LETTER VII.

Illusions depending on the ear—Practised by the ancients.—Speaking and singing heads of the ancients—Exhibition of the Invisible Girl described and explained—Illusions arising from the difficulty of determining the direction of sounds—Singular example of this illusion—Nature of ventriloquism—Exhibitions of some of the most celebrated ventriloquists—M. St. Gille—Louis Brabant—M. Alexandre—Capt. Lyon's account of Eskimaux ventriloquists.

Next to the eye, the ear is the most fertile source of our illusions, and the ancient magicians seem to have been very successful in turning to their purposes the doctrines of sound. In the labyrinth of Egypt, which contained twelve palaces and 1500 subterraneous apartments, the gods were made to speak in a voice of thunder; and Pliny, in whose time this singular structure existed, informs us, that some of the palaces were so constructed that their doors could not be opened without permitting the peals of thunder to be heard in the interior. When Darius Hystaspes ascended the throne, and allowed his subjects to prostrate themselves before him as a god, the divinity of his character was impressed upon his worshippers by the bursts of thunder and flashes of lightning which accompanied their devotion. History has of course not informed us how these effects were produced; but it is probable that, in the subterraneous and vaulted apartments of the Egyptian labyrinth, the reverberated sounds arising from the mere opening

and shutting of the doors themselves afforded a suffieient imitation of ordinary thunder. In the palaee of the Persian king, however, a more artifieial imitation is likely to have been employed, and it is not improbable that the method used in our modern theatres was known to the aneients. A thin sheet of iron, three or four feet long, sueh as that used for German stoves, is held by one corner between the finger and the thumb, and allowed to hang freely by its own weight. The hand is then moved or shaken horizontally, so as to agitate the eorner in a direction at right angles to the surfaec of the sheet. By this simple process a great variety of sounds will be produced, varying from the deep growl of distant thunder to those loud and explosive bursts which rattle in quiek suecession from elouds immediately over our heads. The operator soon acquires great power over this instrument, so as to be able to produce from it any intensity and eharacter of sound that may be required. The same effeet may be produced by sheets of tin-plate, and by thin plates of miea; but, on aceount of their small size, the sound is shorter and more acute. In modern exhibitions an admirable imitation of lightning is produced by throwing the powder of rosin, or the dust of lycopodium, through a flame; and the rattling showers of rain which aceompany these meteors are well imitated by a well-regulated shower of peas.

The principal pieces of acoustic meehanism used by the aneients were *speaking* or *singing heads*, whieh were eonstructed for the purpose of representing the gods, or of uttering oracular responses. Among these, the speaking head of Orpheus, whieh

uttered its responses at Lesbos, is one of the most famous. It was celebrated not only throughout Greece, but even in Persia; and it had the credit of predicting, in the equivocal language of the heathen oracles, the bloody death which terminated the expedition of Cyrus the Great into Scythia. Odin, the mighty magician of the north, who imported into Scandinavia the magical arts of the east, possessed a speaking head, said to be that of the sage Minos, which he had enchased in gold, and which uttered responses that had all the authority of a divine revelation. The celebrated mechanic Gerbert, who filled the papal chair A. D. 1000, under the name of Sylvester II., constructed a speaking head of brass. Albertus Magnus is said to have executed a head in the thirteenth century, which not only moved, but spoke. It was made of earthenware, and Thomas Aquinas is said to have been so terrified when he saw it, that he broke it in pieces, upon which the mechanist exclaimed, "There goes the labour of thirty years."

It has been supposed by some authors, that in the ancient speaking-machines the deception is effected by means of ventriloquism, the voice issuing from the juggler himself; but it is more probable that the sound was conveyed by pipes from a person in another apartment to the mouth of the figure. Lucian, indeed, expressly informs us, that the impostor Alexander made his figure of Æsculapius speak, by transmitting his voice through the gullet of a crane to the mouth of the statue: and that this method was general, appears from a passage in Theodoretus, who assures us, that in the fourth century, when Bishop Theophilus broke to

pieces the statues at Alexandria, he found some which were hollow, and which were so placed against a wall, that the priest could conceal himself behind them, and address the ignorant spectators through their mouths.

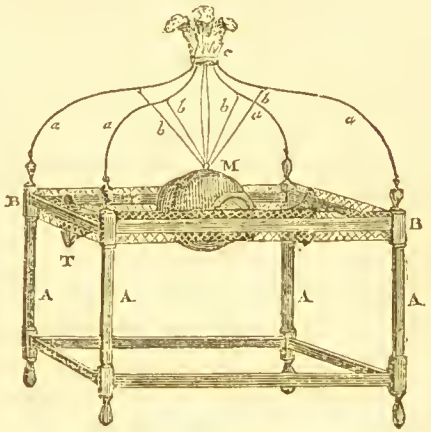
Even in modern times, speaking-machines have been constructed on this principle. The figure is frequently a mere head placed upon a hollow pedestal, which, in order to promote the deception, contains a pair of bellows, a sounding-board, a cylinder and pipes supposed to represent the organs of speech. In other cases these are dispensed with, and a simple wooden head utters its sounds through a speaking trumpet. At the court of Charles II. this deception was exhibited with great effect by one Thomas Irson, an Englishman; and when the astonishment had become very general, a popish priest was discovered by one of the pages in an adjoining apartment. The questions had been proposed to the wooden figure by whispering into its ear, and this learned personage had answered them all with great ability, by speaking through a pipe in the same language in which the questions were proposed. Professor Beekmann informs us that children and women were generally concealed either in the juggler's box or in the adjacent apartment, and that the juggler gave them every assistance by means of signs previously agreed upon. When one of these exhibitions was shown at Göttingen, the Professor was allowed, on the promise of secrecy, to witness the process of deception. He saw the assistant in another room, standing before the pipe with a card in his hand, upon which the signs agreed upon had been marked, and he had

been introduced so privately into the house that even the landlady was ignorant of his being there.

An exhibition of the very same kind has been brought forward in our own day, under the name of the *Invisible Girl;* and as the mechanism employed was extremely ingenious, and is well fitted to convey an idea of this class of deceptions, we shall give a detailed description of it.

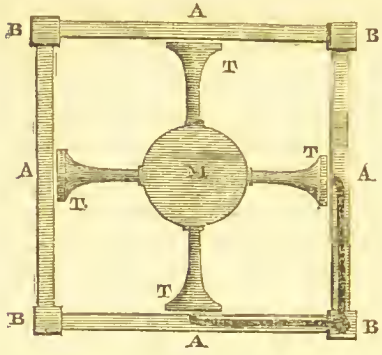
The machinery, as constructed by M. Charles, is shown in Fig. 37 in perspective, and a plan of

Fig. 37.



it in Fig. 38. The four upright posts A, A, A, A, are united at top by a cross rail B, B, and by two similar rails at bottom. Four bent wires *a*, *a*, *a*, *a*, proceeded from the top of these posts, and terminated at *c*. A hollow copper ball M, about a foot in diameter, was suspended from these wires by four slender ribands *b*, *b*, *b*, *b*, and into the copper ball were fixed the extremities of four trumpets T, T, T, T, with their mouths outwards.

Fig. 38.



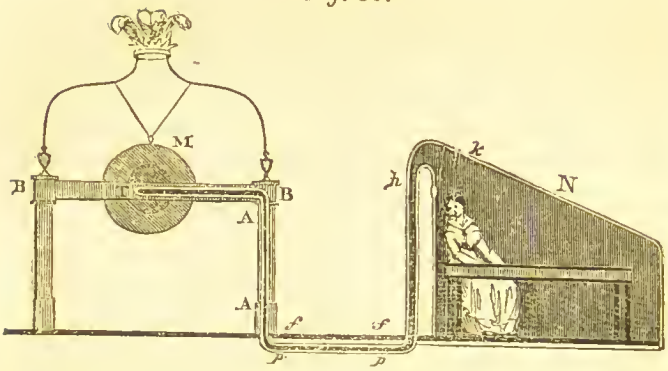
The apparatus now described was all that was visible to the spectator; and though fixed in one spot, yet it had the appearance of a piece of separate machinery, which might have occupied any other part of the room. When one of the spectators was requested by the exhibitor to propose some question, he did it by speaking into one of the trumpets at T. An appropriate answer was then returned from all the trumpets, and the sound issued with sufficient intensity to be heard by an ear applied to any of them, and yet it was so weak that it appeared to come from a person of very diminutive size. Hence the sound was supposed to come from an invisible girl, though the real speaker was a full-grown woman. The invisible lady conversed in different languages, sang beautifully, and made the most lively and appropriate remarks on the persons in the room.

