

tized, in the hope that a minister of their own persuasion would appear. Four years having elapsed without bringing one, they approached me on the subject. As a matter of course, I referred them to their own missionary, Mr. Lawrence, and said that, after satisfying him, I should have no difficulty about dispensing the ordinance in the parish church. Accordingly, on the afternoon of the Saturday on which we left, the boats returned earlier than usual from sea, and over a hundred of the inhabitants met along with my shipwrecked crew in the parish church. The service altogether was the most interesting it has ever fallen to my lot to conduct. There was good reason for this common thanksgiving from myself and companions, and the desire to have the service was spontaneous on the part of the latter. Then, after sermon, there were a few words of acknowledgment to be said to the kind-hearted islanders. Eight children were presented for baptism from six Methodist families, and as we left the church our look-out announced that the smoke of the St. Magnus, on her way to Lerwick, was visible, so all that was left for us was to bid a hurried adieu to our hosts, and set off to intercept the passing steamer, which we accomplished, as the sea was still smooth.

"No one who knows the kind of structure that is commonly in use as a church in these northern isles will expect to find elegance in the church at Fair Isle. I am sorry to say, however, that it is mean in the extreme, and very far from comfortable."

Fair Isle was long the property of the Sinclairs of Querdale, from which family it passed (as tradition says at a game of brag) to Stewart, of Brough, Orkney. In 1866 it was sold by the representative of that family to its present proprietor.

NATURAL MAGIC.

BY JOHN NEVIL MASKELYNE.

IV.—ACOUSTICS.

THE science of acoustics, though little cultivated, is a most valuable one. Sound does not, by any means, "signify nothing," for we owe some of our most pleasing sensations to it. The power of audibly communicating our thoughts, or of appreciating music, is only truly estimated, indeed, by those who have once enjoyed it and then been deprived by deafness of the blessing.

All sound is vibration, and sonorous air-waves travel in ever-widening circles exactly as rings form in water when a pebble is dropped therein; but it can be deflected from its course, obeying much the same laws as light, and presenting some curious effects that come within the scope of our subject. Thus Echo, "the daughter of the voice," is a potent ally in magical arts; she lurks in buildings, grottoes, rocks, forests, and rivers,—

"By whose falls
Melodious birds sing madrigals,"

and is ever ready mockingly to repeat our words. When the reflecting surface is at such a distance from us that the original and return sounds are not blended, the phenomenon is at its best. At Lurley-Feis, upon the Rhine, the voice is reproduced by echo seventeen times; and at the Villa Simonetta, near Milan, there are thirty or more reverberations.

Dr. Plot speaks of an echo in Woodstock Park that has the peculiarity of repeating seventeen syllables by day and twenty by night. The most noted cavern echo was that at Syracuse, in Sicily. This cave was called the "Ear of Dionysius," and it is said to have been a natural ear-trumpet. Here the tyrant placed his prisoners, whose lightest words could be heard by the sentinel without.

One of the most marvellous of echoes is at our own doors in the Whispering Gallery of St. Paul's Cathedral. Here you turn your face to the wall and speak in a low tone, and the words will be heard upon the opposite side of the dome, but not at any intermediate point. The East Gallery of Gloucester Cathedral has a remarkable echo, as also has the Abbey Church of St. Albans; and the Hall of Secrets, in the Observatory, Paris, gives another striking example of this class of phenomena.

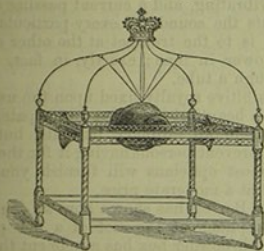
Some of the reflections of sound here named are natural, others artificial. A very curious echo of the latter sort is in the famous Baptistry of Pisa. Sir David Brewster observes that "the architect, Giovanni Pisani, is said to have thus constructed the cupola on purpose. The Pisan cupola has an elliptical 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 person, but it is too feeble to be heard till it has been condensed by a second reflection to the other focus of the ellipse."

In the cathedral of Girgenti, Sicily, a whisper is carried a distance of two hundred and fifty feet. It seems that the focus of one of the reflecting surfaces was, by a malapropos choice, selected for the confessional, and some persons aware of the effect resorted to the other focus to gather the scandalous secrets entrusted by the penitent to the ghostly fathers. It is proverbial that listeners seldom or never hear any good of or for themselves, and it proved so on this occasion, for one of the eavesdroppers, when his wife came to be shriven, listened to the recital of some confessions that led to a domestic catastrophe, and to the revelation of the strange acoustical properties of the building.

