," and are thus introduced:—

14. [70.—Pretenders to perpetual motions, and those who promise greater effects by machinery than is conformable to the reciprocal proportion between the intensities of the powers and weights, and their velocities.] About the year 1720 and 1721, the late John Rowley, mathematical instrument maker, talk'd so much of the wheel which he had seen at Hesse-Cassel (which he believed to be a perpetual motion, as well as a great many persons in that country) that besides the common herd of Perpetual Motion men, which every age affords, some very ingenious men made an attempt that way, and were countenanc'd in it by some great mathematicians, who, when the scheme was laid before them, declar'd they knew no reason why it should not do. But as I always declar'd against all projects tending that way, I was desir'd at that time to publish my reasons why the thing seem'd impossible or impracticable; which I did in the "Philosophical Transactions" (No. 369) in such a manner as might dissuade people at first from any such attempts, in which so much time and money have been lost. I have here printed the whole account again.†

* The Annual Register, for the year 1763, vol. 6, pp. 126-128.

† A Course of Experimental Philosophy. By J. T. Desaguliers, LL D., F.R.S. 2 vols. 4to. Second Edition, 1745. Vol. 1, p. 183.

[The annexed paper, from the "Philosophical Transactions," is the one above-named:—]

Remarks on some Attempts made towards a Perpetual Motion; by the Reverend Dr. Desaguliers, F.R.S.

The wheel at Hesse-Cassel, made by Monsieur Orfireus, and by him called a perpetual motion, has of late been so much talk'd of, on account of its wonderful phænomena, that a great many people have believed it to be actually a self-moving engine; and accordingly have attempted to imitate it as such. Now, as a great deal of time and money is spent in those endeavours, I was willing (for the sake of those that try experiments with that view) to shew that the principle which most of them go upon is false, and can by no means produce a perpetual motion.

They take it for granted, that if a weight descending in a wheel, at a determined distance from the centre, does in its ascent approach nearer to it; such a weight in its descent will always preponderate, and cause a weight equal to it to rise, provided it comes nearer the centre in its rise; and accordingly as itself rises, will be overbalanced by another weight equal to it; and therefore they endeavour by various contrivances to produce that effect, as if the consequence of it would be a perpetual motion.

But I shall shew that they mistake one particular case of a general theorem, or rather a corollory of it, for the theorem itself. The theorem is as follows:—

THEOR.—If one weight in its descent does by means of any contrivance cause another weight to ascend with a less momentum or quantity of motion than itself, it will preponderate and raise the other weight.

COR. 1.—Therefore if the weights be equal, the descending weight must have more velocity than the ascending weight, because the momentum is made up of the weight multiplied into the quantity of matter.

COR. 2.—Therefore if a leaver or balance have equal weights fasten'd or hanging at its ends, and the brachia be ever so little unequal, that weight will preponderate which is farthest from the centre.

SCHOLIUM.—This second corollary causes the mistake; because those, who think the velocity of the weight is the line it describes, expect that that weight shall be overpois'd,

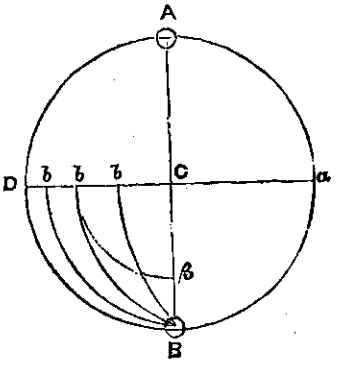
which describes the shortest line, and therefore contrive machines to cause the ascending weight to describe a shorter line than the descending weight. As for example, in the circle A D B *a* (Fig. 3) the weights A and B being supposed equal, they imagine, that if (by any contrivance whatever) whilst the weight A describes the arc A *a*, the weight B is carried in any arc, as B *b*, so as to come nearer the centre in its rising, than if it went up the arc B D; the said weight shall be overpois'd, and consequently, by a number of such weights, a perpetual motion will be produced.

