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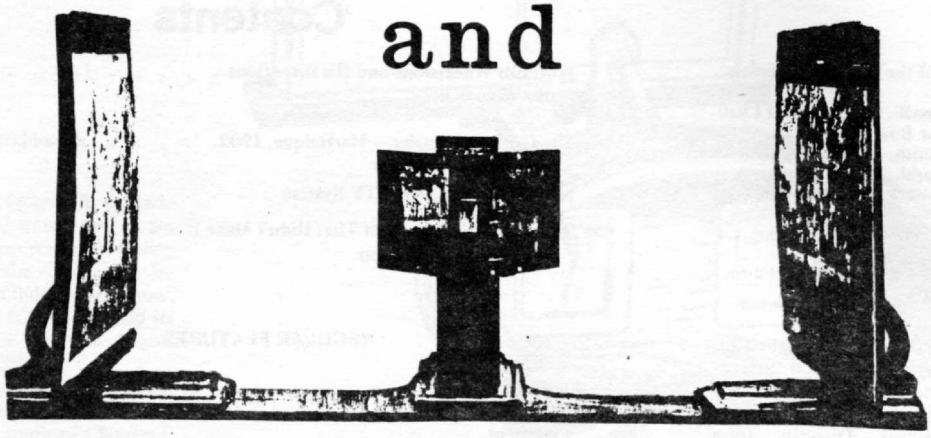
COVER: Looking out at us in this 1837 pencil drawing is Professor Charles Wheatstone at age 35. The drawing is reproduced by special permission of the British National Portrait Gallery. Marking the 139th birthday of the Stereoscope (June 21, 1838) is William Brey's article on Sir Charles Wheatstone which begins on the next page.

Professor Wheatstone and His Inventions



By William Brey

He was a shy man. All his life he suffered acute embarrassment when required to speak in front of an audience. A close friend and fellow member of the Royal Society related the following story: "Wheatstone and the writer of this memoir were for several years members of a small private debating society, comprising several familiar names in science, art, or literature, that met periodically at one another's houses to discuss some extemporized subject, and every member present was expected to speak. Wheatstone could never be induced to open his lips, even on subjects on which he was brimful of information. Several of his more important investigations were for the same reasons from time to time brought before the public by Faraday in the theatre of the Royal Institution."

On one occasion Faraday had cajoled Wheatstone into agreeing to read a paper at a meeting of the Royal Society. As they approached the doors to the theatre Wheatstone panicked, dashed down the stairs and disappeared up the street, leaving Faraday to extemporize before a full house. At future meetings the Director of the Society stationed himself at the head of the stairs to thwart the escape of any other reluctant speakers.

The Early Years

Charles Wheatstone was born February 6, 1802, near Gloucester, England—the second child in a family of two sons and two daughters. His father manufactured and sold musical instruments.

At an early age Wheatstone was sent to school near his home and reportedly could read verses out of the Bible before he was four years old. After his family moved the ninety miles to London, young Wheatstone's education continued in a school at Kensington run by a Mrs. Castlemaine, who was aston-

"Sir Charles Wheatstone" engraved 1876, from a photograph by John Mayall. (*Nature*, April 27, 1876, Vol. XIII No. 139, facing page 501. Courtesy Library of Congress).

ished at the progress made by him while under her care. At this school he acquired the character of being unsociable, because he refused to join the sports of his schoolmates. Actually, timidity and nervousness were the real reasons for his quiet behavior. Most children at times hide their faces in their books, but young Wheatstone hid his there always.

Later on he continued his studies at a school in which he engaged in youthful disputes with his teacher over what he was taught, which he considered inaccurate and deficient. He became so disgusted with this school that he ran away. Those who in later life knew the extremely hesitating and cautious nature of Charles Wheatstone, could well imagine how enormous must have been his effort to carry out this action. His escape was quite brief. He got as far as Windsor, and was brought back again.

At another school in 1813, he earned a gold medal for studies in the French language, against older competitors who had studied for a longer time. However, a rule of the school was that the victor should recite a speech on the occasion when the prizes were distributed. Young Wheatstone could not be persuaded to attempt this, and as a result, did not receive the medal.

When he was 14 his formal education ended and he was apprenticed to his Uncle Charles, who operated a business as a music dealer at number 436 Strand. Within a short time his uncle complained that he neglected his work and spent too much time poring over his books. Indeed, it was not unusual for him to shut himself up in the attic to concentrate on his studies. His father subsequently encouraged these interests by taking him away from his uncle and obtaining a loan of additional books from the University for his studies. For the next few years, young Wheatstone concentrated solely on the study of acoustics, developing numerous practical experiments to prove his theories.

At nineteen, his experiments in the transmission of sound resulted in "the enchanted lyre". A hollow box, shaped like an antique lyre, appeared to be suspended from the ceiling by a metal rod. Actually, the rod pierced the floor of the room above and was suspended from the sounding board of a piano. When the piano was played (unheard in the room below), the vibrations were transmitted down the rod. The effect was magical—a lyre played by invisible hands.

At twenty-one, his first paper, "New Experiments on Sound", was published in Thomson's "Annals of Philosophy". The work was rich in experimental facts concerning the vibrations of chords and rods. This paper was picked up and reprinted by both a French and a German journal which greatly encouraged young Wheatstone. Additional papers appeared in 1827 and 1828 describing his theories; always backed up with actual experimental data to prove them. Wheatstone's mind seemed to reject anything he could not prove by actual experiment. In 1829, shortly after the accordian was invented on the continent, Wheatstone developed and patented the concertina.

In 1831, he summoned up enough courage to read his first paper before the Royal Society—"Transmission of Sound through Solids". Later in that year, he provided interesting experimental proof on theories of the vibration of air in musical instruments. From this date Wheatstone's life became that of an earnest, unassuming and hard-working man of science. No doubt his distaste for public speaking accounted for his interest in actual experimental inquiry. If he had been eloquent, he might have gone the

road of other clever men, and become a lecturer. As it was, he clung to the last to actual experiment upon any subject in which he was interested.