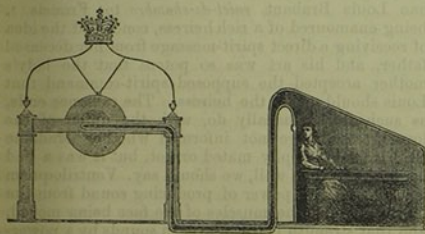
The celebrated Marquis of Worcester, the inventor of the steam-engine in its primitive form (the "fire-engine" used at Ffoxhall [Vauxhall] waterworks in 1670), utilised his knowledge of the reflection of sound, according to Dr. W. Hooper, in the construction of a speaking-machine upon this principle; and undoubtedly it can be accomplished, as Sir David Brewster observes, "by means of two concave mirrors placed directly opposite to each other, so that the head of the assistant may be in one of the foci, and the mouth of the trumpet in the other, a hole being made in the partition between the assistant and the figure, corresponding in size and situation to the mirrors, and filled up by a very thin cloth to prevent suspicion." This scarcely, in my view, meets the marquis's idea, which he thus mentions in his "Century of Inventions": "How to make a brazen or stone head, in the midst of a great field or garden, so artificial and natural that though a man speak never so softly into the ear thereof, it will presently open its mouth and resolve the question in French, Latin, Welsh, Irish, or English, in good terms, uttering it out of its mouth, and then shut it until the next question be asked."

Here we find the machine is to be placed in an open space, and it is difficult to imagine the reflectors would work as in an enclosed place. It is much more likely that the marquis used tubes by which sound can be conveyed for long distances and by devious ways. Even such devices were enigmas once, but they have now left the region of the wonderful for the more steady, if not so brilliant, line of usefulness, performing valuable offices by putting top-floor and basement of our largest hotels and warehouses upon friendly speaking terms.

The first "speaking figure" that we can refer to with certainty as worked upon this principle, was the property of one Irson, an English conjuror, who exhibited the marvellous creation before Charles II. It caused great surprise by its ready and pertinent answers to his Majesty, but one of the pages unfortunately stumbled across the juggler's accomplice in an adjoining apartment, speaking through a tube connected with the figure. The most successful illusion of this kind was that produced in Paris by M. Charles, about 1825, and subsequently in London, and known as "The Invisible Girl." Fig. 1 represents this machine in perspective; it was a fixture in the centre of the floor. A hollow copper ball, about one foot in diameter, was suspended by ribbons from the four bent wires springing from the outer



supports, and to the ball were affixed four trumpets with their mouths outwards. The lips being placed near any of these, a message was sent, and the answer came back in, apparently, a child's voice, but quite audible to those who listened at any of the trumpet-mouths. It is needless to say now that the lady operator sat in another room, and the messages to or from her were conveyed from or to the trumpet-mouths by means of a pipe laid beneath the flooring and passing concealed through the framework to the trumpets. Several other speaking-machines—genuine efforts at obtaining words by



mechanism, and tricks—will be included in my papers upon "Automata."

Wood is a good conductor of sound, especially deals and other light varieties. The stethoscope, invented by Laemac, in 1819, by which we can listen to the heart's action, is simply a wooden cylinder. The scratch of a pin on one end of a fallen tree, though so slight that the person who makes it hears no sound, may be noticed at the other end by applying one's ear to the trunk of the tree. Sir Charles Wheatstone carried a concert from the cellar to the garret of a house by means of four deal rods. The lower ends of these rested respectively upon a piano, violin, violoncello, and a clarinet, and they carried the music from these instruments to elastic sounding-boards in "the parlour that's next to the sky," whose vibrations made a murmuring "i' the air" of such strange beauty as to be only comparable to the strains to which, it may be supposed, fairies trip it on the grass.