This is attempted by several contrivances, which all depend upon this false principle; but I shall only mention one, which is represented by Fig. 4, where a wheel having two parallel circumferences, has the space between them divided into cells, which being curv'd, will (when the wheel goes round) cause weights plac'd loose in the said cells, to descend on the side A, at the outer circumference of the wheel, and on the side D to ascend in the line B *b b b*, which comes nearer the centre, and touches the inner circumference of the wheel. In a machine of this kind, the weights will indeed move in such a manner, if the wheel be turn'd round, but will never be the cause of the wheel's going round. Such a machine is mentioned by the Marquis of Worcester, in his "Century of Inventions," in the following words, No. 56:—

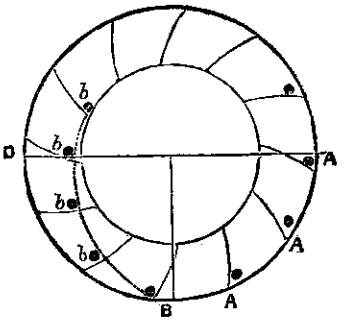
"To provide and make that all the weights of the descending side of a wheel, shall be perpetually farther from the centre, than those of the mounting side, and yet equal in number and heft to the one side as the other. A most incredible thing, if not seen; but tried before the late King (of blessed memory)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

Now the consequence of this, and such like machines, is nothing less than a perpetual motion; and the fallacy is this:

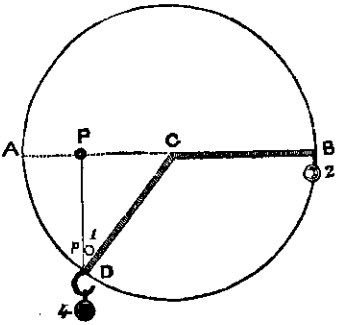
(*Fig.* 3.)



(*Fig.* 4.)



(*Fig.* 5.)



The velocity of any weight is not the line, which it describes in general, but the height that it rises up to, or falls from, with respect to its distance from the centre of the earth. So that when the weight (Fig. 3) describes the arc A *a*, its velocity is the line A C, which shews the perpendicular descent (or measures how much it is come nearer to the centre of the earth), and likewise the line B C denotes the velocity of the weight B, or the height that it rises to, when it ascends in any of the arcs B *b*, instead of the arc B D: so that in this case whether the weight B, in its ascent be brought nearer the centre or not, it loses no velocity, which it ought to do, in order to be rais'd up by the weight A. Nay, the weight in rising nearer the centre of a wheel, may not only not lose of its velocity, but be made to gain velocity, in proportion to the velocity of its counterpoising weights, that descend in the circumference of the opposite side of the wheel; for if we consider two radii of the wheel, one of which is horizontal, and the other (fasten'd to and moving with it) inclin'd under the horizon in an angle of 60 degr. (Fig. 5) and by the descent of the end B of the radius B C, the radius C D by its motion causes the weight at D, to rise up the line *p* P, which is in a plane that stops the said weight from rising in the curve D A, that weight will gain velocity, and in the beginning of its rise, it will have twice the velocity of the weight at B; and consequently, instead of being rais'd, will overpoise, if it be equal to the last mention'd weight. And this velocity will be so much the greater, in proportion as the angle A C D is greater, or as the plane P *p* (along which the weight D must rise) is nearer to the centre. Indeed, if the weight at B (Fig. 3) could by any means be lifted up to *β*, and move in the arc *β b*, the end would be answer'd; because then the velocity would be diminished, and become *β* C.

EXPERIMENT (Fig. 5).—Take the leaver B C D, whose brachia are equal in length, bent in an angle of 120 degr. at C, and moveable about that point as its centre: In this case, a weight of two pounds hanging at the end B of the horizontal part of the leaver, will keep in æquilibrio a weight of four pounds hanging at the end D. But if a weight of one pound be laid upon the end D of the leaver, so that in the motion of D along the arc *p* A, this weight is made to rise up against the plane P *p* (which divides in half the line A C equal to

C B) the said weight will keep in æquilibrio two pounds at B, as having twice the velocity of it, when the leaver begins to move. This will be evident, if you let the weight 4 hang at D, whilst the weight 1 lies above it: for if then you move the leaver, the weight 1 will rise four times as fast as the weight 4.*

Notice of the Wheel of Orffyreus, in the "Gentleman's Magazine," in a letter on—

Perpetual Motion said to be discovered.