This exhibition was obviously far more wonderful than the speaking heads which we have described, as the latter invariably communicated with a wall, or with a pedestal through which

pipes could be carried into the next apartment. But the ball M and its trumpets communicated with nothing through which sound could be conveyed. The spectator satisfied himself by examination that the ribands *b*, *b*, were real ribands, which concealed nothing, and which could convey no sound; and as he never conceived that the ordinary piece of frame-work A B could be of any other use than its apparent one of supporting the sphere M, and defending it from the spectators, he was left in utter amazement respecting the origin of the sound, and his surprise was increased by the difference between the sounds which were uttered and those of ordinary speech.

Though the spectators were thus deceived by their own reasoning, yet the process of deception was a very simple one. In two of the horizontal railings A, A, Fig. 38, opposite the trumpet mouths T, there was an aperture communicating with a pipe or tube which went to the vertical post B, and descending it, as shown at T A A, Fig. 39, went beneath the floor *f f* in the direction *p*, *p*, and entered the apartment N, where the invisible lady sat. On the side of the partition about *h*, there was a small hole through which the lady saw what was going on in the exhibition-room, and communications were no doubt made to her by signals from the person who attended the machine. When one of the spectators asked a question by speaking into one of the trumpets T, the sound was reflected from the mouth of the trumpet back to the aperture at A, in the horizontal rail, Fig. 38, and was distinctly conveyed along the closed tube into the

Fig. 39.



apartment N. In like manner the answer issued from the aperture A, and being reflected back to the ear of the spectator by the trumpet, he heard the sounds with that change of character which they receive when transmitted through a tube and then reflected to the ear.

The surprise of the auditors was greatly increased by the circumstance, that an answer was returned to questions put in a whisper, and also by the conviction that nobody but a person in the middle of the audience could observe the circumstances to which the invisible figure frequently adverted.

Although the performances of speaking heads were generally effected by the methods now described, yet there is reason to think that the ventriloquist sometimes presided at the exhibition, and deceived the audience by his extraordinary powers of illusion. There is no species of deception more irresistible in its effects than that which arises from the uncertainty with which we judge of the direction and distance of sounds. Every

person must have noticed how a sound in their own ears is often mistaken for some loud noise moderated by the distance from which it is supposed to come; and the sportsman must have frequently been surprised at the existence of musical sounds humming remotely in the extended heath, when it was only the wind sounding in the barrel of his gun. The great proportion of apparitions that haunt old castles and apartments associated with death exist only in the sounds which accompany them. The imagination even of the boldest inmate of a place hallowed by superstition, will transfer some trifling sound near his own person to a direction and to a distance very different from the truth, and the sound which otherwise might have no peculiar complexion will derive another character from its new locality. Spurning the idea of a supernatural origin, he determines to unmask the spectre, and grapple with it in its den. All the inmates of the house are found to be asleep—even the quadrupeds are in their lair—there is not a breath of wind to ruffle the lake that reflects through the casement the reclining crescent of the night; and the massive walls in which he is inclosed forbid the idea that he has been disturbed by the warping of pannelling or the bending of partitions. His search is vain; and he remains master of his own secret, till he has another opportunity of investigation. The same sound again disturbs him, and, modified probably by his own position at the time, it may perhaps appear to come in a direction slightly different from the last. His searches are resumed, and he is again disappointed. If this incident

should recur night after night with the same result—if the sound should appear to depend upon his own motions, or be any how associated with himself, with his present feelings, or with his past history, his personal courage will give way; a superstitious dread, at which he himself perhaps laughs, will seize his mind; and he will rather believe that the sounds have a supernatural origin, than that they could continue to issue from a spot where he knows there is no natural cause for their production.

I have had occasion to have personal knowledge of a case much stronger than that which has now been put. A gentleman, devoid of all superstitious feelings, and living in a house free from any gloomy associations, heard night after night in his bed-room a singular noise, unlike any ordinary sound to which he was accustomed. He had slept in the same room for years without hearing it, and he attributed it at first to some change of circumstances in the roof or in the walls of the room, but after the strictest examination no cause could be found for it. It occurred only once in the night; it was heard almost every night, with few interruptions. It was over in an instant, and it never took place till after the gentleman had gone to bed. It was always distinctly heard by his companion, to whose time of going to bed it had no relation. It depended on the gentleman alone, and it followed him into another apartment with another bed, on the opposite side of the house. Accustomed to such investigations, he made the most diligent but fruitless search into its cause. The consideration that the sound had a

special reference to him alone, operated upon his imagination, and he did not scruple to acknowledge that the recurrence of the mysterious sound produced a superstitious feeling at the moment. Many months afterwards it was found that the sound arose from the partial opening of the door of a wardrobe which was within a few feet of the gentleman's head, and which had been taken into the other apartment. This wardrobe was almost always opened before he retired to bed, and the door being a little too tight, it gradually forced itself open with a sort of dull sound, resembling the note of a drum. As the door had only started half an inch out of its place, its change of position never attracted attention. The sound, indeed, seemed to come in a different direction, and from a greater distance.

When sounds so mysterious in their origin are heard by persons predisposed to a belief in the marvellous, their influence over the mind must be very powerful. An inquiry into their origin, if it is made at all, will be made more in the hope of confirming than of removing the original impression, and the unfortunate victim of his own fears will also be the willing dupe of his own judgment.

This uncertainty with respect to the direction of sound is the foundation of the art of ventriloquism. If we place ten men in a row at such a distance from us that they are included in the angle within which we cannot judge of the direction of sound, and if in a calm day each of them speaks in succession, we shall not be able with closed eyes to determine from which of the ten men any of the sounds proceeds, and we shall be incapable of per-

ceiving that there is any differenee in the direetion of the sounds emitted by the two outermost. If a man and a ehild are plaeed within the same angle, and if the man speaks with the aeeent of a child without any eorresponding motion in his mouth or faee, we shall neeessarily believe that the voiee comes from the ehild; nay, if the ehild is so distant from the man that the voiee actually appears to us to come from the man, we shall still continue in the belief that the ehild is the speaker; and this convietion would aequire additional strength if the child favoured the deeeption, by aeeommodating its features and gestures to the words spoken by the man. So powerful, indeed, is the influence of this deeeption, that if a jaek-ass, plaeed near the man, were to open its mouth, and shake its head responsive to the words uttered by his neighbour, we should rather believe that the ass spoke than that the sounds proeeeded from a person whose mouth was shut, and the museles of whose faee were in perfeet repose. If our imagination were even direeted to a marble statue or a lump of inanimate matter, as the souree from which we were to expeet the sounds to issue, we would still be deeeived, and would refer the sounds even to these lifeless objeets. The illusion would be greatly promoted, if the voice were totally different in its tone and eharacter from that of the man from whom it really eomes; and if he oeeasionally speak in his own full and measured voiee, the belief will be irresistible that the assumed voiee proceeds from the quadruped or from the inanimate objeet.

When the sounds whieh are required to proeeed from any given object are sueh as they are ae-

tually calculated to yield, the process of deception is extremely easy; and it may be successfully executed, even if the angle between the real and the supposed direction of the sound is much greater than the angle of uncertainty. Mr. Dugald Stewart has stated some cases in which deceptions of this kind were very perfect. He mentions his having seen a person who, by counterfeiting the gesticulations of a performer on the violin, while he imitated the music by his voice, riveted the eyes of his audience on the instrument, though every sound they heard proceeded from his own mouth. The late Savile Carey, who imitated the whistling of the wind through a narrow chink, told Mr. Stewart that he had frequently practised this deception in the corner of a coffee-house, and that he seldom failed to see some of the company rise to examine the tightness of the windows, while others, more intent on their newspapers, contented themselves with putting on their hats and buttoning their coats. Mr. Stewart likewise mentions an exhibition formerly common in some of the continental theatres, where a performer on the stage displayed the dumb-show of singing with his lips and eyes and gestures, while another person unseen supplied the music with his voice. The deception in this case he found to be at first so complete as to impose upon the nicest ear and the quickest eye; but in the progress of the entertainment, he became distinctly sensible of the imposition, and sometimes wondered that it should have misled him for a moment. In this case there can be no doubt that the deception was at first the work of the imagination, and was not sus-

tained by the acoustic principle. The real and the mock singer were too distant, and when the influence of the imagination subsided, the true direction of the sound was discovered. This detection of the imposture, however, may have arisen from another cause. If the mock singer happened to change the position of his head, while the real singer made no corresponding change in his voice, the attentive spectator would at once notice this incongruity, and discover the imposition.

