SESSION 1906-7

PRESIDENT: THE RIGHT HON. LORD PIRRIE.

58, ROMFORD ROAD, STRATFORD,
January 31, 1907.

PREFACE.

DURING the financial year which has been brought to a close this evening, several lectures have been delivered to the junior section of the membership by Messrs. T. F. Aukland (Companion), A. E. Battle (Member), and J. G. Hawthorn (Member of Council). Abbreviated reports of some of these lectures are now published herewith to give an idea of their scope in the hope that in the coming year arrangements may be made in good time to have a systematic course of lectures specially for the junior section on evenings which will suit the majority and avoid the class evenings.

JAS. ADAMSON,
Hon. Secretary.

Report on Lecture I—Electricity

BY MR. A. E. BATTLE (MEMBER).

Delivered on Monday, October 8th, 1906.

IN undertaking this series of lectures it is my intention to view the subject from a popular rather than a mathematical standpoint. I propose first to deal with the Subject of Electricity, historically tracing its source, touching briefly upon electrical phenomena and illustrating these with experiments.

There is a popular idea that electricity is of modern discovery and the assertion that the knowledge of electrical phenomena is pre-historic will, I have no doubt, be somewhat discredited. Yet such is the case. The savages of the West Indies and South America devised a game of chance with electrified beans.

Lightning has been since the world was. The effect of rubbing certain resins was well known to the Ancients, and even the name electricity dates back 600 years B.C., when Thales the tutor of Socrates investigated the then well-known phenomena—frictional electricity.

It was not, however, until 1672 A.D. that electricity seriously occupied the attention of men of science, and it is interesting to note that such an important part in this discovery was taken by Dr. Gilbert, physician to Queen Elizabeth. One of the earlier forms of frictional machine consisted of a sulphur ball rotated on a spindle and rubbed by a piece of cloth held in the hand.

Towards the end of the eighteenth century Galvin and Volt, both Italians, made this science a special study, and from that date onwards more than rapid strides have been made. Britain, France, Germany, Italy and America can all recall with pride names which will ever be remembered in connexion with electrical science. Scientists to-day are making startling discoveries—discoveries which, in many cases, dash pet theories to the ground, and in some cases seem to suggest that the early ideas of the alchemist were perhaps very near the truth after all, and to certainly indicate that throughout nature electricity plays a most active and prominent part. It is ever present under all conditions, indicating its presence when the electrical equilibrium is disturbed.

Electricity is sometimes referred to as a form of energy, and viewed from that standpoint. It is often stated that electrical energy is mutually convertible with other forms of energy.

Heat energy can be converted directly into the electrical form. An apparatus for this purpose, the Thermo Pile, is now before you. It consists of strips of dissimilar metals, in this case antimony and bismuth converted in series. This forms the Thermo Pile. With this instrument is used the Astatic Galvanometer. (Here the lecturer explained the action of the instrument by experiments and models which, being connected in series, will indicate any slight current of electricity set up by applying heat to the junction of the bars, the current flowing at the heated end, from the bismuth to the antimony. This direction can easily be remembered as being the reverse to the alphabetical order of their names.)

Electricity due to chemical action or galvanism will occupy our attention chiefly this evening. Sometimes this form is known under the name of voltaic electricity.

The apparatus for producing this form is termed a battery, and in simple form it can be said that the electrical current is produced owing to the combustion of zinc in somewhat an analogous way as heat is produced by the combustion of coal. To obtain electricity from zinc it is necessary to make a connexion between that metal with another, by a conductor, and a liquid; the liquid being one which has a chemical action on the zinc, while the conduction is practically free from its action. For this reason we find the liquid is generally a dilute solution of sulphuric acid, while the conducting metal is either copper or carbon.

As in the combustion of coal CO_2 is formed, so when zinc is being consumed we have sulphate of zinc formed, which unlike the CO_2 must be removed.

A single arrangement, such as described above, is called a cell, and a collection of such a battery.

If we take, say, a pint of water in a suitable jar, mixed with one ounce of sulphuric acid, and immerse a sheet of zinc no action is observed. But upon introducing, say, a sheet of copper and connecting the two metals outside the water the zinc at once shows signs of being attacked, and bubbles of gas rise to the surface of the liquid.