MR. URBAN,—Being an admirer of improvements in mechanics, and desirous of seeing the perpetual motion discovered, I was much pleased on reading, some time ago, an account of the automaton constructed by Orffyreus, in two letters, one from Professor s'Gravesande to Sir Isaac Newton, the other from Baron Fischer to Dr. Desaguliers, with the testimonial of the Landgrave of Hesse-Cassel (who had seen the inside of it) in favour of its construction. To which are added some remarks by William Kenrick, the writer of the pamphlet, who takes that opportunity to propose a subscription for a similar machine, which he says he has contrived, and denominated a Rotator.

It is much to be lamented that the learned did not examine more strictly into the merit of Orffyreus's wheel; but, on the contrary, being prepossessed with a notion of the impracticability of the perpetual motion, suffered it to be neglected, and at last destroyed by the hands of a disappointed mechanic, who, with unwearied application and steady perseverance, had brought it to perfection. I wish we may not again let slip an opportunity of becoming acquainted with an invention, which, when made public, will reflect honour on the inventor, and be of the utmost utility to the world. Such, I would hope, is the rotator mentioned by W. Kenrick; for, unless his discovery were real, I cannot think that he would have taken the liberty to express himself as he does in p. 26, &c. "The inventor flatters himself that, if the contents of the foregoing pages are seriously attended to, and it be farther considered, that not a penny of the proposed premium is required, till the subscribers are fully satisfied of the reality and utility of the

* The Philosophical Transactions, vol. 31, for the years 1720, 1721. 4to. No. 369, Sep., Oct., Nov., Dec., 1721, page 237.

invention, his proposal will not be treated with so mortifying a neglect as that of Orffyreus." Again he says, "If it does not supply the place of a first mover, at the expense only of the construction and repair of a simple wheel, subject to very little friction, and that in all such engines and machines, even from the slightest piece of clockwork to the waterworks of Marli or London-bridge, he expects nothing for his discpvery, but to stand exposed to the contempt that will be justly thrown on him, for having so miserably mispent his time, and frivolously engaged the attention of the public."

Now, I think that W. Kenrick's proposals are very fair; and should be glad to be informed, whether any attentien has been paid to them, and whether Sir Isaac Newton took any notice of the letter addressed to him by Professor s'Gravesande. I shall consider it as a favour if any correspondent will oblige me with an answer to these particulars.

A CONSTANT READER.*

Dr. Hutton, in his notice "Of the Perpetual Motion," incidentally condemns the wheel of Orffyreus, observing:—

The perpetual motion has been the quicksand of mechanicians, as the quadrature of the circle, the trisection of an angle, &c., have been that of geometricians: and as those who pretend to have discovered the solution of the latter problems are in general persons scarcely acquainted with the principles of geometry, those who search for, or imagine they have found, the perpetual motion, are always men to whom the most certain and invariable truths of mechanics are unknown.

It may be demonstrated, indeed, to all those capable of reasoning in a sound manner on those sciences, that a perpetual motion is impossible: for, to be possible, it is necessary that the effect should become alternately the cause, and the cause the effect. It would be necessary, for example, that a weight raised to a certain height by another weight, should in its turn raise the second weight to the height from which it descended. But, according to the laws of motion, all that a descending weight could do, in the most perfect machine which the mind can conceive, is to raise another in the same time to a height reciprocally proportional to its mass. But

* The Gentleman's Magazine. Vol. 42. 1772. P. 172.

it is impossible to construct a machine in which there shall be neither friction nor the resistance of some medium to be overcome; consequently at each alternation of ascent and descent, some quantity of motion, however small, will always be lost: each time, therefore, the weight to be raised will ascend to a less height; and the motion will gradually slacken, and at length cease entirely.

A moving principle has been sought for, but without success, in the magnet, in the gravity of the atmosphere, and in the elasticity of bodies. If a magnet be disposed in such a manner as to facilitate the ascension of a weight, it will afterwards oppose its descent. Springs, after being unbent, require to be bent by a new force equal to that which they exercised; and the gravity of the atmosphere, after forcing one side of the machine to the lowest point, must be itself raised again, like any other weight, in order to continue its action.