Appointed a Professor

Two papers, his last on acoustics and first on electricity, were responsible for his appointment, at the age of 32, to the post of Professor of Experimental Philosophy of King's College, London. The paper on acoustics concerned his explanation of Chladni's Figures—the varied patterns produced in thin layers of sand by the vibration of a violin bow when drawn against the edge of the supporting surface. Without the aid of mathematics, he succeeded in predicting the curves the various vibrations should produce.

Wheatstone's first paper in the electrical field was a stunning success. He developed an elegant experiment to measure the speed of electricity by arranging three spark gaps in a wire a quarter of a mile long. The three gaps, placed at the beginning, end, and in the middle of this loop of wire, were arranged adjacent to each other to allow simultaneous observation of the sparks in a revolving mirror. The mirror, revolved by hand at a known speed, was used to observe the displacement of the middle spark relative to the sparks occurring at each end of the wire. The resultant measurement (later proved to be on the high side) was the first real indication of the speed of electricity. Later, the then Professor Wheatstone repeated the experiment with four miles of wire strung around the basement vaults at King's College. His concept of using a revolving mirror as an assist in the measurement was later adapted by Foucault and Fizeau in their measurements of the speed of light. Two years after his appointment to King's College, he was made a Fellow of the Royal Society.

As a Professor he devoted his time to experimental work because he was a failure as a lecturer. He had been caught more than once turning his back to his students and mumbling to his diagrams; nevertheless, he read beautifully, and had a good, although not a powerful voice. Feeling that his place was the laboratory, and not the lecture-room, he gave up his attempts to lecture. It was because of this that Faraday and others brought his inventions and discoveries before public audiences.

He seriously turned his attention to the subject of light and in 1835, in a paper he produced on the subject, he first made known the existance of bright lines in the spectrum emitted when metals are vaporized.

"We have here," he wrote, "a mode of discriminating metallic bodies more readily than that of chemical examination, and which may hereafter be employed for useful purposes." These last words furnish the keynote to all Wheatstone's work; however valuable were the services he rendered to pure science, his ultimate aim was the useful and practical. The science of Spectrum Analysis emerged as a result of these early experiments.

In the year 1836, Professor Wheatstone was approached by a man four years his senior, named William Fothergill Cooke, for technical advice on his version of an electrical telegraph. Thus began a fourteen year association resulting in the world's first practical electric telegraph system — and an embarrassing and widely publicized disagreement over which one of them deserved the greater share of the credit for the achievement. As usual, well-meaning but misguided friends and relatives managed to help fan the flames of controversy over the years. The Reverend T. F. Cooke, William's brother, published two pamphlets years later whose titles alone must have deeply disturbed Wheatstone—the quiet man of science. One was titled "Authorship of the Practical Electric Telegraph of Great Britain" in 1868, and the second and final blast in 1869, "Invention of the Electric Telegraph—The Charge Against Sir Charles Wheatstone of Tampering with the Press".

The controversy was best summed up by Wheatstone's biographer for the Royal Society who wrote: "To Mr. (now Sir W. F.) Cooke much credit is undoubtedly due for the tact and ability he evinced in directing public attention to the importance of the electric telegraph, and in conducting the joint enterprise to a most successful commercial issue; but to Wheatstone alone must be ascribed the inventive genius and fertility of scientific resource which led to the many successive developments of the electric telegraph." The revealing story of this relationship is well told by Geoffrey Hubbard in his 1965 book "Cooke and Wheatstone and the Invention of the Electric Telegraph".

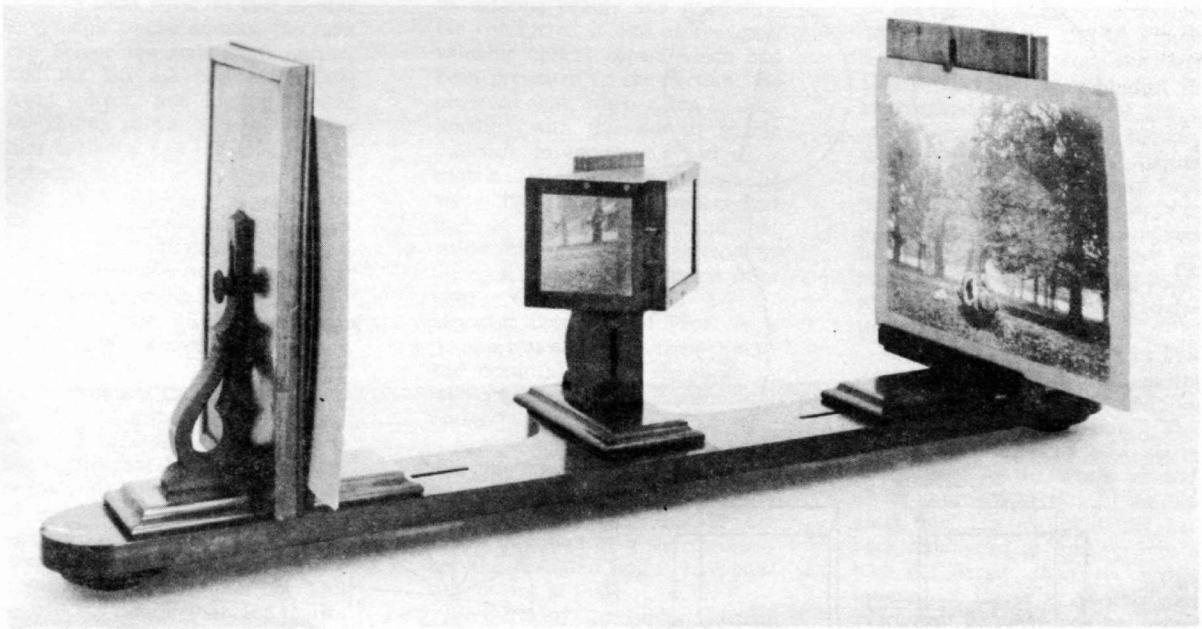
Many other successful telegraphic developments were generated by Wheatstone's fertile mind . . . the alphabet-showing dial telegraph of 1840, the type-printing telegraph in 1841 and the automatic telegraph by which messages could be transmitted at 150 words per minute. This last one enabled the transmission of long columns of news for publication in the daily newspaper.