Now separate the plates and the action ceases. It is obvious, therefore, that for an electrical current to flow, the circuit must be complete ; to use a technical term, there must be a closed circuit. When the plates are separated, the circuit is termed open. The usual terms applied to the respective elements are negative and positive, the electrical current flowing from the positive to the negative.

It is obvious, therefore, that the positive element in the water will be the negative element out of the water, as has been illustrated. The wire through which an electrical current flows possesses many remarkable properties, and here it will not be out of place to call attention to the terms conductor and nonconductor. It can be taken that all substances more or less allow electricity to flow through them, metals to a large extent, whereas such materials as india-rubber and allied substances only very feebly. To the former we give the term good conductors, whereas the latter are classified as bad conductors. Broadly, all substances which are good conductors of heat are also good conductors of electricity, and bad heat conductors are also bad conductors of electricity. The conductive properties of a body are, however, chiefly due to physical or molecular conditions, for it is found that substances which in one physical state are good conductors, in another offer great resistance. Take water, for instance, in its fluid state it is a good conductor, while in the form of ice its insulating properties closely approach that of glass.

Electricity manifests a phenomenon of pressure, known as Electrical Motive Force, E.M.F., and in any circuit, any variation of E.M.F., sets up an electrical current in the circuit. It being always remembered that for an electrical current to flow there must always be a complete (termed a closed) circuit.

The peculiar property of magnetism has been known from ages past, the compass needle being recorded in ancient Chinese chronicles. If a regular bar of steel be magnetized it is found to possess two poles, and say this magnet be suspended free to move, it will take up a position along the magnetic meridian pointing north and south, or, more correctly, magnetic north and south ; evidence seems to point, however, to there being two magnetic south poles. These magnetic poles change slightly in position from time to time, but any serious consideration of them is out of the province of these lectures.

Now electricity and magnetism are so closely allied, and manifest so many phenomena in common, that it is very difficult in many cases to definitely affirm which is magnetism and which is electricity. Each electrical conductor carrying a current has a magnetic whirl as it were around it, and such a wire in the form of a solenoid manifests all the properties of a magnet, and is repelled or attracted by another solenoid or magnet.

An electrical conductor parallel with the magnetic meridian also influences a magnetic needle, deflecting it in a definite direction according to the direction of the flowing current, and also in proportion to the intensity and quantity of flow.

For instance, take a magnetic needle under the influence of an electric current, the conductor being placed over the needle. It is observed that the north-seeking point is deflected to the west should the current be flowing from south to north, and to the east if from north to south. The word SNOW will recall these conditions, and give an indication of the effects to be expected.

The electric current is flowing from south to north over the needle which is deflected to the west.

Referring again to the magnetic properties manifested by a solenoid, it might be mentioned in closing that this is greatly intensified by the introduction of a soft iron core. The magnetic lines of force, as they are termed (conveniently but erroneously), flowing freer through iron than through air. All crowd, as it were, through this easier path, which obviously presents more marked magnetic phenomena.

During the evening the subject was illustrated by experiments and instruments, the lecturer explaining fully the details and special points in connexion with each case.

Report on Lecture II—Electricity

By Mr. A. E. BATTLE (Member),

Delivered on Monday, November 12th, 1906.

My subject for this evening's lecture is Electrical Induction, the Induction Coil and X-Rays. I am afraid that it is, in a measure, dealing with the subject the wrong way round, as X-Rays should really, from technical standpoints, be considered after electrical discharges. However, I rather like departing from beaten tracks, and for this reason, and also that it is convenient to do so, I am including X-Rays in this evening's experiments. It is a well known fact by all possessing the most elementary knowledge of the subject that a magnet will induce magnets of the opposite polarity in soft iron within its sphere of influence. Also, recalling one of the experiments of last lecture, we found that an electrical current flowing round a core of iron or steel induced magnetism. I have here such a solenoid connected to a sensitive galvanometer. Now by moving this permanent magnet backwards and forwards within the core we notice the galvanometer needle deflected first one way and then the other, and from previous experiments we are aware that when the needle is so deflected it indicates the presence of an electrical current. It is obvious, therefore, that as the magnets are moved, the lines of force (if I may be allowed to use such crude terms) wrap themselves around the wires setting up the current which was previously referred to—first in one direction, as the magnet moves one way, and then the other as the magnet's direction of motion is reversed. To put it in ordinary text-book form, whenever the lines of magnetism are cut by the wires of a closed circuit an electrical current is induced in that circuit. To further illustrate the principles of induction, I have here two circuits—one with a battery and key in series to make and break the circuit, and the other a closed circuit with a sensitive galvanometer in series; the two wires being close together, but not touching. You will also observe both are insulated. Now, when the battery circuit is "made," that is the key pressed down and the circuit completed, we see the needle of the galvanometer deflect in such a manner that by applying the rule previously laid down we find an electrical current has been induced and flows in the opposite direction to that of the battery circuit. Also upon the battery circuit being broken the galvanometer indicates that another instantaneous current has been induced in that circuit and in the same direction as that flowing in the battery circuit.