We shall, however, give an account of various attempts to obtain a perpetual motion, because they may serve to show how much some persons have suffered themselves to be deceived on this subject.

Fig. 52, pl. 12.)

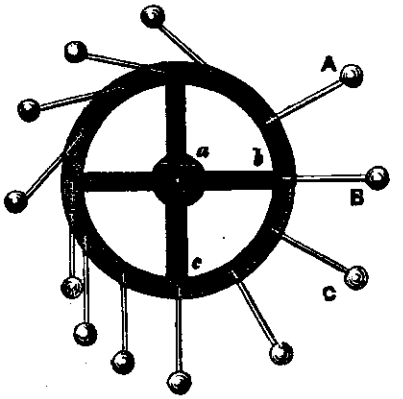
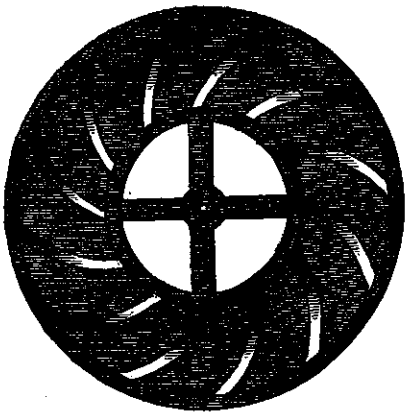


Fig. 52, plate 12, represents a large wheel, the circumference of which is furnished, at equal distances, with levers, each bearing at its extremity a weight, and moveable on a

hinge, so that in one direction they can rest upon the circumference, while on the opposite side, being carried away by the weight at the extremity, they are obliged to arrange themselves in the direction of the radius continued. This being supposed, it is evident that when the wheel turns in the direction *a b c*, the weights A B and C will recede from the centre; consequently, as they act with more force, they will carry the wheel towards that side; and as a new lever will be thrown out, in proportion as the wheel revolves, it thence follows, say they, that the wheel will continue to move in the same direction. But, notwithstanding the specious appearance of this reasoning, experience has proved that the machine will not go; and it may indeed be demonstrated that there is a certain position in which the centre of gravity of all these weights is in the vertical plane passing through the point of suspension, and that therefore it must stop.

The case is the same with the following machine, which it would appear ought to move also incessantly. In a cylindric drum, in perfect equilibrium on its axis, are formed channels as seen in Fig. 53, which contain balls of lead, or a certain

(*Fig. 53.*)

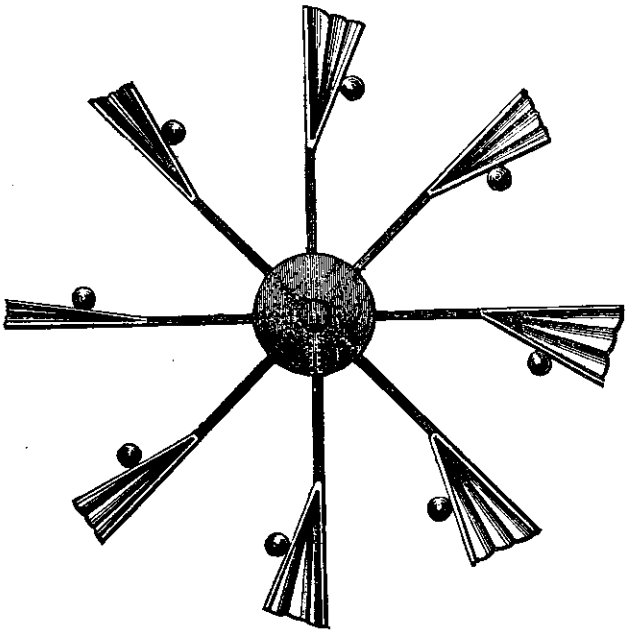


quantity of quicksilver. In consequence of this disposition, the balls or quicksilver must, on the one side, ascend by approaching the centre; and on the other must roll towards

the circumference. The machine then ought to turn incessantly towards that side.