In many of the feats of ventriloquism the performer contrives, under some pretence or other, to conceal his face, but ventriloquists of great distinction, such as M. Alexandre, practise their art without any such concealment.

Ventriloquism loses its distinctive character if its imitations are not performed by a voice from the belly. The voice, indeed, does not actually come from that region; but when the ventriloquist utters sounds from the larynx without moving the muscles of his face, he gives them strength by a powerful action of the abdominal muscles. Hence he speaks by means of his belly, although the throat is the real source from whence the sounds proceed. Mr. Dugald Stewart has doubted the fact, that ventriloquists possess the power of fetching a voice from within: he cannot conceive what aid could be derived from such an extraordinary power; and he considers that the imagination, when seconded by such powers of imitation as some mimics possess, is quite sufficient to account for all the phenomena of ventriloquism which he has heard. This opinion, however, is strongly opposed by the remark made to Mr. Stewart him-

self by a ventriloquist, "that his art would be perfect, if it were possible only to speak distinctly without any movement of the lips at all." But, independent of this admission, it is a matter of absolute certainty, that this internal power is exercised by the true ventriloquist. In the account which the Abbé Chapelle has given of the performances of M. St. Gille and Louis Brabant, he distinctly states that M. St. Gille appeared to be absolutely mute while he was exercising his art, and that no change in his countenance could be discovered*. He affirms, also, that the countenance of Louis Brabant exhibited no change, and that his lips were close and inactive. M. Richerand, who attentively watched the performances of M. Fitz-James, assures us that during his exhibition there was a distention in the epigastric region, and that he could not long continue the exertion without fatigue.

The influence over the human mind which the ventriloquist derives from the skilful practice of his art is greater than that which is exercised by any other species of conjuror. The ordinary magician requires his theatre, his accomplices, and the instruments of his art, and he enjoys but a local sovereignty within the precincts of his own magic circle. The ventriloquist, on the contrary, has the supernatural always at his command. In the open fields as well as in the crowded city, in the private apartment as well as in the public hall, he can summon up innumerable spirits; and though the persons of his fictitious dialogue are not visible to the eye, yet they are unequivocally present to

* Edinburgh Journal of Science, No. xviii. p. 254.

the imagination of his auditors, as if they had been shadowed forth in the silence of a spectral form. In order to convey some idea of the influenee of this illusion, I shall mention a few well-authenticated cases of successful ventriloquism.

M. St. Gille, a grocer of St. Germain en Lay, whose performanees have been recorded by the Abbé de la Chapelle, had occasion to shelter himself from a storm in a neighbouring convent, where the monks were in deep mourning for a much-esteemed member of their community who had been recently buried. While lamenting over the tomb of their deceased brother the slight honours which had been paid to his memory, a voice was suddenly heard to issue from the roof of the choir bewailing the condition of the deceased in purgatory, and reproving the brotherhood for their want of zeal. The tidings of this supernatural event brought the whole brotherhood to the church. The voice from above repeated its lamentations and reproaches, and the whole convent fell upon their faces, and vowed to make a reparation of their error. They accordingly chanted in full choir a *de profundis*, during the intervals of which the spirit of the departed monk expressed his satisfaction at their pious exercises. The prior afterwards inveighed against modern scepticism on the subject of apparitions, and M. St. Gille had great difficulty in convincing the fraternity that the whole was a deception.

On another occasion, a commission of the Royal Academy of Sciences at Paris, attended by several persons of the highest rank, met at St. Germain en Lay to witness the performanees of M. St. Gille

The real object of their meeting was purposely withheld from a lady of the party, who was informed that an aërial spirit had lately established itself in the neighbourhood, and that the object of the assembly was to investigate the matter. When the party had sat down to dinner in the open air, the spirit addressed the lady in a voice which seemed to come from above their heads, from the surface of the ground at a great distance, or from a considerable depth under her feet. Having been thus addressed at intervals during two hours, the lady was firmly convinced of the existence of the spirit, and could with difficulty be undeceived.

Another ventriloquist, Louis Brabant, who had been valet de chambre to Francis I., turned his powers to a more profitable account. Having fallen in love with a rich and beautiful heiress, he was rejected by her parents as an unsuitable match for their daughter. On the death of her father, Louis paid a visit to the widow, and he had no sooner entered the house than she heard the voice of her deceased husband addressing her from above, "Give my daughter in marriage to Louis Brabant, who is a man of large fortune and excellent character. I endure the inexpressible torments of purgatory for having refused her to him. Obey this admonition, and give everlasting repose to the soul of your poor husband." This awful command could not be resisted, and the widow announced her compliance with it.

As our conjuror, however, required money for the completion of his marriage, he resolved to work upon the fears of one Cornu, an old banker at Lyons, who had amassed immense wealth by usury

and extortion. Having obtained an interview with the miser, he introduced the subjects of demons and spectres and the torments of purgatory; and during an interval of silence, the voice of the miser's deceased father was heard complaining of his dreadful situation in purgatory, and calling upon his son to rescue him from his sufferings by enabling Louis Brabant to redeem the Christians that were enslaved by the Turks. The awe-struck miser was also threatened with eternal damnation if he did not thus expiate his own sins; but such was the grasp that the banker took of his gold, that the ventriloquist was obliged to pay him another visit. On this occasion, not only his father but all his deceased relatives appealed to him in behalf of his own soul and theirs; and such was the loudness of their complaints, that the spirit of the banker was subdued, and he gave the ventriloquist ten thousand crowns to liberate the Christian captives. When the miser was afterwards undeceived, he is said to have been so mortified that he died of vexation.

The ventriloquists of the nineteenth century made great additions to their art, and the performances of M. Fitz-James and M. Alexandre, which must have been seen by many of our countrymen, were far superior to those of their predecessors. Besides the art of speaking by the muscles of the throat and the abdomen, without moving those of the face, these artists had not only studied with great diligence and success the modifications which sounds of all kinds undergo from distance, obstructions, and other causes, but had acquired the art of imitating them in the highest perfection. The

ventriloquist was therefore able to carry on a dialogue in which the *dramatis voces*, as they may be called, were numerous; and when on the outside of an apartment, he could personate a mob with its infinite variety of noise and vociferation. Their influence over an audience was still further extended by a singular power over the muscles of the body. Mr. Fitz-James actually succeeded in making the opposite or corresponding muscles act differently from each other; and while one side of his face was merry and laughing, the other was full of sorrow and in tears. At one moment he was tall, thin, and melancholic, and after pausing behind a screen, he came out "bloated with obesity and staggering with fulness." M. Alexandre possessed the same power over his face and figure; and so striking was the contrast of two of these forms, that an excellent sculptor, Mr. Joseph, has perpetuated them in marble.

This new acquirement of the ventriloquist enabled him, in his own single person and with his own single voice, to represent upon the stage a dramatic composition which would have required the assistance of several actors. Although only one character in the piece could be seen at the same time, yet they all appeared during its performance, and the change of face and figure on the part of the ventriloquist was so perfect, that his personal identity could not be recognized in the *dramatis personæ*. This deception was rendered still more complete by a particular construction of the dresses which enabled the performer to reappear in a new character after an interval so short that the audience necessarily believed that it was another person.

It is a curious circumstance that Captain Lyon found among the Eskimaux of Igloolik ventriloquists of no mean skill. There is much rivalry among the professors of the art, who do not expose each other's secrets, and their exhibitions derive great importance from the rarity of their occurrence. The following account of one of them is so interesting that we shall give the whole of it in Captain Lyon's words:—

"Amongst our Igloolik acquaintances were two females and a few male wizards, of whom the principal was Toolemak. This personage was cunning and intelligent; and, whether professionally, or from his skill in the chase, but perhaps from both reasons, was considered by all the tribe as a man of importance. As I invariably paid great deference to his opinion on all subjects connected with his calling, he freely communicated to me his superior knowledge, and did not scruple to allow of my being present at his interviews with Torngа, or his patron spirit. In consequence of this, I took an early opportunity of requesting my friend to exhibit his skill in my cabin. His old wife was with him, and by much flattery and an accidental display of a glittering knife and some beads, she assisted me in obtaining my request. All light excluded, our sorcerer began chanting to his wife with great vehemence, and she in return answered by singing the Amna-aya, which was not discontinued during the whole ceremony. As far as I could hear, he afterwards began turning himself rapidly round, and in a loud, powerful voice vociferated for Torngа with great impatience, at the same time blowing and snorting like a walrus. His

noise, impatience, and agitation increased every moment, and he at length seated himself on the deck, varying his tones, and making a rustling with his clothes. Suddenly the voice seemed smothered, and was so managed as to sound as if retreating beneath the deck, each moment becoming more distant, and ultimately giving the idea of being many feet below the cabin, when it ceased entirely. His wife now, in answer to my queries, informed me very seriously, that he had dived, and that he would send up Tornga. Accordingly, in about half a minute, a distant blowing was heard very slowly approaching, and a voice, which differed from that at first heard, was at times mingled with the blowing, until at length both sounds became distinct, and the old woman informed me that Tornga was come to answer my questions. I accordingly asked several questions of the sagacious spirit, to each of which inquiries I received an answer by two loud claps on the deck, which I was given to understand were favourable.