The induction coil is, in these days of motor bicycles, etc., becoming more generally known and its practical use apparent —at least, in that direction. Its principles of operation are those just explained, i.e. the induction of an electrical current in a closed circuit (called the secondary) due to the making and breaking of the electrical current in the primary coil.

I have here a model of an induction coil showing its construction.

First, we have an iron core made up of soft carbon iron wire wound with insulating material. Upon this is wound a few (two in this case) turns of thick insulated wire, the ends being connected to terminals. This winding is termed the primary winding. Over this is passed a sleeve of vulcanite for high insulating purposes, and upon this sleeve is wound the second winding of many turns of very fine silk-covered wire, the ends of which are connected to a suitable arrangement of spark-gap. The primary circuit is made and broken by the magnetic attraction of the core.

When no current is flowing the primary circuit is closed. When the current is switched on, the core becoming a magnet, attracts the hammer and so breaks the circuit. The current consequently ceases to flow, and so the core, losing its magnetism, releases the hammer which, returning to its normal position by the action of a spring, again completes the primary circuit.

Each time a make and break of the primary circuit is effected an electrical current is induced in the secondary in accordance with the laws of induction already laid down. This is roughly a description of the induction coil. A great improvement was, however, made to this instrument by Fizeau, who introduced an electrical condenser (a series of layers of tinfoil sheet insulated from each other by mica sheet), in short, with the primary winding. The effect of this is that when the circuit is made the current flows directly through the circuit.

When the primary is broken, the extra current—were there no condenser—would surge and give rise to violent sparking at the contacts. When a condenser is fitted, however, this current flows into it, so stopping the sparking, and the condenser receiving this charge is able to assist by discharging at the next operation, so giving a much greater flow of electricity to the primary; and consequently a more intense spark at the secondary terminals.

Induction coils can be divided into two classes—medium and high tension. The one before you is high tension, capable of giving a spark some 6 inches in length. It is needless for me to remark that when operating such coils great care must be exercised, as a shock would be accompanied with somewhat serious results.

When Professor Röntgen, of Wurzburg, first made his epoch-making discovery in 1895, the induction coil assumed a new and important sphere of usefulness.

The phenomena of electrical discharges through high vacuum with Crook's tubes greatly interested the Professor, and it was when so experimenting that it was found that the tubes emitted rays which had the power of fluorescing certain salts.

Experiments with Crook's tubes had previously resulted in the drawing of a form of discharge known as Kathode rays. Hittorf and Lenard, being very prominent in these researches, established the fact that certain substances were transparent to them but that glass and metals were opaque to them. Hittorf, however, discovered that although glass and metals were opaque to the rays, still there seemed to be something in the form of rays emitted from the other side of the metal or glass. Röntgen's discovery was really a continuation of this. It was found that the newly discovered rays freely passed through paper, wood, etc., and, as previously mentioned, caused salts to fluoresce, besides affecting a photographic plate. What these new or X-Rays are I am unable to state. Philosophers have been trying to fathom it from that day to this; but have done little to justify a reliable inference being drawn.

It was, however, found that the transparency of the various substances diminished as their molecular weight and that powder was as transparent as solids to the rays, and that an electrified body—say this leyden jar which I charge at the battery—is discharged by being exposed to the influence of X-Rays.

The modern accepted theory regarding X-Rays is that they are either ether or light waves extremely sensitive and of high frequency.