Wheatstone was the first to suggest and design a submarine telegraph. Early in 1837 he worked on the idea of an underwater telegraph cable and his first practical experiments were conducted on Swansea Bay in 1844 when he succeeded in telegraphing between a boat and a lighthouse. His expertise in this area was called upon when he testified before a Select Committee of the House of Commons on the practicality of an under the channel Telegraph Cable to France.

The Stereoscope

In 1838, at the age of 36, his earlier investigations into the properties of light resulted in the publication of "Contributions to the Physiology of Vision. — On Some Remarkable, and Hitherto Unobserved, Phenomena of Binocular Vision". This paper was presented to the Royal Society on June 21st and then to the British Association at Newcastle in August the same year. The Professor was led into this line of investigation upon observing a curious effect when bringing a candle near a metal plate that had been smoothed in a lathe. What he saw was a line of light apparently standing out from this plate, one half above and half below the surface. Closing either eye caused the relief to disappear.

Today we can recreate this illusion (somewhat crudely) that prompted Wheatstone's investigations into binocular vision by using a phonograph record in place of the metal plate. The grooves of the record are similar to the concentric circles produced on a metal plate in the operation



Professor Wheatstone's reflecting stereoscope. (Reproduced by special permission under British Crown Copyright, Science Museum, London).

of smoothing in a lathe. While seated at a table, place a phonograph record flat on the table top in front of you. Next, place a candle in a holder, with the flame approximately twelve inches above the table, next to the record. Slide the candle holder slowly around the edge of the record—first to the right and then to the left. The line of light you will see reflected across the surface of the record always passes through the center of the record. That portion of the line of light nearest the candle appears to come up from the depth of the table and pass through the center of the record. Closing one eye eliminates this illusion of depth. Viewed with both eyes open, the line appears like an arrow piercing the center of the record.

In his paper, Professor Wheatstone states: "It is curious that an effect like this, which must have been seen thousands of times, should never have attracted sufficient attention to have been made the subject of philosophic observation. It was one of the earliest facts which drew my attention to the subject I am now treating."

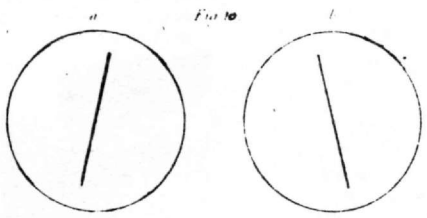
He went on to demonstrate that the mind perceives an object in three dimensions because each eye receives a slightly different view of it. He then asked himself the key question, (a question previous investigators into binocular vision had never asked), "What would be the visual effect of simultaneously presenting to each eye, instead of the object itself, its projection on a plane surface as it appears to the eye?" To answer that question, he had an instrument constructed that would do exactly that. The first use of the name he created for this instrument appears in the following sentence. "The frequent reference I shall have occasion to make to this instrument, will render it convenient to give it a specific name; I therefore propose that it be called a Stereoscope, to indicate its property of representing solid figures." (According to the Gernsheims' "History of Photography", the word "Stereoscopique" appeared in print in 1613 and the word "Stereoscope" in 1815, neither of which referred to a binocular device.) Wheatstone's use of the word was developed independently of these, combining the Greek words for stereo = solid and graph = I look at.

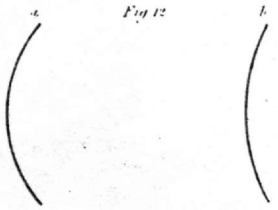
Shown in illustration is Wheatstone's drawing of his first Stereoscope and a photograph of similar instrument attributed to him now on display at the Science Museum in London.

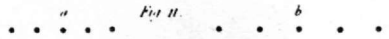
To help answer his key question, he had prepared drawings of single objects as seen by each eye. The eleven sets of drawings are the world's first stereo views — reproduced approximately half the size actually employed by Wheatstone. He stated, "The drawings, it has already explained, are two different projections of the same object seen from two points of sight, the distance between which is equal to the interval between the eyes of the observer; this interval is generally about 2½ inches."

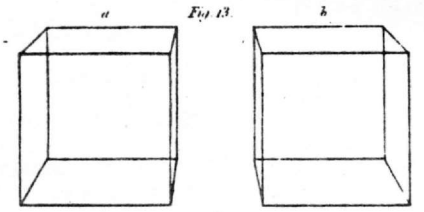
- Figure 10 will appear as a single line with its lower end inclined towards the observer.
- Figure 11 will appear as a series of points with the right hand ones successively closer to the observer.
- Figure 12 will appear curving towards the observer.
- Figure 13 - a cube.
- Figure 14 - a cone with its tip facing the observer.
- Figure 15 - a truncated pyramid with its base farthest from the eye.
- Figure 16 - two circles at different distances from the eye.
- Figures 17 through 20 are self-evident.

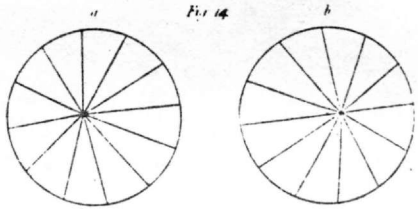
Professor Wheatstone's drawings that he used in his reflecting stereoscope. The world's first stereo views.