"A very hollow, yet powerful voice, certainly much different from the tones of Toolemak, now chanted for some time, and a strange jumble of hisses, groans, shouts, and gabblings like a turkey succeeded in rapid order. The old woman sang with increased energy; and as I took it for granted that this was all intended to astonish the Kabloona, I cried repeatedly that I was very much afraid. This, as I expected, added fuel to the fire, until the poor immortal, exhausted by its own might, asked leave to retire.

"The voice gradually sunk from our hearing as at first, and a very indistinct hissing succeeded;

in its advance it sounded like the tone produced by the wind on the bass chord of an Æolian harp. This was soon changed to a rapid hiss like that of a rocket, and Toolemak with a yell announced his return. I had held my breath at the first distant hissing, and twice exhausted myself, yet our conjuror did not once respire, and even his returning and powerful yell was uttered without a previous stop or inspiration of air.

"Light being admitted, our wizard, as might be expected, was in a profuse perspiration, and certainly much exhausted by his exertions, which had continued for at least half an hour. We now observed a couple of bunches, each consisting of two stripes of white deer-skin, and a long piece of sinew, attached to the back of his coat. These we had not seen before, and were informed that they had been sewn on by Tornga while he was below*."

Captain Lyon had the good fortune to witness another of Toolemak's exhibitions, and he was much struck with the wonderful steadiness of the wizard throughout the whole performance, which lasted an hour and a half. He did not once appear to move, for he was so close to the skin behind which Captain Lyon sat, that if he had done so he must have perceived it. Captain Lyon did not hear the least rustling of his clothes, or even distinguish his breathing, although his outcries were made with great exertion†.

* *Private Journal of* Captain G. F. Lyon. Lond. 1824. pp. 358, 361.

† Id. p. 366.

this feeling was soon removed by M. Vaucanson, who exhibited and explained to a committee of the Academy of Seienees the whole of the meehanism. This learned body was astonished at the ingenuity whieh it displayed; and they did not hesitate to state, that the maehinery employed for produeing the sounds of the flute performed in the most exaet manner the very operations of the most expert flute-player, and that the artist had imitated the effects produced, and the means employed by nature, with an aeeuracy whieh exeeeded all expectation. In 1738, M. Vaueanson published a memoir, approved of by the Aeademy, in whieh he gave a full deseription of the maehinery employed, and of the principles of its eonstruetion. Following this memoir, I shall therefore attempt to give as popular a deseription of the automaton as ean be done without lengthened details and numerous figures.

The body of the flute-player was about 5½ feet high, and was plaeed upon a pieee of roek, surrounding a square pedestal 4½ feet high by 3½ feet wide. When the panel whieh formed the front of the pedestal was opened, there was seen on the right a eloek movement, whieh, by the aid of several wheels, gave a rotatory motion to a steel axis about 2½ feet long, having eranks at six equidistant points of its length, but lying in different direetions. To eaeh erank was attaehed a eord, whieh deseended and was fixed by its other end to the upper board of a pair of bellows, 2½ feet long and 6 inehes wide. Six pair of bellows arranged along the bottom of the pedestal were then wrought, or made to blow in suecession, by turning the steel axis

At the upper face of the pedestal, and upon each pair of bellows, is a double pulley, one of whose rims is 3 inches in diameter, and the other 1½. The cord which proceeds from the crank coils round the smallest of these pulleys, and that which is fixed to the upper board of the bellows goes round the larger pulley. By this means the upper board of the bellows is made to rise higher than if the cords went directly from them to the cranks.

Round the larger rims of three of these pulleys, viz. those on the right hand, there are coiled three cords, which, by means of several smaller pulleys, terminate in the upper boards of other three pair of bellows placed on the top of the box.

The tension of each cord when it begins to raise the board of the bellows to which it is attached, gives motion to a lever placed above it between the axis and the double pulley in the middle and lower region of the box. The other end of this lever keeps open the valve in the lower board of the bellows, and allows the air to enter freely, while the upper board is rising to increase the capacity of the bellows. By this means there is not only power gained, in so far as the air gains easier admission through the valve, but the fluttering noise produced by the action of the air upon the valves is entirely avoided, and the nine pair of bellows are wrought with great ease, and without any concussion or noise.

These nine bellows discharge their wind into three different and separate tubes. Each tube receives the wind of three bellows, the upper boards of one of the three pair being loaded with a weight of four pounds, those of the second three pair with

a weight of two pounds, and those of the other three pair with no weight at all. These three tubes ascended through the body of the figure, and terminated in three small reservoirs placed in its trunk. These reservoirs were thus united into one, which, ascending into the throat, formed by its enlargement the cavity of the mouth terminated by two small lips, which rested upon the hole of the flute. These lips had the power of opening more or less, and by a particular mechanism, they could advance or recede from the hole in the flute. Within the cavity of the mouth there is a small moveable tongue for opening and shutting the passage for the wind through the lips of the figure.

The motions of the fingers, lips, and tongue of the figure were produced by means of a revolving cylinder, thirty inches long, and twenty-one in diameter. By means of pegs and brass staples fixed in fifteen different divisions in its circumference, fifteen different levers, similar to those in a barrel-organ, were raised and depressed. Seven of these regulated the motions of the seven fingers for stopping the holes of the flute, which they did by means of steel chains rising through the body, and directed by pulleys to the shoulder, elbow, and fingers. Other three of the levers communicating with the valves of the three reservoirs, regulated the ingress of the air, so as to produce a stronger or a weaker tone. Another lever opened the lips so as to give a free passage to the air, and another contracted them for the opposite purpose. A third lever drew them backwards from the orifice of the flute, and a fourth pushed them forward. The

remaining lever enabled the tongue to stop up the orifice of the flute.

Such is a very brief view of the general mechanism by which the requisite motions of the flute-player were produced. The airs which it played were probably equal to those executed by a living performer, and its construction, as well as its performances, continued for many years to delight and astonish the philosophers and musicians of Europe.

Encouraged by the success of this machine, M. Vaucanson exhibited in 1741 other automata, which were equally, if not more, admired. One of these was the automaton duck, which performed all the motions of that animal, and not only ate its food, but digested it*; and the other was his pipe and tabor player, a piece of mechanism which required all the resources of his fertile genius. Having begun this machine before he was aware of its peculiar difficulties, he was often about to abandon it in despair, but his patience and his ingenuity combined, enabled him not only to surmount every difficulty, but to construct an automaton which performed complete airs, and greatly excelled the most esteemed performers on the pipe and tabor.

The figure stands on a pedestal, and is dressed like a dancing shepherd. He holds in one hand a flageolet, and in the other the stick with which he beats the tambourin as an accompaniment to the airs of the flageolet, about twenty of which it is capable of performing. The flageolet has only three holes, and the variety of its tones depends principally on a proper variation of the force of the

* See Letter XI.

wind, and on the different degrees with which the orifices are covered. These variations in the force of the wind required to be given with a rapidity which the ear can scarcely follow, and the articulation of the tongue was required for the quickest notes, otherwise the effect was far from agreeable. As the human tongue is not capable of giving the requisite articulations to a rapid succession of notes, and generally slurs over one-half of them, the automaton was thus able to excel the best performers, as it played complete airs with articulations of the tongue at every note.

In constructing this machine M. Vaucanson observed that the flageolet must be a most fatiguing instrument for the human lungs, as the muscles of the chest must make an effort equal to fifty-six pounds in order to produce the highest notes. A single ounce was sufficient for the lowest notes, so that we may, from this circumstance, form an idea of the variety of intermediate effects required to be produced.