The value of such an apparatus for surgical purposes is obvious ; but its further use will be increased when it is said that real gems are said to be transparent to the rays, while paste and dense glass imitations are opaque. These, in addition to the utility of the apparatus for post-office purposes, makes its use much more wide than is generally credited. The source of the rays is the first solid surface struck by them, and this is really the idea aimed at in the tube designed by Mr. Jackson, of King's College, a type of which I am using.

It will be observed that there are two plates, the one at an angle of 40°, being the anode, which is made of platinum. The curved plate, the Kathode, emits Kathode rays which bombard the anode plate when the X-Rays are generated.

It might be mentioned that for different classes of work different tubes are required. Tubes of comparatively low vacuum are more suitable for a short spark. These tubes, however, change during working, the gas being rarefied and requiring a longer spark. It is often necessary, when working, to heat the tubes by means of spirit lamps owing to this, and ultimately to have the tube opened and re-exhausted to the required vacuum again. A very good plan, should such trouble arise, is to send a small spark through the reverse way to lower the vacuum.

For photographic work the mercury interrupter is often used. It has been found that a 2 to 3 inch spark will give fairly good results, this being about what we are working with to-night.

The use of the fluorescope is instructive and illustrates X-Ray effects as you see. The screen is ordinary card coated with calcium chloride salts. The action of the X-Rays causes this salt to fluoresce, and when an opaque object or one partially so is placed between the flow of the rays and the screen the rays are obstructed, with the result of a shadow picture produced upon the screen.

In order to illustrate the lecture the blackboard was here drawn before the Crook's tubes, the screen being held facing the audience. Certain objects were placed behind the board including a human hand, purse, metal tools in cases, etc.

During the evening two X-Rays photos were taken. Experiments illustrating the subjects were also shown.

Report on Lecture III—Electricity

BY MR. A. E. BATTLE (MEMBER),

Delivered on Monday, December 10th, 1906.

BEFORE proceeding with the popular idea of an electrical discharge, it would be advisable to touch upon the various frictional machines.

The first of this type was invented as far back as 1671, and consisted of a ball of sulphur rubbed by the hand while being rotated.

Newton improved upon this machine by using glass and introducing a prime conductor into the apparatus.

The modern development is now the glass or vulcanite plate machine, similar to that before you. The Wimshurst machine consists of, in this case, two ebonite plates rotating in the opposite direction, upon which are gummed tinfoil strips. The two conductors, you will observe, are at right angles to each other. The conductors terminate in brushes which, as the machine works, come into contact with the tinfoil strips. Insulated collecting combs collect the electricity, and are connected to the discharging part of the machine. When the machine is in motion the friction of the brushes generates electricity. The early form of electrical machine required very careful handling. A fire in close proximity, freeness from dust, all add to efficient working. To intensify the discharge Leyden jars are introduced.

A number of interesting experiments can be shown by this machine, the principles of induction, attraction and repulsion, and the usual phenomena of an electrical discharge.

(The lecturer here conducted a series of experiments with the Wimshurst machine, starting from the discharge of a Leyden jar and following on to the induction motion, the electric whirl, condensation of smoke by electrical discharges, electrical chimes, etc., etc.)

Proceeding now to the induction coil, it is interesting to note that the discharge is not continuous, but is made up of a large number of discharges in what may be termed a shower. This can be nicely illustrated by holding a piece of paper between the discharging terminals, when it will be found the paper is perforated with a number of small pin holes. The electric pen is constructed upon this principle and consists of an ordinary metal point well insulated and attached to an induction coil. (Here the working of the pen was explained, and a design traced out on black paper with a wire from one terminal of the induction coil, and the stencil so formed passed round for inspection.)

Electrical Discharges in Air.

By introducing a flame between the discharging points of an induction coil, a much larger spark can be obtained. By inserting a sheet of glass between, however, it is found that the discharge bends round the side of the glass.

Should the plate be somewhat thin the electrical discharge will perforate it.

Magnets also possess the power of deflecting the discharge.

A very good illustration, and also a very pretty experiment, can be given by placing two wires from a coil, one each side of a mirror, when by changing the direction of the primary current it is observed the discharge varies, which indicates that the position and negative discharges are decidedly different in their action.

Crystals are also illuminated by electrical discharges.

(Here a number of pieces of sugar were placed between the discharging points and were brilliantly illuminated.)

Discharges in Partial Vacua.