Sound is likewise conducted by the forehead or teeth through the bony parts of the head. By holding the opposite extremities of a thin piece of wood between their teeth two persons may converse in low tones at some distance from each other, or if you lay your watch upon the table, and retire from it so far as to be out of hearing, its tick will be rendered audible if you take one end of the stick in your teeth and place the other end upon the watch—this, too, though you hold your hands over your ears. So, if you fill your ears with cotton and put your fingers to the teeth of one who speaks (not *between* them, please), you will hear his voice. String will also conduct sound when held between the teeth by two persons; and a "boy's own telegraph" may be constructed by our juveniles without expense. Let them cut the remaining end out of a tin can, such as preserved milk is sold in; stretch a moistened piece of parchment across the aperture, which will tighten like a drumhead when dry. In the middle of this make a small hole and pass a string through it, leaving a knot upon the end which will not go through this aperture. Then at the other end of the twine, which may be a few yards in length, place another can similarly arranged to the previous one. A whisper into the can at one end will be heard by the listener whose ear is applied to the can at the other. If our young friends wish also to bring the tones of the minster bell to their own firesides, they can do so by tying a string round the handle of a poker. Leave two ends to the twine and hold one of these close to each ear, then let some one give the poker a smart blow with a stick.

The boy's telegraph has been named, but the magician's use of the real electric wire for such purposes has not yet been touched upon. Fertile in expedients as is the ready-witted master of "hanky-panky," he would yet be occasionally at a loss for novelties unless he walked hand in hand with science. Electricity, which almost beats time, is really made to do so by the conjuror, who enlists it into his service for his magic drum, his goblin cymbals, and his fairy bells; and it is his henchman, tried and true, when he deceives the ears and eyes of his audience by throwing marked coins into "Aladdin's Crystal Cash-box," suspended from the ceiling. There cannot be any mistake about it! You see the professor go through the action of throwing, and you hear the chink of the money as it drops by some mysterious means within the glass. Alas! we could not quite "see through" that fair-seeming crystal casket; for before it had been brought upon the stage the marked

coins had been conveyed off, and shut securely, and invisible to the spectator, within its false top. When the casket is slung in the air the wizard apparently throws the real coins towards it, but really only "palms" representative ones. The motion of throwing imposes upon the eyes and misleads the imaginations of the spectators. At the same moment an electric current passes along the wire and releases the spring confining the false top to its position, and the coins thus liberated fall with a rattle on the glass to complete the deception; and very curious it is to the uninitiated when one's own crooked sixpence is found within the box. On the same principle "spirit rapping" can be heard at any place to which electricity can pass by a wire to move a hidden hammer.

The latest marvel, and the most magical addition to the world of science, is in the *Telephone*. Acoustics and electricity united have achieved the seemingly impossible in the electrical transmission of the human voice. The telegraph had "gone on circuit" of the earth for a goodly number of years, and Koenig's inventions had been known for a long time also, before it struck any one that the wires might be made vocal. Koenig made what he called a *Phonograph*, which was a membranous covering stretched over the end of a trumpet and provided with a flexible point. A note sounded at one end caused vibrations at the other, and the point by these means wrote a musical air of seven notes. The same genius also produced "Koenig's flames," by which the visible image of the *timbre*, or quality of sound of the voice, was called forth. His voice in this case acted upon a membrane, whose vibrations were as a bellows to the jet of flame, making it rise and fall. The famous philosopher, Dr. Robert Hooke, of Freshwater, in the Isle of Wight, had visions of the telephone two hundred years ago, but he was before the age of the electrical girdle. Hooke experimented, as did Sir Charles Wheatstone nearer our own time, with light wooden rods carrying the sounds to thin vibrating boards. When he placed musical-boxes in padded chests so that no sound escaped, he could yet convey the tones to a distant sounding-board by his wooden rods. But Dr. Hooke was a little in advance of the times, like Roger Bacon, the Marquis of Worcester, and some others. For the benefit of those who wish to make experiments in private, I may name an excellent trick upon this principle, which causes much astonishment to the uninitiated. Two musical-boxes playing the same airs are required. Place one within a padded box in an upper room, and pass a wire connected with it through the floor and the ceiling of the apartment beneath. At the lower end of the wire hang an empty deal box. Now your duplicate musical-box upon the table in this lower room shall be set going to some particular air, and when it is concluded the same strains may be heard proceeding from the empty box; for by some pre-arranged signal your confederate has started the musical-box in the upper room, and the sound is conveyed down the wire into the box beneath. The first idea of the telephone dawned upon Herr Reiss, a German, in 1852. His original instrument was the hollowed-out bung of a beer-barrel closed with the skin of a Strasbourg sausage. A strip of platinum, fixed in its position by sealing-wax, "made" or "broke" the electric circuit. The receiving instrument was a knitting-needle with wire wound round it, and this was placed upon a violin, which acted as a sounding-board. He afterwards made a wooden box

with a trumpet mouth. On the top of this box was a round hole covered with a bladder, and on its upper surface a sheet of thin metal connected with a galvanic battery. When any one spoke through the trumpet the vibrations interrupted the current. This gave out the same sounds at one end that were spoken into it at the other.

