Introduction.

ous contrivances, calculated both for instruction and amusement. It is the object of the present article to bring these under one point of view, and to add a few of the more curious or useful experiments and contrivances which could not before be conveniently introduced. In particular, we propose to explain some of those scientific deceptions which have excited so much interest and admiration, and to describe several useful philosophical instruments, which either are of very late invention, or have been overlooked in the preceding parts of the work. We shall thus be enabled to supply several deficiencies (otherwise unavoidable), and shall render the present article a sort of general index or table of reference to the various subjects of scientific amusement which are dispersed through the Encyclopædia.

For greater convenience, and more easy reference to preceding articles, we shall arrange the sections under which the various amusements of science may be reduced, in alphabetical order, according to the series of the principal mathematical and philosophical treatises. Thus the article will be divided into 13 sections, comprehending the recreations and contrivances that relate to *Acoustics*, *Arithmetic*, *Astronomy*, *Chemistry*, *Electricity*, *Galvanism*, *Geography*, *Geometry*, *Hydrodynamics*, *Magnetism*, *Mechanics*, *Optics* and *Pneumatics*.

It must not be supposed, from the title of this article, that the subjects which we are here to discuss are puerile or trifling. They will be such as are best calculated to excite the attention, quicken the ingenuity, and improve the memory of our young readers, and they will be similar to those pursuits which have employed the lighter hours of some of the most distinguished philosophers and mathematicians. The names of Bacon, of Boyle, of Newton, of Desaguliers, of Ozanam, of Montucla, and of Hutton, stamp a value on the recreations of science, and prevent us from considering them as frivolous or trifling.

3 Writers on scientific recreations.

The subject of scientific recreations must be regarded as entirely modern, as, previous to the era of Lord Bacon, philosophers were much more attached to rigid demonstration and metaphysical reasoning, than to experimental illustration. Much may be found on these subjects in the works of Lord Bacon and Mr Boyle; but the earliest collection of scientific amusements which deserves notice, is the work of Ozanam, entitled *Récréations Mathématiques et Physiques*, published in 1692, in 2 vols 8vo, and afterwards several times republished with improvements and additions, till it was enlarged to 4 vols 8vo. This work was soon translated into most of the modern languages, and was given to the English reader by Dr Hooper, under the title of *Rational Recreations*, first published, we believe, in 1774, and again in 1783, in 4 vols 8vo. The original work of Ozanam has been lately recomposed and greatly improved by M. Montucla, and a translation of this improved edition into English was published in 1803, in 4 vols 8vo, by Dr Charles Hutton. In this English edition, the work is much better adapted than in any former copy, to the English reader, and is enriched by some of the latest improvements in natural philosophy and chemistry.

4 Popular works on experimental philosophy.

It may not be improper to add, to this notice of works on the amusements of science, a list of the best popular treatises on natural and experimental philosophy and chemistry, to which our younger readers may have recourse for an explanation of the principles of these sciences, if they should find some of the articles in this Encyclopædia too abstruse or too mathematical.

Recreations in Acoustics.

To young people who have never read any work on these sciences, we may recommend Mr Joyce's *Scientific Dialogues*, *Dialogues on Chemistry*, and *Dialogues on the Microscope*, and Mr Frend's *Evening Amusements*. After attentively perusing these, they may enlarge their information by reading Brewster's edition of *Ferguson's Lectures*; Nicholson's *Introduction to Natural Philosophy*; Gregory's *Economy of Nature*; or Dr Young's *Lectures on Natural Philosophy*; and Henry's *Epitome of Chemistry*, 8vo edition.

Sect. I. *Recreations and Contrivances relating to Acoustics.*

5 Recreations in Acoustics.

In the article Acoustics, Vol. I. p. 159. we have related six amusing experiments and contrivances, and explained them on the principles of acoustics. These are, the *conversing statue*, explained on the principle of the reflexion of sound; the *communicative busts*, and the *oracular head*, explained from the reverberation of sound; the *solar sonata*, the *automaton harpsichord*, and the *ventose symphony*, explained partly on the principles of acoustics, and partly on those of mechanics. We have now to explain a deception connected with the conveyance of sound, well known to many of our readers, by the name of the *invisible lady* or *invisible girl*; and to notice some curious figures assumed by sand or other light bodies on the surface of vibrating plates.

6 Invisible lady.

Some years ago M. Charles, brother to the well-known philosopher of that name, exhibited in London, and afterwards in most of the large towns of Great Britain and Ireland, the experiment of the *invisible girl*. The apparatus by means of which this experiment was conducted, and the principal circumstances attending the exhibition, have been described by Mr Nicholson, in his Philosophical Journal, from which the following account is principally taken.

In the middle of a large lofty room, in an old house, where, from the appearance of the wainscot, and other circumstances, there seemed to be no situation for placing acoustic tubes or reflectors, was fixed a wooden railing, about 5 feet high, and as many wide, inclosing a square space. A perspective view of the apparatus is given at fig. 1. of Plate CCCCLXX, where A, A, A, A, represent the four upright posts. These posts were united by a cross rail near the top, BB, and by two or more similar rails at the bottom. The frame, thus constructed, stood upon the floor, and from the top of each of the four upright pillars proceeded a strong bended brass wire *a*, *a*, *a*, *a*, so that they all met together at the top *c*, where they were secured by a crown and prince's feather, or other ornaments. From these four wires was suspended a hollow copper ball, about a foot in diameter, by means of slight ribbons, so as to cut off all possible communication with the frame. Round this ball were placed four trumpets, at right angles to each other, as represented at A, A, A, A, fig. 2. having their mouths opening externally.