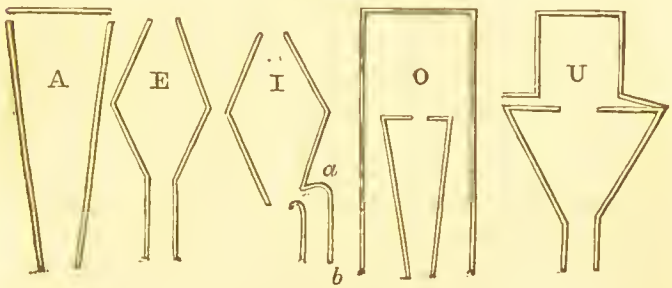
While M. Vaucanson was engaged in the construction of these wonderful machines, his mind was filled with the strange idea of constructing an automaton containing the whole mechanism of the circulation of the blood. From some birds which he made, he was satisfied of its practicability; but as the whole vascular system required to be made of elastic gum or caoutchouc, it was supposed that it could only be executed in the country where the caoutchouc-tree was indigenous. Louis XVI. took a deep interest in the execution of this machine. It was agreed that a skilful anatomist should proceed to Guiana to superintend the construction of

the blood-vessels, and the king had not only approved of, but had given orders for, the voyage. Difficulties, however, were thrown in the way, Vaucanson became disgusted, and the scheme was abandoned.

The two automata which we have described were purchased by Professor Bayreuss of Helmstadt; but we have not been able to learn whether or not they still exist.

Towards the end of the nineteenth century a bold and almost successful attempt was made to construct a *talking automaton*. In the year 1779, the Imperial Academy of Sciences at St. Petersburg proposed as the subject of one of their annual prizes an inquiry into the nature of the vowel sounds, A, E, I, O, and U, and the construction of an instrument for artificially imitating them. This prize was gained by M. Kratzenstein, who showed that all the vowels could be distinctly pronounced by blowing through a reed into the lower ends of the pipes of the annexed figures, as shown in Fig. 48,

Fig. 48.

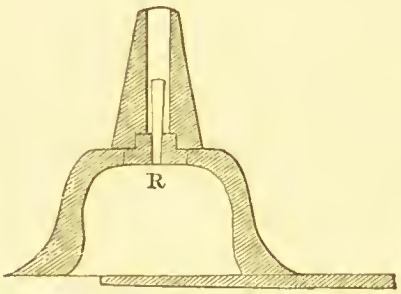


where the corresponding vowels are marked on the different pipes. The vowel I is pronounced by

merely blowing into the pipe *a b*, of the pipe marked I, without the use of a reed.

About the same time that Kratzenstein was engaged in these researches, M. Kempelen of Vienna, a celebrated mechanician, was occupied with the same subject. In his first attempt he produced the vowel sounds, by adapting a reed R, Fig. 49, to

Fig. 49.



the bottom of a funnel-shaped cavity A B, and placing his hand in various positions within the funnel. This contrivance, however, was not fitted for his purpose, but after long study, and a diligent examination of the organs of speech, he contrived a hollow oval box, divided into two portions attached by a hinge so as to resemble jaws. This box received the sound which issued from the tube connected with the reed, and by opening and closing the jaws, he produced the sounds, A, O, O U, and an imperfect E, but no indications of an I. After two years' labour he succeeded in obtaining from different jaws the sounds of the consonants P, M, L, and by means of these vowels and consonants, he could compose syllables and words, such as *mamma*, *papa*, *aula*, *lama*, *mulo*. The

sounds of two adjacent letters, however, ran into each other, and an aspiration followed some of the consonants; so that, instead of *papa*, the word sounded *phaa-ph-a;* these difficulties he contrived with much labour to surmount, and he found it necessary to imitate the human organs of speech by having only one mouth and one glottis. The mouth consisted of a funnel, or bell-shaped piece of elastic gum, which approximated, by its physical properties, to the softness and flexibility of the human organs*. To the mouth-piece was added a nose made of two tin tubes, which communicated with the mouth. When both these tubes were open, and the mouth-piece closed, a perfect M was produced; and when one was closed and the other open, an N was sounded. M. Kempelen could have succeeded in obtaining the four letters D, G, K, T, but, by using a P instead of them, and modifying the sound in a particular manner, he contrived to deceive the ear by a tolerable resemblance of these letters.

There seems to be no doubt that he at last was able to produce entire words and sentences, such as *opera*, *astronomy*, *Constantinopolis*, *Vous êtes mon ami*, *Je vous aime de tout mon cœur*, *Venez avec moi à Paris*, *Leopoldus secundus*, *Romanorum imperator semper Augustus*, &c., but he never fitted up a speaking figure; and probably, from being dissatisfied with the general result of his

* Had M. Kempelen known the modern discovery of giving glue any degree of softness, by mixing it with molasses or sugar, which is always absorbing moisture from the atmosphere, he might have obtained a still more perfect imitation of the human organs.

labours, he exhibited only to his private friends the effects of the apparatus, which was fitted up in the form of a box.

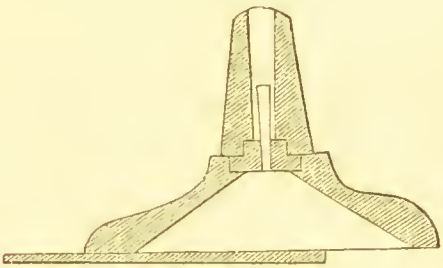
This box was rectangular, and about three feet long, and was placed upon a table, and covered with a cloth. When any particular word was mentioned by the company, M. Kempelen caused the machine to pronounce it, by introducing his hands beneath the cloth, and apparently giving motion to some parts of the apparatus. Mr. Thomas Collinson, who had seen this machine in London, mentions, in a letter to Dr. Hutton, that he afterwards saw it at M. Kempelen's own house in Vienna, and that he then gave it the same word to be pronounced which he gave it in London, viz. the word *Exploitation*, which, he assures us, it again distinctly pronounced with the French accent.

M. Kratzenstein seems to have been equally unsuccessful; for though he assured M. de Lalande, when he saw him in Paris in 1786, that he had made a machine which could speak pretty well, and though he showed him some of the apparatus by which it could sound the vowels, and even such syllables as *papa* and *mamma*, yet there is no reason to believe that he had accomplished more than this.

The labours of Kratzenstein and Kempelen have been recently pursued with great success by our ingenious countryman, Mr. Willis, of Cambridge. In repeating Kempelen's experiment, shown in Fig. 49, he used a shallower cavity, such as that in Fig. 50, and found that he could entirely dispense with the introduction of the

hand, and could obtain the whole series of vowels by sliding a flat board C D over the mouth of the cavity. Mr. Willis then conceived the idea of adapting to the reed cylindrical tubes, whose

Fig. 50.



C D

length could be varied by sliding joints. When the tube was greatly less than the length of a stopped pipe in unison with the reed, it sounded I, and by increasing the length of the tube, it gave E, A, O, and U, in succession. But what was very unexpected, when the tube was so much lengthened as to be 1½ times the length of a stopped pipe in unison with the reed, the vowels began to be again sounded in an inverted order, viz. U, O, A, E, and then again in a direct order, I, E, A, O, U, when the length of the tube was equal to twice that of a stopped pipe, in unison with the reed.

Some important discoveries have been recently made by M. Savart respecting the mechanism of the human voice*; and we have no doubt that, before another century is completed, a *Talking* and a *Singing machine* will be numbered among the conquests of Science.

* See Edinburgh Journal of Science, No. viii. p. 200.

person who emits the sound. A person who sings hears only his own voiee, while those who listen hear only the eeho, which sometimes seems to approaeh, and at other times to reeede from the ear; one person hears a single sound, another several sounds, and one hears it on the right, and another on the left, the effect always changing as the hearer changes his position. Dr. Bireh has deseribed an extraordinary eeho at Roseneath, in Argyleshire, which eertainly does not now exist. When eight or ten notes were played upon a trumpet, they were eorreetly repeated, but on a key a third lower. After a short pause, another repetition of the notes was heard in a still lower tone, and after another short interval they were repeated in a still lower tone.