It has been found that the density of the air plays an important part in connexion with electrical discharges. Take a case of a discharge in air of high density; it is observed that the spark is shortened considerably; whereas when the air is rarefied up to a certain point, discharges of much greater length can be obtained. It is also observed that there is a marked difference between the effects at the positive and negative terminals, a dark space showing at the latter. These discharges can be rotated and are found to obey the same laws as ordinary electrical conductors. The purple light is what is termed a brush discharge, and owing to being richly supplied with ultra violet rays possesses great fluorescing powers.

(Experiments were here conducted illustrating discharges in low vacuum electrodes and the stratification of rarefied gases, allusion being also made to the bearing of these matters upon modern ideas of chemistry, namely, the Ions or Atoms of the Atom.)

Discharges in High Vacuum.

When a vacuum tube is exhausted to high degrees of vacuum quite a different set of phenomena present themselves, and it is found that the rarefied gases behave in such a way as to suggest the existence of a fourth state of matter called radiant, differing entirely from gases as widely as gases differ from liquids or solids.

(Experiments were here shown in connexion with high vacuum discharges and the theory of the gaseous Mean Free Path explained. The dark space at the negative terminal was also further explained, and it was shown how, by exhausting, this space may be extended and also the power of the bombarding molecules to excite phosphorescence.)

In conclusion the lecturer showed a large collection of tubes illustrating the subject, including sea-shells, under an electrical discharge, and also produced some very striking effects by rotating vacuum tubes of various designs by means of an electrical motion.

Report on Lecture IV—Electricity

By Mr. A. E. BATTLE (Member),

Delivered on Monday, January 28th, 1907.

The subject, "Signalling through Space," is, if anything, far more vast to deal with in one evening than perhaps any of the preceding lectures, and I must confess to a feeling of attempting to deal with too wide and interesting a subject in the limited time at our disposal.

The necessity of signalling through space was very early apparent to man, and the first form of speech was the first move in this direction. The method of signalling by beacon fires is well known to the readers of Scott's novels.

Besides the primitive methods, and prior to the electric telegraph, a system of semaphore signalling was introduced and adopted in the Navy and Army. (This was illustrated.)

It was not, however, until 1836 that any practical strides were made in regard to electrical telegraphy, when Professor Charles Wheatstone began experimenting in the vaults of King's College, London, with four miles of properly insulated wire, and worked out the details of his electric telegraph, he having already laid down the scientific principles of the same and devised an original method whereby the signal could be transmitted along a greater number of wires; the principle of his system being the deflection of a magnetic needle by a flowing current, which will now be illustrated. In 1837 Wheatstone completed his five-needle instrument, the identical instrument being now on exhibition in the South Kensington Museum.

Shortly after the taking out of the patent, Professor Wheatstone laid down wires between Euston Station and Camden Town on the L. & N. W. Railway. Late in the evening of July 25, 1837, sat Wheatstone in a dingy little room at Euston Square with his hand on the sending apparatus and anxiously watching the needle of the receiving instrument still in motionless repose. At the other end of this historic wire at Camden Town sat his partner, Mr. Cook, together with Sir Charles Fox, Robert Stephenson, and others. The feelings of the inventors can better be imagined than described, sitting before their instruments and for the first time in history signalling by electricity through space, and that signal which has been so frequently used, but on no occasion with more dramatic details and such thrilling interest passed through, "All's well, thank God!" To use Wheatstone's own words, "Never did I feel such a tumultuous sensation before, as when all alone in the still room I heard the needle click, and spelled out the words. I felt all the magnitude of the invention now proved beyond dispute."

The original use of carrying merely railway messages speedily gave place to the wants of the general public, and eight years after Wheatstone's first patent, telegraph lines to the extent of 500 miles were laid. In 1855 the Electric Telegraph Co. was formed, using the needle instrument of Wheatstone & Cook.

The telegraphic message was demonstrated of invaluable and practical utility by telegraphing the description of a murderer and his arrest upon the train's arrival.

The Duplex and Quadruplex systems were gone into. The sending of two signals each way along a wire at the same instant was explained by diagram by request.

The subject of signalling without wires was then dealt with from historical, theoretical and experimental standpoints, Mr. Battle intimating that he proposed dealing more with this subject at the March lecture.