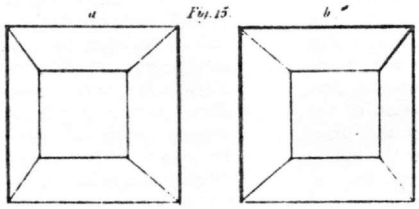


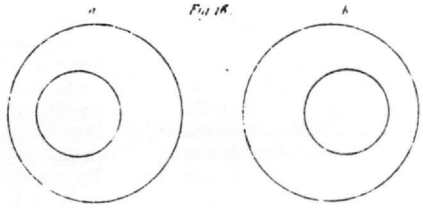


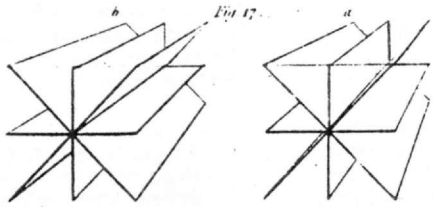


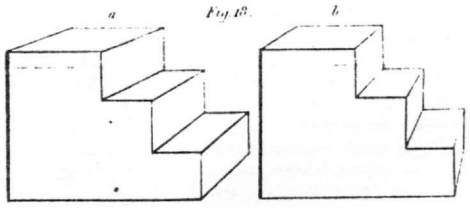


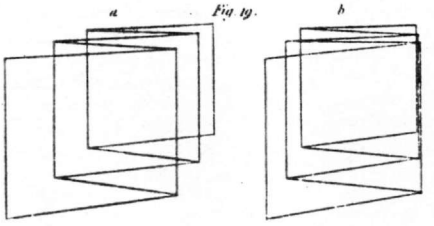


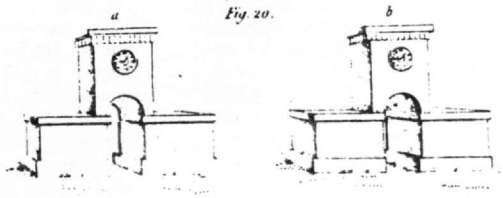












Page Eight

His precise instructions on using this new apparatus were: "The observer must place his eyes as near as possible to the mirrors, the right eye before the right-hand mirror, and the left eye before the left-hand mirror, and he must move the sliding panels E E to or from him until the two reflected images coincide at the intersection of the optic axes, and form an image of the same apparent magnitude as each of the component pictures. There is only one position in which the binocular image will be immediately seen single, of its proper magnitude, and without fatigue to the eyes."

The Professor then carefully pointed out — "For the purposes of illustration I have employed only outline figures, for had either shading or colouring been introduced it might be supposed that the effect was wholly or in part due to these circumstances, whereas by leaving them out of consideration no room is left to doubt that the entire effect of relief is owing to the simultaneous perception of the two monocular projections, one on each retina. But if it be required to obtain the most faithful resemblances of real objects, shadowing and colouring may properly be employed to heighten the effects. Careful attention would enable an artist to draw and paint the two component pictures, so as to present to the mind of the observer, in the resultant perception, perfect identity with the object represented. Flowers, cyrstals, busts, vases, instruments of various kinds, etc. might thus be represented so as not to be distinguished by sight from the real objects themselves."

Keep in mind that these words appeared before the brilliant photographic discoveries of Niepce, Daguerre and Talbot had been announced to the world.

How was this scientific instrument so uniquely suited to its purpose received? With surprise and delight! No one was more competent than Sir David Brewster to appreciate it fully, and no one seemed more surprised and gratified, according to the following statement in the proceedings of the British Association: "Sir David Brewster feared that the members could scarcely judge from the very brief and modest account given by Prof. W. of the principle, and of the instrument devised for illustrating it, of its extreme beauty and generality. He considered it one of the most valuable optical papers which had been presented to the Section. He observed that, when taken in conjunction with the law of visible direction in monocular vision, it explains all those phenomena of vision by which philosophers had been so long perplexed; and that vision in three dimensions received the most complete explanation from Prof. W.'s researches. Sir J. Herschel characterized Prof. W.'s discovery as one of the most curious and beautiful for its simplicity in the entire range of experimental optics."

Note well Brewster's remarks at this time because as you will see he later attempted to reduce the claim of Professor Wheatstone to the simple invention of a stereoscope—not the first and not a very convenient one at that!

In Germany the subject excited still more interest and it was at once eagerly taken up. The new light thrown upon the subject of double vision engaged the most able physiologists and metaphysicians—Bruecke, Volkman, Morer, Tourtual; and in Geneva, M. Prevost wrote upon the subject.

It is important to recognize that all of Wheatstone's papers were the culmination of much work performed over many years. Even though the birth date of the Stereoscope can be considered June 21, 1838, because that's when the world first observed it, we will see later that its conception took place as early as 1832. The first of two Royal Medals he received was awarded to him for this work on Binocular Vision.

Meanwhile, events outside of England foreshadowed a new use for the Professor's novel instrument. "It was at the beginning of 1839, about six months after the appearance of my memoir in the Philosophical Transactions, that the photographic art became known, and soon after, at my request, Mr. Talbot, the inventor, and Mr. Collen (one of the first cultivators of the art) obligingly prepared for me stereoscopic Talbotypes of full-sized statues, buildings, and even portraits of living persons. M. Quetelet, to whom I communicated this application and sent specimens, made mention of it in the Bulletins of the Brussels Academy of October 1841. To M. Fizeau and M. Claudet I was indebted for the first Daguerreotypes executed for the stereoscope. The beautiful stereoscopic representations of statuary, architecture, machinery, natural history specimens, portraits of living persons, single and in groups, etc., which have recently been produced by M. Soleil and M. Claudet, are now too well known to the public to need more than a slight reference to them."

These words were written by Professor Wheatstone in 1852 in the second part of his "Contributions to the Physiology of Vision". This new work introduced new stereo instruments to the world as well as an improved version of his original one. His earlier model had been redesigned to fold up into a box not larger than six inches square. See figure 3. Another new instrument he developed he named the "Pseudoscope" which converted to the mind false perceptions of objects viewed with it. The prisms were arranged so that each eye sees what the other eye did without the instrument. When viewed through the Pseudoscope (See figure 7) concave objects appeared convex, etc.