This was more scientific, if less powerful, than that apocryphal speaking-trumpet mentioned by Kircher,—"the Horn of Alexander,"—by means of which the soldiers received orders from their commander when he was ten or twelve miles off! Even this fabulous transmitter of vocal sounds has been left a long march in the rear by the latest (the "articulating") telephone of Professor Graham Bell, an English naturalised American, which not alone conveys the tone and pitch of the voice, but its *timbre* also, and that with telegraphic, not mechanical, speed. Round one end of a bar-magnet insulated wire is wound, and the ends of this are connected with screws in the small end of the box. A wire from one screw is "run to earth," the other connected with the telegraph. Between the hole, where is fixed a trumpet-mouth and the magnet, is a very thin disc of soft iron—"the drum of the ear." The other end of the telegraph wire has a precisely similar arrangement. Speaking into the mouth-piece at one end sets the iron disc vibrating, and a current passing along the wire repeats the sounds in every particular—to one whose ear is to the trumpet at the other end—save in being lower in tone; exactly, in fact, as if one spoke through a tube.

The prohibitive royalty fixed upon the use of Professor Bell's beautiful invention in its patented form puts it outside all ordinary pursuits, but there is nothing to prevent persons having it for their private use, and most opticians will furnish you with the instrument at a moderate price.

Professor Barrett has shown how we can ourselves make a telephone at the cost of a few pence. A wooden tooth-powder box has a hole cut through lid and bottom; a disc of tinned iron is fastened between them; a small, straight bar-magnet is put through a silk or small cotton-reel, and fixed near the disc, and round the reel wire is wound. This is the "originator," and the "receiver" is similar. Some trials will be needed to adjust the distances, but the wire between originator and receiver may extend for some hundred yards.

No article upon acoustics would be complete without mention of that kind of familiar spirit which some men carry about with them. This is Ventriloquism; and if its possessor be also a spirit medium, he finds it a valuable addition to his *craft*. Indeed, one Louis Brabant, *valet-de-chambre* to Francis I, being enamoured of a rich heiress, conceived the idea of receiving a direct spirit-message from her deceased father, and his art was so potent that the lady's mother accepted the supposed spirit-command that Louis should marry the heiress. The romance ends, as such stories usually do, with the union of the lovers, so we are not informed whether Madame Brabant was happily mated or not, but it was a bad beginning to end well, we should say. Ventriloquism is said to be the power of producing sound from the larynx without the muscles of the face being moved, and that strength is given to such sounds by a powerful action of the abdominal muscles. This may be so, but the face is never quite motionless in such cases as far as my observation extends. The effects

depend less upon the performer's power of imitation than in his knowledge of the actions and tricks of manner by which he directs attention to the spot from whence the sounds are supposed to proceed. The oft-asserted power of *throwing the voice* is an absurdity; in fact, the difference in the pitch of the voice, by which the sounds are made to come as from a distance, deceives the ear, while the illusion is completed by the gestures of the performer.