The principle of the telephone also was explained and illustrated by experiment, and in conclusion the lecturer said that his reason for taking up the subject was that on modern steamships it is now necessary for engineers to be familiar with electricity, not merely as picked up from the management of a dynamo, but as based upon sound and solid lines beyond the mere mechanism of that very useful apparatus the dynamo with which we are all more or less familiar.

There are many appliances being gradually adopted in the merchant, as they are in His Majesty's, navy which demand the attention of engineers, and it is well to be ahead of the times in gaining knowledge of such and of the principles involved, so that when the time for action arrives the engineer is there to meet it. Ventilating fans, refrigerators, bells, telephones, signalling apparatus, need only be named to show what is now required of the marine engineer in the passenger steamer of to-day.

Lecture on Character.

By Mr. T. F. AUKLAND (Companion).

"Character" was the subject of a most admirable address delivered by Mr. T. F. Aukland on Monday, November 26, 1906 The lecture, as prefaced by the lecturer, consisted entirely and exclusively of extracts from the writings of the late Dr. Samuel Smiles and a few from Ralph Waldo Emerson, thoughts to awaken noble aims and ambitions, and still higher raise the ideal of those who already realize that "a man's life consisteth not in the abundance of things that he possesseth." The following quotations give some idea of its scope.

Although genius always commands admiration, character most secures respect. Men of genius stand to Society as its intellect, but men of character as its conscience, and while the former are admired the latter are followed. "A handful of good life," says George Herbert, "is worth a bushel of learning." Character exhibits itself in conduct, guided and inspired by principle, integrity and practical wisdom. It chooses its way considerately and pursues it steadfastly, esteeming duty above reputation and the approval of conscience more than the world's praise. While respecting the personality of others it preserves its own individuality and independence, and has the courage to be morally honest, though it may be unpopular, trusting tranquilly to time and experience for recognition. The same qualities which determine the character of individuals also determine the character of nations. Unless they are high-minded, truthful, honest, virtuous and courageous they will be held in light esteem by other nations and be without weight in the world. Stability of institutions must depend upon stability of character in their continuance. Any number of depraved units cannot form a great nation; the people may seem to be highly civilized and yet fall to pieces at the first touch of adversity. Without integrity of individual character they can have no real strength, cohesion or soundness. The influence of the home and of companionships were touched upon, and of work as a practical educator of character the following extracts show the potency. It evokes and disciplines obedience, self-control, attention, application and perseverance. It is idleness that is the curse of man—not labour. Idleness eats out the heart of men as of nations and consumes them as rust does iron. Indolence always failed in life and always will—it is a burden, an incumbrance to noble work and a nuisance—always useless, complaining, fault finding, melancholy and miserable. It is indolence that exhausts—not action, in which there is life, health and pleasure. All that is great in man comes through work, and civilization is its product.

We have each to do our duty in that sphere of life in which we have been placed. Duty alone is true; there is no true action but in its accomplishment; it is the end and aim of the highest life; the truest pleasure of all is that derived from the consciousness of its fulfilment, and the man who in his unselfish devotion to a high ideal of duty is the one who tends to elevate his generation.

The lecture was rich in illustration and the after results will doubtless remain with those who were privileged to hear Mr. Aukland while instilling noble thoughts and giving inspiration towards a study of the best of all ages.

Lecture on Boiler Construction

By Mr. J. G. HAWTHORN (Member).

On January 14th, 1907, Mr. J. G. Hawthorn gave a lecture specially for the Junior Section, on boiler construction, in the course of which he pointed out the principles on which the boiler is constructed to get the best out of it, both in respect to its work and its longevity. Treating first on the importance of designing a boiler with a view to the work it has to do, it is no less important to consider the process of manufacture and the most economical way of putting every part together with accuracy for it to stand the various strains to which each detail is subjected. The next point the lecturer dealt with was how to choose the class of material best adapted for the shell, the tube plates, fireboxes, stays and tubes, indicating the different properties of iron and steel, the brands most suitable for exposure to heat, with the percentage of carbon contained in these, and the qualities due to the percentages. Strength of material, margin of safety allowances, and rules for thicknesses of shells, fireboxes, furnaces and tube plates were next explained, also methods and rules for staying the various parts. In closing, Mr. Hawthorn showed how the firegrate, heating surface and water and steam spaces influenced the evaporation, coal consumption and the indicated horse-power of the engine.

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