A popular magazine of the day, "Household Words", edited by Charles Dickens, gave the following simple explanation of what one sees through a pseudoscope—"Let him take up a pseudoscope, and look through it, properly focussed. Let him look at some man on the other side of the way. He will not appear to be on the other side at all, the street will have come in doors, and the house will be turned out of window. Let him look at a friend's face. The cheeks will so decidedly fall in, that the face will become no face but a hollow mould. Let him look into the bottom of a teacup. For a minute he may see it as it is; but—O, hocus, focus—in the twinkling of an eye, it has turned inside out. It has no hollow, but is all solid. Let him look at a framed picture hung against the wall. It will seem to be, not hung against the wall, but to be let into it. The frame will appear to surround it like a moat. There is a pretty instrument for turning everything hind-

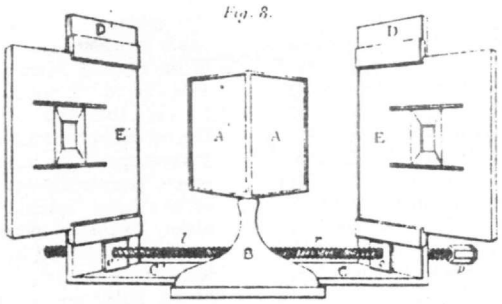


Fig. 8.

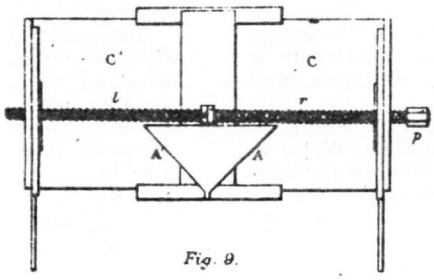


Fig. 9.

side foremost!"

Another new instrument he called the Refracting Stereoscope and its illustration in figure 4 accompanied the paper. Of this instrument, Wheatstone had this to say—"The refracting stereoscope has the advantage of portability, but it is limited to pictures of small dimensions. It is well suited for Daguerreotypes, which are usually of small size, and, on account of the nature of their reflecting surface, must be viewed in a particular direction with respect to the light which falls upon them; . . . . It consists of a base 6 inches long and 4 inches broad, upon which stands an upright partition, 5 inches high, dividing it equally; this partition is capable of extension by means of a slide to double the length."

In addition to 'Stereoscope', Wheatstone is responsible for two other words commonly used today. He was the first to use the word 'microphone' and the first to use 'rheostat'. He developed and named this last device to aid him in his electrical experiments.

There is evidence that Professor Wheatstone maintained a continuing interest in the new science of Photography despite his obviously busy schedule. He was a member of the Photographic Society of London and served on their Council as late as 1873. Occasional letters from him appeared in their Journal. One suggested the use of certain chemicals for photographic work in 1853. In another letter the same year, he described a different type of reflecting stereoscope. He wrote: "I have constructed an instrument, very convenient for carrying about, which is adapted to exhibit pictures of the largest dimensions usually taken, as well as smaller ones, and which may be made use of either for mounted or unmounted pictures. . . . . The base and sides consist of jointed bars on the principle of the lazy-tongs; the two mirrors fold together back to back, and, by means of a hinge on their support, fall into a groove on the base fitted to receive them." The reflected images in this instrument were viewed through a pair of ordinary spectacle lenses. "The lenses are moveable in a vertical direction, in order that they may be fixed at the proper point of sight; the effect of a stereoscopic picture greatly depends on its being thus viewed, though it is a circumstance which is very generally disregarded."

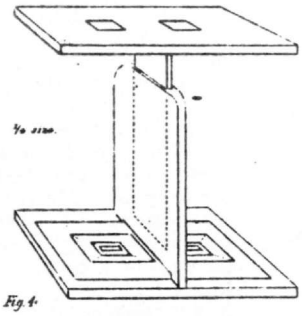


Fig. 4.

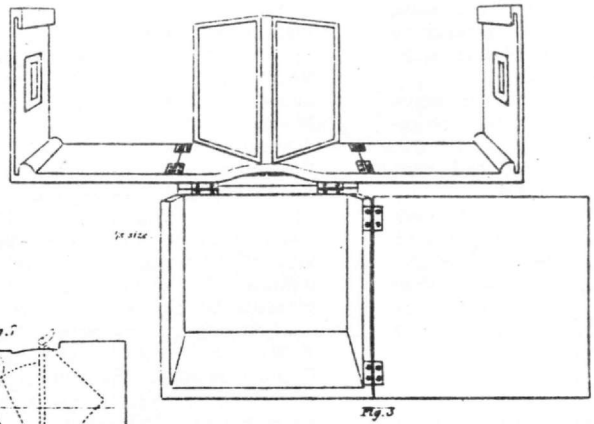


Fig. 3

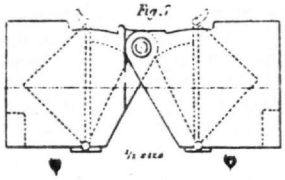


Fig. 5

Professor Wheatstone became ensnared in a number of controversies with Sir David Brewster in later years, the exact reasons for which have not been fully explained to this day. Sir David Brewster, "a disputatious antagonist," to use Wheatstone's words, wrote a book in 1856 that can only be considered a personal attack on Professor Wheatstone's intelligence and character. In "The Stereoscope", Brewster states that the theory of binocular vision, first advanced by Wheatstone twenty-two years earlier, was well known centuries before and that even the concept of the Stereoscope had been anticipated by another, one James Elliot, a Professor of Mathematics in Brewster's home town of Edinburgh. The ordinary lay reader of this attack may well have been taken in by Brewster's scientific credentials and title, but his scientific contemporaries were not. The following excerpts are from a review of "The Stereoscope" that appeared in the contemporary literature section of the "Westminster Review" for October 1856.