A third machine of this kind is represented Fig. 54. It consists of a kind of wheel formed of six or eight arms, proceeding from a centre, where the axis of motion is placed. Each of these arms is furnished with a receptacle in the form of a pair of bellows, but those on the opposite arms stand in con-

(*Fig.* 54.)



trary directions, as seen in the figure. The moveable top of each receptacle has affixed to it a weight, which shuts it in one situation and opens it in the other. In the last place, the bellows of the opposite arms have a communication by means of a canal, and one of them is filled with quicksilver.

These things being supposed, it is visible, that the bellows on the one side must open, and those on the other must shut;

consequently the mercury will pass from the latter into the former, while the contrary will be the case on the opposite side.

It might be difficult to point out the deficiency of this reasoning; but those acquainted with the true principles of mechanics will not hesitate to bet a hundred to one that the machine, when constructed, will not answer the intended purpose.

The description of a pretended perpetual motion, in which bellows, to be alternately filled with and emptied of quicksilver, were employed, may be seen in the "Journal des Savans" for 1685. It was refuted by Bernouilli and some others, and it gave rise to a long dispute. The best method which the inventor could have employed to defend his invention would have been to construct it, and shew it in motion; but this was never done.

We shall here add another curious anecdote on this subject. One Orfyreus announced, at Leipsic, in the year 1717, a perpetual motion, consisting of a wheel which would continually revolve. This machine was constructed for the Landgrave of Hesse Cassel, who caused it to be shut up in a place of safety, and the door to be sealed with his own seal. At the end of forty days, the door was opened, and the machine was found in motion. This, however, affords no proof in favour of a perpetual motion; for as clocks can be made to go a year without being wound up, Orfyreus's wheel might easily go forty days, and even more.

The result of this pretended discovery is not known. We are informed that an Englishman offered 80,000 crowns for this machine; but Orfyreus refused to sell it at that price: in this he certainly acted wrong, as there is reason to think he obtained by his invention, neither money, nor even the honour of having discovered the perpetual motion.

The Academy of Painting at Paris possessed a clock which had no need of being wound up, and which might be considered as a perpetual motion, though it was not so. But this requires some explanation. The ingenious author of this clock employed the variations in the state of the atmosphere for winding up his moving weight. Various artifices might be devised for this purpose; but this is no more a perpetual motion than if the flux and reflux of the sea were employed to keep the machine continually going; for this

principle of motion is exterior to the machine, and forms no part of it.

But enough has been said on this chimera of mechanics. We sincerely hope that none of our readers will ever lose themselves in the ridiculous and unfortunate labyrinth of such a research.

To conclude, it is false that any reward has been promised by the European Powers to the person who shall discover the perpetual motion; and the case is the same in regard to the quadrature of the circle. It is this idea, no doubt, that excites so many to attempt the solution of these problems; and it is proper they should be undeceived.*

Dr. William Kenrick published "A Lecture on the Perpetual Motion," in 1770 and following year; it is a quarto pamphlet of ninety-two pages, now very rare, a copy of which, however, is in the valuable library connected with the Patent Office. We shall proceed to give it in an abridged form.

In the Apology, occupying six pages, he says:—

The mere exhibition of a self-moving machine, without a display of its mechanism, or the principles on which its motion is begun and continued, could produce no conviction. The fate of Orffyreus and his machine is a proof of this. Scarce fifty years ago that whimsical mechanician exhibited a perpetual motion at Hesse Cassel, the constancy of whose operation was experienced for many weeks under the most exact caution of the Landgrave of that Principality, whose testimony of such operation, as well as in favour of its construction (to the secret of which he was admitted), was given in the most explicit and determinate form. And yet, because Orffyreus would not display the mechanism without the previous assurance of a premium of 200,000 florins (near twenty thousand pounds), or because he would not or could not discover the principles on which it acted, his pretensions were neglected, his machine was destroyed by his own hands, and his life made a sacrifice to the chagrin attending his disappointment. Twenty years had he racked his brains for in-

* Recreations in Mathematics and Natural Philosophy. First composed by M. Ozanam, greatly enlarged by M. Montucla, and translated into English and improved by Chs. Hutton, LL.D. and F.R.S. In 4 vols. 8vo. 1803. [See vol. 2, p. 102 and plate 12.]

vention, and expended a patrimonial competence with parsimony in prosecuting his design. And, when success inspired the hope of reward, he found his ingenuity suspected of imposture, and his industry rewarded with contempt.

