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Fundamental Electricity

BY W. P. WIEMAN

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FUNDAMENTAL ELECTRICITY

By W. P. Wieman

Steam and Electrical Engineer
Member Society Astronomers De France

A Practical Treatise on the Fundamental Principles Underlying Electricity

The Relationship Between Physical Astronomy and Electrical Phenomena Fully Explained

27 Illustrations

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PREFACE

In reaching into Astronomy to explain Electricity would seem only to intensify the feeling against these subjects in the minds of many, who regard Astronomy as a study of pure curiosity, and Electricity as a prohibitive study; but a perusal of this book should dispel the idea that Astronomy is a study of curiosity, and that Electricity is beyond understanding. On the contrary, Astronomy has a great deal to recommend it. Navigation of the seas, our daily time, seasons of the year and, in fact, the concerns of our daily life depend upon the practical application of Astronomy, while Electricity has already performed sufficiently well to permit its examination, notwithstanding the advice of some writers "not to try to fathom the science of electricity too deeply."

In performing its functions, electricity surrenders itself for investigation. Former efforts to solve electricity have failed for the sole reason that physical astronomy was ignored. In view of past failures, it would seem fair and profitable to review the two branches together and ascertain their mutual relationship.

In a review of the subject of Fundamental Electricity, it is imperative that the whole

field of Natural Laws be investigated in order to secure only such laws as bear most directly on electricity. From a practical standpoint, the Author is favorably equipped for this work, with theoretical and practical experience of thirty-five years in the designing, machining, installing and operating of electrical appliance in its many branches, from the days of the introduction of commercial electricity, when the small Bi-pole Dynamo was a wonder, through the long process of electrical development to the monstrous Turbo-driven Polyphase Generators of today.

For many years the writer has been a student of Physical Astronomy, in which study he found many indications of electrical phenomena, which induced the thought that Physical Astronomy was a close relative of Electricity. With this in mind the two branches were investigated together, with the result as followed in this review.

With this method of investigation, and with the knowledge of prejudice to leaving the well-beaten path of Electrical Theories and Hypothesis, the writer offers the following review with the hope that the knowledge of Fundamental Electricity will be advanced and simplified for the benefit of all.

THE AUTHOR.

FAMOUS WRITERS

Theories and Hypothesis of Electricity, by Famous Writers

Prof. Elihu Thompson:

(Address, Thompson Scientific Club, Lynn, Mass., 1890.)

What is Electricity; can we answer it? No. We can only point out the lines of progress in that direction and hope that sometime in the future the secret will be out; at least so far as finite mind can obtain an answer.

The current magnetizes, not air, because of we take away the air you will find the magnetism there still. Well, then, it must magnetize the universal ether which is present everywhere. The current produces lines of magnetic strain in it.

Light is electric magnetic waves; they are waves in the ether, and are electric waves. The whole science of optics is an electric study.

Electric waves go through glass, but do not go through a copper plate.

N. Hawkins, M.E. (Hawkin's Catechism of Electricity):

Electromotive Force acts not on matter, but on Electricity and tends to move it.

Following from Dictionary of Electrical

Words, by Edwin J. Houston, A.M., Ph.D.:

Clark Maxwell:

Vibrations of light are electric waves.

Sylvanus P. Thompson:

Electricity, whatever its true nature, is one, not two; that this electricity, whatever it may prove to be, is not matter and is not energy; that it resembles both matter and energy in one respect, however, in that it cannot be created nor destroyed.

W. Perrin Maycock:

Whatever Electricity is, it is impossible to say; but for the present it is convenient to look upon it as a kind of invisible something which pervades all bodies.

Prof. Rowland:

There is nothing more certain today than that Electricity is not a fluid.

A. Stoletow:

Throughout the Nineteenth century this enigma (What is Electricity?) has been the object of numerous reserches . . . and yet the inner workings of Electrical phenomena remain still a deeper mystery.

Faraday:

Moving a wire across a magnetic field cuts

lines of force and generates a current of electricity in that wire.

Hughes-Ewing:

The atoms of matter possess naturally opposite magnetic polarities, which are respectively North and South.

Angelo Secchi:

The Earth's magnetism is due to induction from an already magnetized Sun (this is not credited by writers).

Biglow:

The Earth's magnetism is caused by rotation in the magnetic field of the Sun's light and radiation.

Ampere:

The ultimate particles of all magnetizable bodies have closed electric circuits in which electric currents are continually flowing.

Edwin J. Houston, A.M., Ph.D.:

Electricity, no matter how produced, is believed to be one and the same thing. The terms, Frictional, Pyro, Magneto, Voltaic, Galvanic, Thermo, Contact, Animal Electricity, etc., though convenient for distinguishing their origin, have no longer the significance formerly attributed to them as representing different kinds of electrical force.

The cutting of lines of force produce difference of potential. This is true whether the conductor moves through the stationary field or whether the field moves through the stationary conductor, so that the lines of force and the conductor cut one another. This cutting is mutual. Each line of force cuts and is cut by the circuit. Since all lines of force form closed circuits or paths, the cutting of the circuit by the lines of force, or the reverse, form a link or chain, and the cutting takes place at the moment of linking or unlinking, i. e., of cutting.

INTRODUCTION

To Know—

That which before us lies in daily life,
That is the prime wisdom.
—Milton.