Such was the apparent construction of the apparatus, and it was pretended that there resided within the ball an invisible lady, capable of giving answers to any questions that were put to her. When a question was proposed,

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Recreations in Acoustics.

posed, it was uttered in at the mouth of one of the trumpets, and an answer immediately proceeded from all the trumpets, so distinctly loud as to be heard by an ear applied to any of them, and yet so distant and feeble, that it appeared to come from a very diminutive being. In this consisted the whole of the experiment, except that the lady could converse in several languages, sing, describe all that happened in the room, and display a fund of lively wit and accomplishment that admirably qualified her to support the character she had undertaken.

The principles on which this experiment is constructed are similar to those of the *oracular head* described under ACOUSTICS; except that in the present deception, an artificial echo is produced by means of the trumpets, and thus the sound is completely reversed, instead of proceeding in its original direction. Fig. 3. represents a section of the aparatus, and will explain the method by which the deception is effected. One of the posts A, A, as well as one-half of the hand-rail connected with it, is hollowed into a tube, the end of which opens on the inside of the rail, opposite the centre of the trumpet on that side, though the hole is very small, and is concealed by reeds or other mouldings. At the other end the tube communicates with a long tin pipe *pp* about half an inch in diameter, concealed below the floor of the room *ff*, and passing up the wall to a large deal case, *k*, almost similar to an inverted funnel, and large enough to contain the confederate, and a piano forte, on which tunes may be occasionally played. A small hole closed with glass is left through the funnel and side-wall of the room, as at *h*, so that the confederate may have an opportunity of observing and commenting on any circumstances which may take place in the room. Thus, when any question is asked at one of the trumpets, the sound is conveyed through the communicating tubes into the funnel-shaped case, so as to be heard by the confederate, who then gives the answer, which in like manner is conveyed through the tube below the floor to one of the trumpets, and is heard, either from that, or any of the rest.

Fig. 3.

On the Figures produced by Light Bodies on Vibrating Surfaces.

7 Vibration figures.

About the year 1787, Dr Chladni of Wittemberg drew the particular attention of philosophers to the nature of vibration, by investigating the curves produced by the moving points of vibrating surfaces. It is found that if sand, or a similar substance, be strewed on the surface of an elastic plate, such as glass or the sonorous metals, and if the plate be made to vibrate, the sand will arrange itself on particular parts of the surface, showing that these points are not in motion. These figures are often extremely curious, and may be varied according to the pleasure or address of the experimentalist. Some of the more remarkable are represented at figs. 5, 6, 10, 11.

Fig. 5, 6, 10, 11.

To produce these figures, nothing is necessary but to know the method of bringing that part of the surface which we wish not to vibrate into a state of rest; and of putting in motion that which we wish to vibrate: on this depends the whole expertness of producing what are called *vibration figures*.

Those who have never tried these experiments may imagine that to produce fig. 5. it would be necessary to damp, in particular, every point of the part to be kept at rest, viz. the two concentric circles and the diameter, and to put in motion every part intended to vibrate. This, however, is not the case; for we need damp only the points *a* and *b*, and cause to vibrate one part *c*, at the edge of the plate; for the motion is soon communicated to the other parts which we wish to vibrate, and the required figure will in this manner be produced.

Recreations in Acoustics.

Fig. 5.

The damping may be best effected by laying hold of the place to be damped between the fingers, or by supporting it with only one finger. This will be more clearly comprehended by turning to fig. 8, where the hand is represented in the position necessary to hold the plate. In order to produce fig. 6. we must hold the plate horizontally, placing the thumb above at *a*, with the second finger directly below it; and besides this, we must support the point *b* on the under side of the plate. If the bow of a violin be then rubbed against the plate at *c*, there will be produced on the glass the figure which is delineated at fig. 6. When the point to be supported or damped lies too near the centre of the plate, we may rest it on a cork, not too broad at the end, brought into contact with the glass in such a manner as to supply the place of the finger. It is convenient also, when we wish to damp several points at the circumference of the glass, to place the thumb on the cork, and to use the rest of the fingers for touching the part which we wish to keep at rest. For example, if we wish to produce fig. 7. on an elliptic plate, the larger axis of which is to the less as 4 to 3, we must place the cork under *c*, the centre of the plate; put the thumb on this point, and then damp the two points of the edge *p* and *q*, as may be seen at fig. 8, and make the plate to vibrate by rubbing the violin bow against it at *r*. There is still another convenient method of damping several points at the edge when large plates are employed. Fig. 4. represents a strong square piece of metal *a b*, a line in circumference, which is screwed to the edge of the table, or made fast in any other manner; and a notch, about as broad as the edge of the plate, is cut into one side of it by a file. We then hold the plate resting against this piece of metal, by two or more fingers when requisite, as at *c* and *d*, by which means the edge of the plate will be damped in three points *d*, *c*, *e*; and in this manner, by putting the plate in vibration at *f*, we can produce fig. 13. In cases of necessity, the edge of a table may be used, instead of the piece of metal; but it will not answer the purpose so well.

Fig. 8. Fig. 6. Fig. 6. Fig. 7. Fig. 4. Fig. 13.

To produce the vibration at any required place, a common violin bow, rubbed with rosin, is the most proper instrument to be employed. The hair must not be too slack, because it is sometimes necessary to press pretty hard on the plate, in order to produce the tone sooner.

When we wish to produce any particular figure, we must first form it in idea upon the plate, in order that we may be able to determine where a line at rest, and where a vibrating part, will occur. The greatest rest will always be where two or more lines intersect each other, and such places must in particular be damped. For example, in fig. 9. we must damp the part *n*, and stroke with the bow in *p*. Fig. 13. may be produced with no less ease, if we hold the plate at *r*, and stroke with the

Fig. 13.

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