"Sir David Brewster's treatise on the Stereoscope appears to have been written with three principal objects: —First, to show that in the idea of the stereoscope there is no novelty whatever, and that Professor Wheatstone's merit in the invention consists merely in his having been one of the first to carry that idea into practice, and this in a very clumsy manner; second, to prove that as Sir D. Brewster devised a method of applying the same principle, which, by rendering the instrument cheaper and more convenient, has at the same time rendered it popular, his share of the merit is far greater than that of Professor Wheatstone; and, third, to demonstrate that he is the only philosopher who knows anything about the principles on which the effects of the stereoscope are produced. So that, in fact, both for that particular form of the instrument which is now in everybody's hands, and for all our scientific knowledge of its action, we are indebted to nobody else than the author of this book. Although this is by no means the first time that Sir D. Brewster has shown a strong development of the organ of acquisitiveness respecting discoveries for which he claims credit, and although the same assertions have already been put forth in his behalf in anonymous articles distinguished by a style seemingly identical with his own, yet we are astonished that he should venture to put forth in his own name such a series of sophisms and misstatements, for the same of raising his own reputation at the expense of another. Sir D. Brewster may pretty safely take it for granted, that the public generally is either too ignorant or too careless to form its own judgement in the case, and that it will receive anything which comes from a man of his name in optical science with unquestioning confidence; but that he should imagine that the scientific world ever will quietly stand by to see a piece of valuable property belonging to one of its most distinguished members carried off from him in open day, without raising a hue and cry after the depredator, is to impute to it an amount of insouciance to which we, at least, do not plead guilty . . . .

"Sir D. Brewster's own appreciation of this invention, at a time when, not having himself any participation in it, he was free to form a candid opinion, is, fortunately, preserved in the contemporary record of the proceedings of the British Association, to which Professor Wheatstone communicated it in 1839, shortly after having laid it before the Royal Society. The contrast between the Sir D. Brewster of 1839 and the Sir D. Brewster of 1856, affords an instructive lesson as to the degree in which the mind even of a professed philosopher may be warped by the greed of fame . . .

"Fully conceding, therefore, to Sir D. Brewster all the credit which can fairly attach to the popularization of the instrument, we affirm that he has added nothing whatever of importance to our scientific knowledge of the principles of binocular vision; and that, in fact, almost everything which he has written on the subject has tended to confuse it further, instead of to clear up its difficulties."

In this same month, an anonymous letter to 'The Times' appeared that repeated statements first appearing in Brewster's book concerning Elliot's concept of the Stereoscope preceding Wheatstone's.

Professor Wheatstone responded to this anonymous letter with some facts that had not previously been known.

"To the Editor of 'The Times'. Sir,—Allow me to make a few remarks on a letter which appeared in your columns yesterday, relating to the invention of the Stereoscope. Your correspondent "A", by exclusively adopting the dates and statements put forward in various publications by Sir D. Brewster, with the intention of proving that Mr. Elliot had conceived the idea of a stereoscope before I had, has given the extensive circulation of 'The Times' to these imperfect allegations, and I wish to show by sufficient facts that the claim thus supported is untenable."

He then pointed out that Professor Herbert Mayo's book "Outlines of Human Physiology" which mentions Wheatstone's work, appeared a year before Elliot's claim. He also quoted Brewster's flattering words of 1838 and concluded with: —"and Sir David is the last person who ought to have advanced them, since I can shew, from our correspondence, that he was aware, so early as 1832, that at that time I was preparing for publication my memoir on the subject."

After this appeared in 'The Times' the orginal letterwriter removed his cloak of anonymity to reveal himself as Sir David Brewster. He wrote two additional letters using his own name, both of which Professor Wheatstone responded to. As we can imagine, this series of letters generated considerable interest in scientific and photographic circles and the entire series of six letters was reprinted in the "Liverpool and Manchester Photographic Journals" of January, 1859.

In his second letter, Brewster pointed out that the reference to Wheatstone's work in Mayo's Outlines makes no mention whatever of any instrument or method of combining the pictures. He also stated: "In the preceding observations I have avoided the offensive personalities with which this subject has been noticed in a silly article in the "Westminster Review". I have no personal feelings to gratify in giving an opinion on this question. As the inventor of the lenticular stereoscope now in universal use, and of other forms of the instrument, I, of course, feel an in-

terest in the subject, and involving as it does nice questions in the theory of vision, that interest has been greatly increased."

The reference to the "silly article" in the "Westminster Review" prompted the Editor of 'The Times' to include the following footnote to Brewster's letter: "The author of the "silly article" to which Sir David here alludes is a gentleman of the highest attainments and standing in the scientific world. His opinions, as there stated, we know to be a true reflex of the feelings of those who are best competent to give a judgement on this subject."

Once again the Professor wrote to 'The Times' providing additional evidence of priority: "Sir—It is difficult to deal with Sir David Brewster's reasoning. I have proved by incontrovertible dates my priority both in the discovery of the principle of the stereoscope and in the invention of the instrument. Sir David, in his reply, fully admits these dates, and says, 'it is evident that Mr. Wheatstone was acquainted with the principles of the stereoscope in 1833, and therefore earlier than Mr. Elliot;' yet he announces that unless additional evidence be brought forward he will continue to place that gentleman's claims above mine whenever he has occasion to write or speak on the subject; and he further requires a proof of my having constructed a stereoscope at the time my discovery was first announced. I cannot conceive why such a proof should be thought necessary, but I trust that the following evidence of Mr. Murray, of the firm of Murray and Heath, opticians in Piccadilly, will be deemed conclusive as to this point: Piccadilly, Oct. 27th. 'Sir—From an examination of the accounts furnished to you by Mr. Newman, of Regent-street, during the time I was in his establishment, and which were prepared by myself, I am able to assign the date of my first knowledge of your stereoscopes, both with reflecting mirrors and refracting prisms, to the latter part of 1832. I am, Sir, yours faithfully, R. Murray'