In the same manner as light is always lost by reflexion, so the waves of sound are enfeebled by reflexion from ordinary surfaees, and the echo is in sueh cases fainter than the original sound. If the refleeting surfaee, however, is eireular, sound may be eondensed and rendered stronger in the same manner as light. I have seen a fine example of this, in the eireular turn of a garden wall nearly a mile distant from a weir aeross a river. When the air is pure and homogeneous, the rushing sound of the water is refleeted from the hollow surface of the wall, and eoneentrated in a focus, the place of whieh the ear ean easily diseover from the intensity of the sound being there a maximum. A person not acquainted with the loeality eoneeives that the rushing noise is on the other side of the wall.

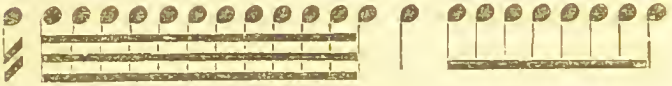
In whispering galleries, or places where the

lowest whispers are carried to distances at which the direct sound is inaudible, the sound may be conveyed in two ways, either by repeated reflexions from a curved surface in the direction of the sides of a polygon inscribed in a circle, or where the whisperer is in the focus of one reflecting surface, and the hearer in the focus of another reflecting surface, which is placed so as to receive the reflected sounds. The first of these ways is exemplified in the whispering gallery of St. Paul's, and in the octagonal gallery of Gloucester Cathedral, which conveys a whisper seventy-five feet across the nave; and the second in the baptistery of a church in Pisa, where the architect, Giovanni Pisano, is said to have constructed the cupola on purpose. The cupola has an elliptical form, and when one person whispers in one focus, it is distinctly heard by the person placed in the other focus, but not by those who are placed between them. The sound first reflected passes across the cupola, and enters the ears of the intermediate persons, but it is too feeble to be heard till it has been condensed by a second reflexion to the other focus of ellipse. A naval officer, who travelled through Sicily in the year 1824, gives an account of a powerful whispering place in the cathedral of Girgenti, where the slightest whisper is carried with perfect distinctness through a distance of two hundred and fifty feet, from the great western door to the cornice behind the high altar. By an unfortunate coincidence, the focus of one of the reflecting surfaces was chosen for the place of the confessional; and when this was accidentally discovered, the lovers of secrets resorted to the other

focus, and thus became acquainted with confessions of the gravest import. This divulgence of scandal continued for a considerable time, till the eager curiosity of one of the dilettanti was punished, by hearing his wife's avowal of her own infidelity. This circumstance gave publicity to the whispering peculiarity of the cathedral, and the confessional was removed to a place of greater secresy.

An echo of a very peculiar character has been described by Sir John Herschel in his Treatise on Sound, as produced by the suspension bridge across the Menai strait in Wales. "The sound of a blow with a hammer," says he, "on one of the main piers, is returned in succession from each of the cross beams which support the road-way, and from the opposite pier at a distance of five hundred and seventy-six feet; and in addition to this, the sound is many times repeated between the water and the road-way. The effect is a series of sounds which may be thus written: the first return is

Fig. 51.



sharp and strong from the road-way overhead; the rattling which succeeds dies away rapidly, but the single repercussion from the opposite pier is very strong, and is succeeded by a faint palpitation, repeating the sound at the rate of twenty-eight times in five seconds, and which, therefore, corresponds to a distance of a hundred and eighty-four feet, or very nearly the double interval from the road-way to the water. Thus it appears that in the reper-

cussion between the water and road-way, that from the latter only affects the ear, the line drawn from the auditor to the water being too oblique for the sound to diverge sufficiently in that direction. Another peculiarity deserves especial notice, namely, that the echo from the opposite pier is best heard when the auditor stands precisely opposite to the middle of the breadth of the pier, and strikes just on that point. As it deviates to one or the other side, the return is proportionally fainter, and is scarcely heard by him when his station is a little beyond the extreme edge of the pier, though another person, stationed (on the same side of the water) at an equal distance from the central point, so as to have the pier between them, hears it well."

A remarkable subterranean echo is often heard when the hoofs of a horse or the wheels of a carriage pass over particular spots of ground. This sound is frequently very similar to that which is produced in passing over an arch or vault, and is commonly attributed to the existence of natural or artificial caves beneath. As such caves have often been constructed in times of war as places of security for persons and property, many unavailing attempts have been made to discover hidden treasures where their locality seemed to be indicated by subterraneous sounds. But though these sounds are sometimes produced by excavations in the ground, yet they generally arise from the nature of the materials of which the ground is composed, and from their manner of combination. If the hollow of a road has been filled up with broken rock, or with large water-worn stones, having hollows either left entirely empty, or filled up with

materials of different density, then the sound will be reflected in passing from the loose to the dense materials, and there will arise a great number of echoes reaching the ear in rapid succession, and forming by their union a hollow rumbling sound. This principle has been very successfully applied by Sir John Herschel to explain the subterranean sounds with which every traveller is familiar who has visited the Solfaterra, near Naples. When the ground at a particular place is struck violently by throwing a large stone against it, a peculiar hollow sound is distinctly heard. This sound has been ascribed by some geologists to the existence of a great vault communicating with the ancient seat of the volcano, by other writers to a reverberation from the surrounding hills with which it is nearly concentric, and by others to the porosity of the ground. Dr. Daubeny, who says that the hollow sound is heard when any part of the Solfaterra is struck, accounts for it by supposing that the hill is not made up of one entire rock, but of a number of detached blocks, which, hanging as it were by each other, form a sort of vault over the abyss within which the volcanic operations are going on*. Mr. Forbes, who has given the latest and most interesting description of this singular volcano †, agrees in opinion with Dr. Daubeny, while Mr. Scrope ‡ and Sir John Herschel concur in opinion that no such cavities exist. "It seems most probable," says the latter, "that the hollow

* Description of Volcanoes, p. 170.

† *Edinburgh Journal of Science*, N. Series, No. i. p. 124.

‡ Considerations on Volcanoes, and *Edinburgh Journal of Science*, No. xx. p. 261, and No. xiv. p. 265.

reverberation is nothing more than an assemblage of partial echoes arising from the reflexion of successive portions of the original sound in its progress through the soil at the innumerable half-coherent surfaces composing it: were the whole soil a mass of sand, these reflexions would be so strong and frequent as to destroy the whole impulse, in too short an interval to allow of a distinguishable after sound. It is a case analogous to that of a strong light, thrown into a milky medium or smoky atmosphere; the whole medium appears to shine with a nebulous undefined light. This is to the eye what such a hollow sound is to the ear*."

It has been recently shown by M. Savart, that the human ear is so extremely sensible as to be capable of appreciating sounds which arise from about *twenty-four thousand* vibrations in a second, and consequently, that it can hear a sound which lasts only the twenty-four thousandth part of a second. Vibrations of such frequency afford only a shrill squeak or chirp; and Dr. Wollaston has shown that there are many individuals with their sense of hearing entire, who are altogether insensible to such acute sounds, though others are painfully affected by them. Nothing, as Sir John Herschel remarks, can be more surprising than to see two persons, neither of them deaf, the one complaining of the penetrating shrillness of a sound, while the other maintains there is no sound at all. Dr. Wollaston has also shown that this is true also of very grave sounds; so that the hearing or not hearing of musical notes at both extremities of the scale seems to depend wholly on the pitch or

* Art. *Sound*, Encycl. Metrop. § 110.

frequeney of vibration eonstituting the note, and not upon the intensity or loudness of the noise. This affeetion of the ear sometimes appears in cases of eommon deafness, where a shrill tone of voiee, sueh as that of women and ehildren, is often better heard than the loud and deeper tone of men.