Whether any of his successors in the same pursuit will meet with a better fate is at length to be determined. One species of our predecessor's merit, however, I (adds Dr. Kenrick*) presume myself at least entitled to, that of perseverance; it being now fifteen years since I first engaged in this undertaking, which I have since pursued with almost unremitted assiduity, and that not only at a considerable waste of time and expence, but under the constant mortification of hearing it equally ridiculed, by those who do know, and by those who do not know, anything of the matter.

It is, indeed, generally supposed, and as confidently affirmed, that the mathematicians have published demonstrations of the impossibility of a perpetual motion. But I can safely take upon me to affirm that no such demonstration was ever published by any. Within these twelve years past, the mathematicians who deny the possibility of a perpetual motion have been repeatedly and publicly called upon, both in the foreign and English prints, to produce a single instance of these demonstrations. They have not done it. They might have produced, indeed, the demonstrations of Huygens, De la Hire, and others, to prove, as Desaguliers very properly expresses it, the fallacy of the schemes of most of the pretenders to the perpetual motion. They proved nothing more; and this was so far unnecessary, in that the fallacy evidently appeared in the discovery of the principle on which they were founded.

This was done in the last century by the celebrated Marquis of Worcester, in the presence of the King and his Court, at the Tower, by the exhibition of a wheel so contrived that, in revolving on its axis, it carried up several weights nearer its centre on one side than they descended on the other. The scheme was plausible, and to appearance practicable; but, though the wheel was polite enough to turn about while his

* We learn from Gorton's Biographical Dictionary that William Kenrick was born at Watford, and brought up to the business of a rule-maker. He procured a doctor's degree at Leyden, and died in 1779, less lamented than he might have been, owing to his generally malignant and vituperative style of writing.

Majesty was present, it could not be prevailed upon to be so complaisant in his absence.* The mathematicians avenged themselves of the short triumph of the mistaken Marquis, but were equally mistaken themselves in thinking they had routed the problem, or that, in hunting down the jackal, they had destroyed the lion. The perpetual motion survived; it had still its advocates; Professor 'S Gravesande and John Bernouille maintained its practicability, the former giving his testimony in favour of Orffyreus's machine, after a long and scrutinous examination. It is not twelve years since this testimony was republished by Dr. Allaman, the present Professor of Natural Philosophy at Leyden, whose own opinion, given at the same time, is also greatly in favour of the discovery. It is even some years later that a dissertation still more in its favour, written, if I am not mistaken, by the celebrated De Gorter, of Petersberg, appeared in the "Philosophical Transactions" of Haarlem. My end is not to amuse or persuade, but, with due deference, to inform and convince. To remove every cause of objection, I must beg leave to expatiate somewhat at large on the theory of this discovery. It is with the more propriety I presume on this method, as the discovery to which I pretend has not been (as frequently happens) the effect of mechanical accident, but the premeditated result of mathematical reasoning and physical experiment. I shall proceed to elucidate the principal arguments *à priori*, that prove the practicability of a perpetual motion to be the necessary consequence of the known and established laws of nature.

Having proceeded thus far, he opens his lecture at page 7 with the Introduction; and first "On the nature of motion in general," which, in fourteen pages, being more metaphysical than mechanical, affords no extractable matter for our present object. Part 1, is "On the cause and effect of motion." This elementary part is needlessly laboured and elaborated through twenty-seven pages. In the course of his remarks he states:—

The discovery of a perpetual motion, says De la Hire,

* On what authority he presumes to make this statement of its inoperativeness does not appear, and, indeed, seems quite apocryphal.

would be to discover a body at once heavier and lighter than itself. But this is not a fair state of the question. It is not necessary that all the parts of a perpetually-moving machine should be attached to, and inseparable from, each other; which they must be, to constitute one gravitating body of a determinate weight.