"A public journal is not the proper place to enter into a public controversy on points of scientific theory, but I cannot allow Sir D. Brewster's assertion, that he has 'given the true and demonstrable theory of the stereoscope, after Mr. Wheatstone had wholly failed and acknowledged his failure,' to remain unnoticed. It is true that I have stated, and still believe, that there are some points requiring further investigation; but I venture to affirm that Sir D. Brewster has done nothing to advance our previous theoretical knowledge of the subject; and many of the views he has brought forward regarding the philosophy of vision I hold to be manifestly erroneous. In his recent work, and elsewhere, he misrepresents my facts and conclusions in a most extraordinary manner; and he attributes to me, without the slightest foundation, a hypothesis which I never for a moment maintained, and which I utterly repudiate. He makes no mention of some of my most important results, and, when he does borrow from my memoirs, unless he has a depreciating remark to make, he omits all mention of my name; and further, he entirely ignores the memoirs of those eminent writers who, since my first publication, have treated of the stereoscopic phenomena; and the names of Bruecke, Tourtual, Prevost, Moser, Volkmann, Dove, Rogers, Serre, etc., who have all brought much thought to bear upon the subject, are not even once mentioned in his pages. I am, Sir, your obedient Servant, C. Wheatstone. Oct. 29th, 1856."

An additional letter from each of them concluded this remarkable exchange in a public forum. The Professor's final letter notes the reason for the six year span between his early work on binocular vision in 1832 and publication of the results in 1838.

"If any justification of the delay in publishing my complete results, after I had announced the general facts, be necessary, it may be found in the following circumstances. Between the periods referred to, I published, in 1833, my memoir 'on the figures of vibrating surfaces,' and, in 1834, my memoir 'on the velocity of electricity and the duration of electric light.' which gained for me admission to the French Academy of Sciences; from 1834 to 1838 I was engrossingly engaged in those experiments relating to electrical phenomena to which my last investigations had led me, and from which resulted all my inventions connected with the electric telegraph. It is not much to be wondered at, that, during this interval I was obliged to defer to a future time the consideration of subjects of less immediate interest, some of which I have not even yet had the opportunity of resuming."

He summed up his feelings on the entire matter with these words: "I was far from thinking, when answering an anonymous letter in the columns of 'The Times', that it had emanated from the same source from which had proceeded all the attacks which have, with reference to this matter, during the last four years been directed against me; but I cannot regret the opportunity which that circumstance has offered me to correct, in the most efficacious manner, a few of the most prominent of the misstatements made."

All of the above took place in 1856. But the damage had been done. Brewster's book has become a reference work for other writers who have perpetuated the name of Elliot. Brewster also wrote a long article on the Stereoscope for the Encyclopedia Britannica of 1860. Elliot was again featured prominently.

Elliot's Mistake:

Incredibly enough, the true story of Elliot's stereoscope had appeared in print in 1852. "The Photographic News" of September 7, 1860, retold the true story of Elliot's claim once again for their readers: "So much nonsense has been written on the subject of the stereoscope, and the physiology of stereoscopic vision, that it is quite a relief to turn to some observations on these subjects by so excellent a physiologist as Dr. Wharton Jones, professor of ophthalmic medicine in University College. The introductory remarks respecting the history of the stereoscope, are of necessity brief, and give Professor Wheatstone full credit for the discovery as far as Sir David Brewster is concerned. But as if that it was impossible for even the best informed person to touch upon this subject without falling into error, Mr. Elliot's name is introduced as being a rival claimant with Professor Wheatstone for the honour of the discovery. The history of this claim is a rather remarkable one, and ought to be a warning to any one who is not quite certain of a

statement, to pause before he commits it to print. In the "Philosophical Magazine" for April, 1852, appeared a paper by Professor Wheatstone, in which the theory and construction of the stereoscope was fully described. A foot-note to this paper however stated that it was a reprint from the "Philosophical Transactions" for 1838. A Mr. Elliot, not having noticed this foot-note, thereupon published a letter, stating that Professor Wheatstone's discovery was not new, he having found out the same thing some years before, (i.e. before 1852). The foot-note to the paper was then pointed out to Mr. Elliot, showing that the original publication of the paper by Professor Wheatstone dated as far back as 1838. Whereupon, Mr. Elliot at once wrote to renounce all claim to the discovery, stating that he had not noticed the prior date, and giving Professor Wheatstone full credit for the invention, as well as for the priority of publication. Mr. Elliot undoubtedly acted rather hastily in the first instance, but he immediately made all the amends in his power, and as the correspondence was all contained in successive numbers of the "Philosophical Magazine", we should have imagined that the matter might have been allowed to end here. Other persons, however, besides Mr. Elliot, form an opinion upon only reading a part of the evidence. Many who ought to know more of the real merits of the case place Mr. Elliot in the position of first discoverer, although they sometimes say that Professor Wheatstone discovered it independently; but in no single instance that we have yet seen is full justice done to the inventor of that wonderful instrument the stereoscope, the discovery of which is absolutely and solely due to the genius of Professor Wheatstone, who, moreover, has given in his original paper, the best, if not the only, account of the theoretical and physiological laws upon which it is based."

An examination of the periodical referenced, "The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science", to give it its full title, reveals that one of the four editors of this monthly was Sir David Brewster. He was certainly aware of Elliot's original letter that appeared in the May, 1852 issue, so as Editor he was surely aware that Wheatstone himself pointed out Elliot's mistake in a letter that was printed in their June issue. Appearing directly beneath Wheatstone's letter is the following:

> "We have, since the publication of our last Number, received a note from Mr. Elliot, stating, that had he been aware that Prof. Wheatstone had produced his Stereoscope so early in 1838, he would not have sent the statement inserted therein.
> —Editor"

Despite this disclaimer by Elliot, Brewster trumpeted Elliot's name in his 1856 book and in subsequent correspondence and articles. A most amazing individual was Brewster to so arrogantly ignore the facts.

Brewster's personal animosity towards Wheatstone apparently began around the latter part of 1852 based on Wheatstone's remarks in 'The Times' about the attacks of the past four years. As an editor of the Philosophical Magazine, it is doubtful if Brewster would have reprinted Wheatstone's 1838 paper in April 1852 if he had harbored any ill will towards him at that time. Whatever was the cause, it has never been satisfactorily explained to this day.