Dr. Wollaston remarked, that when the mouth and nose are shut, the tympanum or drum of the ear may be so exhausted by a foreible attempt to take breath by the expansion of the chest, the pressure of the external air upon the membrane gives it sueh a tension that the ear beeomes insensible to grave tones, without losing in any degree the pereeption of sharper sounds. Dr. Wollaston found, that after he had got into the habit of making the experiment, so as to be able to produce a great degree of exhaustion, his ears were insensible to all sounds below F, marked by the base clef. "If I strike the table before me," says he, "with the end of my finger, the whole board sounds with a deep dull note. If I strike it with my nail, there is also at the same time a sharp sound produeed by quicker vibrations of parts around the point of eontaet. When the ear is exhausted, it hears only the latter sound, without pereeiving in any degree the deeper note of the whole table. In the same manner, in listening to the sound of a carriage, the deeper rumbling noise of the body is no longer heard by an exhausted ear; but the rattle of a chain or loose serew remains at least as audible as before exhaustion." Dr. Wollaston supposes that this exeessive tension of the drum of the ear, when produeed by the eompressed air in the diving-bell, will also produee a corresponding *deafness to*

low tones. This curious experiment has been since made by Dr. Colladon, when descending in the diving-bell at Howth, in 1820. "We descended," says he, "so slowly that we did not notice the motion of the bell; but as soon as the bell was immersed in water, we felt about the ears and the forehead a sense of pressure, which continued increasing during some minutes. I did not, however, experience any pain in the ears; but my companion suffered so much that we were obliged to stop our descent for a short time. To remedy that inconvenience, the workmen instructed us, after having closed our nostrils and mouth, to endeavour to swallow, and to restrain our respiration for some moments, in order that, by this exertion, the internal air might act on the Eustachian tube. My companion, however, having tried it, found himself very little relieved by this remedy. After some minutes, we resumed our descent. My friend suffered considerably; he was pale; his lips were totally discoloured; his appearance was that of a man on the point of fainting; he was in involuntary low spirits, owing, perhaps, to the violence of the pain, added to that kind of apprehension which our situation unavoidably inspired. This appeared to me the more remarkable, as my case was totally the reverse. I was in a state of excitement resembling the effect of some spirituous liquor. I suffered no pain; I experienced only a strong pressure round my head, as if an iron circle had been bound about it. I spoke with the workmen, and had some difficulty in hearing them. This difficulty of hearing rose to such a height, that during three or four minutes I could not hear them speak. I

could not, indeed, hear myself speak, though I spoke as loudly as possible; nor did even the great noise caused by the violence of the current against the sides of the bell reach my ears."

The effect thus described by Dr. Colladon is different from that anticipated by Dr. Wollaston. He was not merely deaf to low tones, but to all sounds whatever; and I have found, by repeated experiment, that my own ears become perfectly insensible even to the shrill tones of the female voice, and of the voice of a child, when the drum of the ear is thrown into a state of tension by yawning.

With regard to sounds of high pitch at the other extremity of the scale, Dr. Wollaston has met with persons, whose hearing was in other respects perfect, who never heard the chirping of the *Gryllus campestris*, which commonly occurs in hedges during a summer's evening, or that of the house-cricket, or the squeak of the bat, or the chirping of the common house-sparrow. The note of the bat is a full octave higher than that of the sparrow; and Dr. Wollaston believes that the note of some insects may reach one octave more, as there are sounds decidedly higher than that of a small pipe, one-fourth of an inch in length, which he conceives cannot be far from six octaves above the middle E of the piano-forte. "The suddenness of the transition," says Dr. Wollaston, "from perfect hearing to total want of perception, occasions a degree of surprise, which renders an experiment on this subject with a series of small pipes among several persons rather amusing. It is curious to observe the change of feeling manifested by various individuals of the party, in succession, as the sounds

approaeh and pass the limits of their hearing. Those who enjoy a temporary triumph are often compelled in their turn to aeknowledge to how short a distanee their little superiority extends." In coneluding his interesting paper on this subject, Dr. Wollaston eonjeeturcs that animals, like the grylli (whose powers of hearing appear to commencc nearly where ours terminatc), may have the power of hearing still sharper sounds which at present we do not know to exist, and that there be other inseets having nothing in common with us, but who are endowed with a power of exeiting, and a sense of pereeiving vibrations whieh make no impression upon our organs, while their organs are equally insensible to the slower vibrations to which we are aeeustomed.

With the view of studying the elass of sounds inaudible to eertain ears, we would recommend it to the young naturalist to examine the sounds emitted by the inseet tribe, both in relation to their effect upon the human ear, and to the meehanism by which they are produeed. The Cicadæ or locusts in North Ameriea appear, from the observations of Dr. Hildreth*, to be furnished with a bagpipe on which they play a variety of notes. "When any one passes," says he, "they make a great noise and sereaming with their air-bladder or bagpipes. These bags are plaeed under, and rather behind, the wings in the axilla, something in the manner of using the bagpipes with the bags under the arms —I eould eompare them to nothing else; and, indeed, I suspeet the first inventor of the instrument borrowed his ideas from some insect of this kind.

* *Edinburgh Journal of Science*, No. xvii., p. 158.

They play a variety of notes and sounds, one of which nearly imitates the scream of the tree toad."

Among the acoustic wonders of the natural world may be ranked the vocal powers of the statue of Memnon, the son of Aurora, which modern discoveries have withdrawn from among the fables of ancient Egypt. The history of this remarkable statue is involved in much obscurity. Although Strabo affirms that it was overturned by an earthquake, yet as Egypt exhibits no traces of such a convulsion, it has been generally believed that the statue was mutilated by Cambyses. Ph. Casselius, in his dissertation on vocal or speaking stones, quotes the remark of the scholiast in Juvenal, "that, when mutilated by Cambyses, the statue which saluted both the sun and the king, afterwards saluted only the sun." Philostratus, in his life of Apollo, informs us, that the statue looked to the east, and that it spoke as soon as the rays of the rising sun fell upon its mouth. Pausanias, who saw the statue in its dismantled state, says, that it is a statue of the sun, that the Egyptians call it Phamenophis, and not Memnon, and *that it emits sounds every morning at sunrise, which can be compared only to that of the breaking of the string of a lyre.* Strabo speaks only of a single sound which he heard; but Juvenal, who had probably heard it often during his stay in Egypt, describes it as if it emitted several sounds.

> Dimidio magicæ resonant ubi Memnone chordæ.
> Where broken Memnon sounds his magic strings.

The simple sounds which issued from the statue were, in the progress of time, magnified into intelligible words, and even into an oracle of seven

verses, and this prodigy has been recorded in a Greek inscription on the left leg of the statue. But though this new faculty of the colossus was evidently the contrivance of the Egyptian priests, yet we are not entitled from this to call in question the simple and perfectly credible fact that it emitted sounds. This property, indeed, it seems to possess at the present day; for we learn*, that an English traveller, Sir A. Smith, accompanied with a numerous escort, examined the statue, and that at six o'clock in the morning he heard very distinctly the sounds which had been so celebrated in antiquity. He asserts that this sound does not proceed from the statue but from the pedestal; and he expresses his belief that it arises from the impulse of the air upon the stones of the pedestal, which are arranged so as to produce this surprising effect. This singular description is, to a certain extent, confirmed by the description of Strabo, who says, that he was quite certain that he heard a sound which proceeded either *from the base*, or from the colossus, or from some one of the assistants. As there were no Egyptian priests in the escort of Sir A. Smith, we may now safely reject this last, and, for many centuries, the most probable hypothesis.

The explanation suggested by Sir A. Smith had been previously given in a more specific form by M. Dussaulx, the translator of Juvenal. "The statue," says he, "being hollow, the heat of the sun heated the air which it contained, and this air, issuing at some crevice produced the sounds of which the priests gave their own interpretation."

Rejecting this explanation, M. Langles, in his

* Révue Encyclopédique, 1821, tome ix. p. 592.

dissertation on the vocal statue of Memnon, and M. Salverte, in his work on the occult sciences, have ascribed the sounds entirely to Egyptian priest-craft, and have even gone so far as to describe the mechanism by which the statue not only emitted sounds, but articulated distinctly the intonations appropriate to the seven Egyptian vowels, and consecrated to the seven planets. M. Langles conceives that the sounds may be produced by a series of hammers, which strike either the granite itself, or sonorous stones like those which have been long used in China for musical instruments. M. Salverte improves this imperfect apparatus, by supposing that there might be adapted to these hammers a clepsydra, or water-clock, or any other instrument fitted to measure time, and so constructed as to put the hammers in motion at sunrise. Not satisfied with this supposition, he conjectures that the spring of all this mechanism was to be found in the art of concentrating the rays of the sun, which was well known to the ancients. Between the lips of the statue, or in some less remarkable part of it concealed from view by its height, he conceives an aperture to be perforated, containing a lens or a mirror capable of condensing the rays of the rising sun upon one or more metallic levers, which by their expansion put in motion the seven hammers in succession. Hence he explains why the sounds were emitted only at sunrise, and when the solar rays fell upon the mouth of the statue, and why they were never again heard till the sun returned to the eastern horizon. As a piece of mechanism, this contrivance is defective in not providing for the change in the sun's amplitude, which is very

considerable even in Egypt, for as the statue and the lens are both fixed, and as the sounds were heard at all seasons of the year, the same lens which threw the midsummer rays of the sun upon the hammers could not possibly throw upon them his rays in winter. But even if the machinery were perfect, it is obvious that it could not have survived the mutilation of the statue, and could not, short of a miracle, have performed its part in the time of Sir A. Smith.