The amusing talking dolls we sometimes see are much easier to work than ordinary ventriloquism, where the voice has apparently to be thrown. This is mimicry pure and simple, and the dolls being so near to the performer the words can be produced with little or no movements of the muscles of the face. All kinds of sounds have been imitated by clever ventriloquists. Mr. Love ran through the gamut of the whole farmyard and stable vocabulary, from the high-mettled racer to Neddy Bray, Mr. Bull, Madame Dun Cow, Master Calf, pigs, ducks, and chanticleer. Mr. Thurton's "Odd Folks" were highly amusing, and his ventriloquial production of the cheering of a crowd was a remarkable achievement. Thurton, indeed, was the greatest artist in his line in our time. Neither of these gentlemen, however, were so great as some performers in the past, if we may credit all that has been stated of them, which is hazardous. In the "Memoirs of the Empress Josephine" an anecdote is related of one Thiemet, a ventriloquist, at the time creating considerable sensation in Paris. He was invited to the house of Eugene Beauharnais, where were met to breakfast a gay circle of young officers. Of these, "first one and then another heard himself distinctly called out of the room by the voice of his serving-man, until the whole party had in turn made a fruitless expedition downstairs. Each returned more amazed than another, and it was finally resolved to sally forth in a body. Thiemet, who, not personally known, save as a guest, to any of the party, had all this time continued quietly seated at table, opening his lips only to eat or drink, functions which he seemed to perform with great address, now rose to assist in the search of the invisible serving-men. No sooner had the party reached the hall than the calls, apparently from all different quarters, were repeated. Each scampered off in various pursuit of the supposed culprit, crying out, 'Here! here's the rascal!' till, in the inexplicable confusion, Eugene's loud laugh discovered the whole plot. The greater part received it as a 'passably excellent joke,' but some there were disposed to bestow the chastisement of the innocent valets on the guilty professor."

Even a more amusing story is told of another French ventriloquist, which may take rank with Theodore Hook's famous hoax for its fun, and is without the more disagreeable consequence of that rather ill-natured frolic. It is related of Alexandre, the ventriloquist in question, that passing one day near the now defunct Temple Bar he observed a large load of hay struggling through the gateway. He instantly imitated the cries of a suffocating man, and drew the attention of the passers-by to the muffled sounds. The cart was stopped in its most inconvenient position, and a crowd of persons assisted to unload the hay, the cries of the supposed man within growing fast and furious as the mob worked with redoubled energy. Just as they were getting to the bottom of the cart the moaning ceased, and the workers gave up the man as dead, though

still proceeding to throw the hay into the roadway to the stoppage of all traffic. The cause of the silence, however, was not the sudden decease of the supposed entombed man, but the discreet exit of the ventriloquial joker, who retired before the *dénouement* of the drama.

PREDICTIVE METEOROLOGY.

WITHOUT attempting to enter into a general consideration of the laws of storms, we may make a few remarks upon what is known as predictive meteorology. Storms have long been recognised as a part of the great order of nature, subject to law as strictly as any other phase of the handiworks of the Creator. We are very far as yet from a full acquaintance with the details of this branch of atmospheric inquiry; but the main principles are understood so far that conditions of danger can be recognised, and that in 1861 the late Admiral Fitzroy was enabled to initiate his system of storm warnings, which has been improved and extended under the present management of the Meteorological Office. An excellent general outline of the work of this office will be found in a capital little book by Mr. R. H. Scott, F.R.S., the director, "Weather Charts and Storm Warnings." In order, however, to understand even the first principles of predictive meteorology, it must be borne in mind that the great gaseous envelope of the earth which we call the atmosphere has, like the ocean, its currents and tides and waves and eddies. Heat, qualified by hygrometric and electrical conditions, is the exciting cause of the circulation of the atmosphere. Air, when heated by the sun, expands and ascends, and flows from the warmer to the colder regions, and these latter again supply currents which take the place below of the air which has ascended. This is the simple and original cause of the persistent phenomena known as the trade winds, of the periodic monsoons of the Indian Ocean, of the alternating night and day land and sea-breezes. To it we owe also such intermittent but well-characterised winds as the *bisa* of France, the *gallego* of Spain, the *bora* of Istria and Dalmatia, the *mistral* of Southern France, the *sirocco* of Italy, the *harmattan* of the African Atlantic, and the *simoom* of the Desert. To it are likewise due the seemingly casual and lawless storms. These great disturbances of the atmosphere are now recognised as cyclonic in their character. They have both a rotatory and a forward motion, and, so far as Great Britain is concerned, commonly approach us from the westward.

When a storm has commenced, and its direction is known, it is very easy, by the aid of the electric telegraph, to send warning in advance to the localities it is likely to visit; but this is only a part of the work of a meteorological office. Our meteorologists aim higher than this—they seek to detect the storm in its inception. This is effected by the aid of the barometer. But our readers must be prepared to give up the old belief which has led so many to denounce this instrument as untrustworthy, "that the actual height of the barometer at one station gives a certain indication of the probable direction or force of the wind, or of the character of the weather at that station." What the barometer does is to show the pressure of the atmosphere. The Meteorological Office compares the weather observations re-