Chimenti Pictures:

In 1860 Sir David received another opportunity to erode the Professor's reputation by raising doubts as to the originality of his work when he reported to the Photographic Society of Scotland the discovery of "the Binocular drawings of Jacapo Chimenti". The following, by Sir David Brewster, appeared in "The Photographic Journal" of May 15, 1860:

"Last summer when Mr. Alexander Crum Brown and his brother Dr. John Brown were visiting the Musée Wicar at Lille, Mr. Brown observed two drawings placed side by side, and so perfectly similar that he could account for the fact only by supposing that they were binocular pictures intended to be combined into relief either by the eye or by an instrument.

"The following is the account of these pictures which he communicated to Principal Forbes, who brought it under my notice:—

'In the Musée Wicar at Lille there are two drawings, with a pen and in water colours of a young man sitting upon a bank and drawing with a pair of compasses. These two drawings are by Jacopo Chimenti, a painter of the Florentine school, who was born at Empoli, near Florence, in 1554, and died in 1640.

'They are drawings of the same object, from points of view slightly different.

'They are so exactly on the same scale, that, by converging the optic axes, I succeeded in uniting the two so as to produce an image in relief. They united so easily and completely that I could not help thinking that they had been drawn for the purpose of being looked at in that way. The figure has one arm extended towards the spectator, and with the other has drawn a line upon the floor. As far as I could judge, the difference between the two pictures was greater than would be produced by a change of the position of a spectator equal to the distance between the two eyes, so that the stereoscopic effect was somewhat exaggerated.

'I think, if we had a photograph of the pictures, it would be much easier to prove the stereoscopic character than merely by referring to them; and if the photographs were of such a size that they could be transposed and put into the stereoscope, any one could see it.'

Brewster concluded with: "This account of the two drawings is so distinct and evinces such a knowledge of the subject, that we cannot for a moment doubt that they are binocular drawings intended by the artist to be united into relief either by the eye or by an instrument."

In June, 1860, Professor Wheatstone obtained photographs of the Chimenti Drawings, placed them in a Stereoscope and he and his friends found them not to be stereoscopic. Copies were sent to the French Photographic Society and laid before the members at their July meeting. They reported: "When placed in the stereoscope, the two pictures united perfectly, but did not present the smallest effect of relief. We think it is fair, therefore, to presume that, whatever may have been the object proposed by the artist in executing the two similar pictures, it was certainly not from any knowledge of the stereoscopic phenomenon, and that Sir David Brewster was in this instance wrong in his conjecture."

It was not until March 11, 1862, that Brewster himself obtained pic-

that the device is called "Wheatstone's Bridge" to this day. His electric clocks were well known, various electrical registers were invented by him—to record a variety of meteorological data and to register the velocity of a bullet. Wheatstone contributed to the development of the dynamo by grouping the armature coils to give a really continuous current. He also produced a type-printing telegraph (forerunner of the teletype machine).

The Catalog of the Royal Society contains 31 headings on his papers. Heat, light, electricity, sound, all received his attention at different periods.

Still another area of Wheatstone's widespread interest was in the field of cryptography. The British Museum had purchased what appeared to be an important document. Each of its seven pages bore the signature of King Charles the First; however, the pages were filled with columns of numbers. This long cipher, which had baffled all other experts, was translated by Professor Wheatstone in 1860. What had at first appeared to be a cipher in English turned out to be one in French! He also created a cipher machine that favorably impressed experts in this esoteric field, so far removed from his work in electricity. In addition, the Professor developed a cipher that was used for many years by the British Army. It was ideal for field use because it depended on a keyword that could be easily remembered and changed. This cipher was spoken of so glowingly (and often) by Lord Playfair, a close friend of the Professor and fellow cipher enthusiast, that his name, instead of Wheatstone's, gradually became associated with it. To this day, it is known as the Playfair cipher.

One month before his sixty-sixth birthday, Professor Wheatstone became Sir Charles Wheatstone when he was Knighted by the Queen. Many scientific honors had been bestowed on the great physicist over the years; he had been elected a Fellow of the Royal Society in 1836, a Chevalier of the Legion of Honour in 1855, and a foreign Associate of the Academy of Sciences of France in 1873; he possessed thirty-four distinctions or diplomas conferred upon him by various governments, universities, and learned societies, of which eight were German, six French, five English, three Swiss, two Scotch, two Italian, two American, and one each of Irish, Belgian, Russian, Swedish, Dutch, and Brazilian origin.

Sir Charles Wheatstone remained busy and active right up to the end of his life. He was visiting Paris to observe the inauguration of his automatic telegraph between that city and Marseilles when he caught cold. He died there of congestion of the lungs on the 19th of October at age 73. His body was returned to England where he was buried on a raw October morning in Kensal Green Cemetery in the same plot with his wife, brother, and sister. A large gathering of his scientific compatriots attended his funeral.

In his will, dated October 16, 1875, he bequeathed his collection of scientific books and instruments as well as his medals and diplomas to King's College, London, where they are preserved to this day in the Wheatstone collection. A legacy of 500 pounds for the purchase of scientific instruments was also earmarked for King's College. His collection of portraits of men of science he bequeathed to the Royal Society.

Wheatstone's early work on submarine cables helped to speed the news of his passing around the world. Within two days of his death, the 'New York Times' printed his obituary, having received the word via that remarkable wonder of the age—the Atlantic Cable.

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Other sources used are noted in text.

*Brewster's book was republished in 1972, but unfortunately, no mention of the controversy with Wheatstone appears in the introduction. So once again Brewster's legacy of misinformation is praising the name of Elliot (who was no more than a minor footnote in the history of the stereoscope) and degrading that of Wheatstone.

Note: Anyone wishing to experience the Victorian Age in which Professor Wheatstone lived and worked, would do well to read Michael Crichton's best seller "The Great Train Robbery". The atmosphere, social attitudes, and emerging technology are all interwoven into a crackerjack of a true story. Available in paperback.