If we abandon the idea of the whole being a trick of the priesthood, which has been generally done, and which the recent observations of Sir A. Smith authorize us to do, we must seek some natural cause for the phenomena similar to that suggested by Dussaulx. It is curious to observe how the study of nature gradually dispels the consecrated delusions of ages, and reduces to the level of ordinary facts what time had invested with all the characters of the supernatural: and in the present case it is no less remarkable that the problem of the statue of Memnon should have been first solved by means of an observation made by a solitary traveller wandering on the banks of the Orinoco. "The granitic rock," says Baron Humboldt, "on which we lay, is one of those where travellers on the Orinoco have heard from time to time, towards sunrise, subterraneous sounds resembling those of the organ. The missionaries call these stones *loxas de musica*. 'It is witchcraft,' said our young Indian pilot. We never ourselves heard these mysterious sounds either at Cariehana Vieja or in the upper Orinoco: but from information given us by witnesses worthy of belief, the existence of

a phenomenon that seems to depend on a certain state of the atmosphere cannot be denied. The shelves of rock are full of very narrow and deep creviees. They are heated during the day to about 50°. I often found their temperature at the surfaee during the night at 39°, the surrounding atmosphere being at 28°. It may easily be conceived that the difference of temperature between the subterrancous and the external air attains its maximum about sunrise, or at that moment which is at the same time farther from the period of the maximum of the heat of the preeeding day. May not these sounds of an organ, then, which are heard when a person sleeps upon the roek, his ear in contact with the stone, be the effect of a current of air that issues out through the crevices? Does not the impulse of the air against the elastic spangles of mica that intercept the crevices contribute to modify the sounds? May we not admit that the ancient inhabitants of Egypt, in passing incessantly up and down the Nile, had made the same observation on some rock of the Thebaid, and that the music of the rocks there led to the jugglery of the priests in the statue of Memnon?"

This curious case of the production of sounds in granite rocks at sunrise might have been regarded as a transatlantie wonder which was not applicable to Egypt; but by a singular eoincidence of observation, MM. Jomard, Jollois, and Devilliers, who were travelling in Egypt nearly about the same time that M. Humboldt was traversing the wilds of South Ameriea, heard, *at sunrise*, *in a monument of granite*, situated near the centre of the spot on whieh the palaee of Carnae stands, *a noise*

resembling that of a breaking string, the very expression by which Pausanias characterizes the sound in the Memnonian granite. The travellers regarded these sounds as arising from the transmission of rarefied air through the crevices of a sonorous stone, and they were of the same opinion with Humboldt, that these sounds might have *suggested* to the Egyptian priests *the jugglerics of the Memnonium*. Is it not strange that the Prussian and the French travellers should not have gone a step farther, and solved the problem of two thousand years, by maintaining that the sound of the statue of Memnon was itself a natural phenomenon, or a granite sound elicited at sunrise by the very same causes which operated on the Orinoco and in the temple of Carnac, in place of regarding it as a trick in imitation of natural sounds? If, as Humboldt supposes, the ancient inhabitants of Egypt had, in passing incessantly up and down the Nile, become familiar with the music of the granite rocks of the Thebaid, how could the imitation of such natural and familiar sounds be regarded by the priests as a means of deceiving the people? There could be nothing marvellous in a colossal statue of granite giving out the very same sounds that were given out at the same time of the day by a granite rock; and in place of reckoning it a supernatural fact, they could regard it in no other light than as the duplicate of a well-known natural phenomenon. It is a mere conjecture, however, that such sounds were common in the Thebaid; and it is therefore probable that a granite rock, possessing the property of emitting sounds at sunrise, had been discovered by the priests, who

were at the same time the philosophers of Egypt, and that the block had been employed in the formation of the Memnonian statue for the purpose of impressing upon it a supernatural character, and enabling them to maintain their influence over a credulous people.

The inquiries of recent travellers have enabled us to corroborate these views, and to add another remarkable example of the influence of subterraneous sounds over superstitious minds. About three leagues to the north of Tor in Arabia Petræa, is a mountain, within the bosom of which the most singular sounds have been heard. The Arabs of the Desert ascribe these sounds to a convent of monks preserved miraculously underground; and the sound is supposed to be that of the *Nakous*, a long narrow metallic ruler suspended horizontally, which the priest strikes with a hammer for the purpose of assembling the monks to prayer. A Greek was said to have seen the mountain open, and to have descended into the subterranean convent, where he found fine gardens and delicious water; and, in order to give proof of his descent, he produced some fragments of consecrated bread, which he pretended to have brought from the subterranean convent. The inhabitants of Tor likewise declare that the camels are not only frightened but rendered furious when they hear these subterraneous sounds.

M. Seetzen, the first European traveller who visited this extraordinary mountain, set out from Wodyel Nackel on the 17th of June, at five o'clock in the morning. He was accompanied by a Greek Christian and some Bedouin Arabs, and after a

quarter of an hour's walk they reached the foot of a majestic rock of hard sandstone. The mountain itself was quite bare and entirely composed of it. He found inscribed upon the rock several Greek and Arab names, and also some Koptic characters, which proved that it had been resorted to for centuries. About noon the party reached the foot of the mountains called *Nakous*, where at the foot of a ridge they beheld an insulated peaked rock. This mountain presented upon two of its sides two sandy declivities about 150 feet high, and so inclined that the white and slightly adhering sand which rests upon its surface is scarcely able to support itself; and when the scorching heat of the sun destroys its feeble cohesion, or when it is agitated by the smallest motions, it slides down the two acclivities. These declivities unite behind the insulated rock, forming an acute angle, and, like the adjacent surfaces, they are covered with steep rocks which consist chiefly of a white and friable freestone.

The first sound which grected the ears of the travellers took place at an hour and a quarter after noon. They had climbed with great difficulty as far as the sandy declivity, a height of seventy or eighty feet, and had rested beneath the rocks where the pilgrims are accustomed to listen to the sounds.

While in the act of climbing, M. Seetzen heard the sound from beneath his knees,[3] and hence he was led to think that the sliding of the sand was the cause of the sound, and not the effect of the vibration which it occasioned. At three o'clock the sound became louder, and continued six mi-

nutes, and after having ceased for ten minutes, it was again heard. The sound appeared to have the greatest resemblance to that of the humming-top, rising and falling like that of an Eolian harp. Believing that he had discovered the true origin of the sound, M. Seetzen was anxious to repeat the experiment, and with this view he climbed with the utmost difficulty to the highest rocks, and, sliding down as fast as he could, he endeavoured, with the help of his hands and feet, to set the sand in motion. The effect thus produced far exceeded his expectations, and the sand in rolling beneath him made so loud a noise, that the earth seemed to tremble to such a degree that he states he should certainly have been afraid if he had been ignorant of the cause.

M. Seetzen throws out some conjectures respecting the cause of these sounds. Does the rolling layer of sand, says he, act like the fiddle-bow, which on being rubbed upon a plate of glass raises and distributes into regular figures the sand with which the plate is covered? Does the adherent and fixed layer of sand perform here the part of the plate of glass, and the neighbouring rocks that of the sounding body? We cannot pretend to answer these questions, but we trust that some philosopher competent to the task will have an opportunity of examining these interesting phenomena with more attention, and describing them with greater accuracy.

The only person, so far as I can learn, who has visited El-Nakous since the time of Seetzen, is Mr. Gray, of University College, Oxford; but he has not added much to the information acquired by

his predeeessor. During the first visit whieh he made to the plaee, he heard at the end of a quarter of an hour a low continuous murmuring sound beneath his feet, whieh gradually changed into pulsations as it became louder, so as to resemble the striking of a cloek, and at the end of five minutes it became so strong as to detaeh the sand. Returning to the spot next day, he heard the sound still louder than before. He could not observe any crevices by which the external air eould penetrate; and as the sky was serene and the air calm, he was satisfied that the sounds eould not arise from this eause*.

* See *Edinburgh Journal of Science*, No. xi. p. 153; and No. xiii. page 51.

86356

LETTERS

ON

NATURAL MAGIC,

ADDRESSED TO

SIR WALTER SCOTT, BART.

BY

SIR DAVID BREWSTER, K.H.

LL.D., F.R.S., V.P.R.S.E., &c. &c.

LONDON:

JOHN MURRAY, ALBEMARLE-STREET.

MDCCCXXXIV.