He proceeds to consider the nature of the circulation of the blood, pneumatic pressure, the steel-yard, real and relative weight, and spiral action. Again, we have Hobbes, Locke, and Stewart, in the same sentence with such language as—"I could almost as readily impute ingenuity to vegetables and fossils—to the sensitive plant and the loadstone—as mediation to muscles, or cogitabundity to cockles, periwinkles, and rock oysters!" In conclusion, he says:—

I have endeavoured to make it appear that motion is the mechanical effect of the physical action of the primary elements; that the direction of motion only comes within the province of animal intellect; that the vital system is supported by mere mechanic motion, kept up by the elasticity of the solids and the gravity of the fluids composing the animal body; that by the same means a more simple inanimate system or machine may be framed, which may have the same property of continued action (or, as it is called, self-motion). And this is all that is, or can be, expected of a perpetual motion; the momentum of which may be increased to any degree, according to the weight of the bodies employed and the work required to be done.

The second part of this lecture commences with a Proem of thirteen pages:—

I am induced (he says) to trespass farther, by extending in like manner the subsequent divisions of it; making the second and third parts of my printed syllabus the topics of the present reading, and reserving the last part, with the concluding experiment, to the third and final lecture.

I pretend merely to the investigation of the general principles of mechanics, and even to illustrate these so far only as I conceive they relate to the immediate object of my lecture, the discovery of an artificial perpetual motion; leaving

the application of such principles, in the solution of particular phænomena, or the construction of particular machines, to such as make the different arts and sciences their peculiar study.

He very prudently ends, observing :—

But I beg pardon, gentlemen, for the length of this digressive introduction, and shall proceed to the more immediate subject of my lecture.

Section 1, of this lecture, is "On the composition and combination of motion." After discussing, in his own peculiar style, mechanical principles of motion, he adds :—

It would require a volume, and that not a small one, to illustrate these subjects, and support them by the necessary demonstrations and experiments. Should Providence give me life and health, therefore, they (his auditors) shall have it. Indeed, I have already spent some years in preparing such a volume for the press.

He is very prolix on gravity and motion, then commences Section 2, "On the communication and dissipation of motion." Five pages are occupied in discussing motion, in popular language, in the course of which he remarks :—

And as to the imperfectly elastic bodies, their power of retaining or communicating motion depends entirely on their *vis inertiæ* and weight; nor can they on any occasion whatever communicate a greater momentum to another body than they themselves possess. It is sufficient for the purpose of a perpetual motion that they can do this. And, indeed, here all the difficulty lies, viz., in the means of communicating the momentum or moving force of a heavy body to a light one. Now, the most virulent opponents to the practicability of perpetual motion have never pretended to demonstrate the impracticability of this communication. The *quomodo*, or means of effecting it, being the point in dispute. It is to this discovery that I pretend; and to show that my pretensions are well grounded, have taken the liberty to invite you to this lecture.

The lectures appear to have been illustrated by a plate having two figures of a simple apparatus used to demonstrate

the action of a spring and two unequal weights; also an inflexible ruler suspended between two unequal balls,—with both he experimented before his auditors; but the engraving is wanting in the edition now used. In conclusion, he observes:—

You see, gentlemen, I am purposely provided here with a very simple and clumsy apparatus. The perpetual motion does not need the assistance of friction wheels, or depend on the niggling nicety of tooth and pinion. If the practical part of my discovery be not superior to the manual dexterity of a village carpenter or country smith, I am satisfied. There will be no great discernment required to comprehend the design they are to put in execution. You will permit me, however, at present, to defer what I have farther to offer on the subject to another opportunity.*

* A Lecture on the Perpetual Motion. Part the first. London, 1771. 4to. Pp. 49. A Lecture on the Perpetual Motion. Part the second. London, 1771. 4to. Pp. 43. An "Address" follows the first title page, dated 24 Jan, 1771, signed W. Kenrick; and has a notice at the end that "The plates will be delivered with the third and last part of the lecture." This "third and last part," if published, does not form part of the copy in the Patent Office library.