During our lives that which we have been taught differs greatly from that which we have learned. One of the greatest things we have learned is that we live in a very Natural World, a world in which Natural Law reigns supreme; laws which were handed down at the beginning of time; laws that have performed their function without error through countless ages, in all parts of the Universe, giving life to all matter in whatever form. These untiring, undestroyable forces from which no deviation can be made, provided free and in unlimited quantity, to provide the comforts and conveniences of man, in a thousand different ways. Electricity is only one of the many gifts to this world to be used by man for his comfort, and it is a duty we owe ourselves to know more about nature's work, that we may better apply these generous gifts so abundantly supplied.

We are living in an age of progress and enlightenment. Every day brings us closer to the realization of nature's work. The existence of all materials in whatever form, nat-

ural or manufactured, all manifestations of activity or conditions as observed by man, are the direct result of Natural Forces.

Man's wonderful accomplishments in applying natural forces in the past should be an incentive to the present mind to learn the WHY? of these results, and strive to advance still further.

Let us, therefore, make a strong effort to go a step forward and if possible, master the fundamental principles of one of nature's greatest gifts—Electricity.

It should be emphasized here that no matter in what form electricity may present itself, Lightning, Wireless Waves, Heating, Power, Electrolysis or by any other manifestation, it is the same thing, and it is the desire here to find a solution to the Source, Nature and Action of electricity and to present the matter in the most simple and understandable way, to avoid the use of mathematics and complicated references, to use photographs of fact, and simple drawings of practice, along with plain talk.

Sir Isaac Newton gave the world the Law of Universal Gravitation in 1667; Faraday, the Electric Dynamo in 1831; Brush and Edison, the Arc and Incandescent Lights in 1878,

which latter date marks the beginning of commercial electricity, and after forty years of unparalleled growth, Fundamental Electricity still remains a mystery.

ELECTRICITY

Electricity is a name by which electric phenomena is known, but does not give the slightest hint to the fundamental principles of the phenomena, so that the word can be used only to designate electric manifestation.

Electricity is not one thing, but a result of a combination of several Natural Forces acting on matter, which will readily admit of explanation, providing sufficient range be permitted.

Owing to the range limit placed on the source of magnetism, electricity has been propounded in the past without the slightest prospect of solution. The fear of being discredited (as was Secchi who proposed a magnetized Sun), morally restricts the investigator to expressions borne out only by precedent reference. This unwritten law acts as a brake on electrical investigation, and will be set aside in this instance.

We will leave the well-beaten path of speculation as to what electricity ought to be, that it resembles or acts like something which is not itself understood, avoid long reference explanations that do not explain (and very often lead the subject into foreign channels,

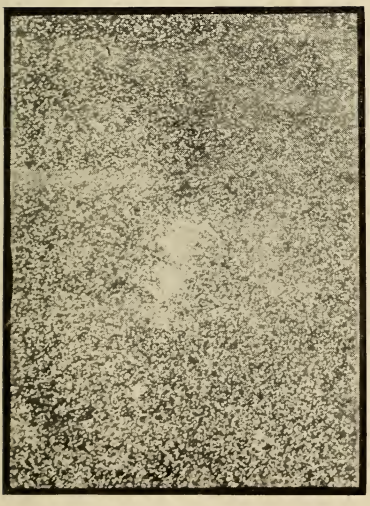
making the subject more confusing than ever), and remain within plain reason and facts that give practical proof that we can understand.

There are many writers on this subject who have explained electricity from many angles, and with few exceptions their work has been confined to special branches of the subject, on the whole, seeming to form a ring around the main subject within which none will enter. However, during the many years of electrical progress in which the writers and publishers have propounded electricity, the practical engineer, electrical worker and experimentor have been a great factor in the success of electrical advancement, and, as a matter of fact, owing to the isolated position of this class of workers, their voices are seldom or never heard, their ambitions and accomplishments are very often rewarded with a steady job, while their standing in a progressive world is zero. It is for this reason that the writer, who has been a worker along these lines for the past thirty-five years, in addition to many years of study in Astronomy, will make the effort to explain the fundamental principles of electricity as he

understands it, without resort to mathematical gymnastics or literary luster.

Electricity will be analyzed to find its component parts, to locate their source and learn their nature. Some parts are found close at hand, while others extend very far away. Approved or condemned theories and hypothesis must take their chances as the subject is weighed with facts that will give a practical understanding to form a solid foundation upon which to build a better electrical education.

Fig. 1.



Double Cluster of Stars in Perseus.

UNIVERSAL GRAVITATION

Gravitation is that force which forms an attraction between all particles of matter, and acts as a tie between the Sun and its Planets, holding the Planets at a fixed distance in their travel around the Sun, and is essential in showing universal control between celestial bodies, which we shall expect to find in our research of the physical universe.

As we view the heavens on a clear night, we see thousands of stars (Suns). Their brilliancy and number multiply many times when viewed through a telescope. Even the telescope is improved on by the sensitive photograph plate which permits of long exposures and reveals many wonderful things in the sky. Following are a few photographs which show what is going on in the heavens at this time:

Fig. 1. A double cluster of stars in the constellation Perseus. Over two thousand suns are shown in this picture. Many of them cannot be seen with our largest telescopes, owing to their great distance. It is characteristic of star photographers to make the stars appear in the plane of the picture, but while the nearest star in the picture is many billion miles from us, the farthest

Fig. 2.

Great Star Cloud in the Milky Way.

away may be a billion times the distance of the nearest. Stars travel through space at great velocity, and reach a speed of one thousand miles per second or more. They travel in vacuum, and are not hindered by resistance, such as air resistance of our atmosphere.

Fig. 2. Star cloud in the Milky Way. This is the most complex system of stars in the universe. This plate contains over ten thousand stars (or suns), all moving at high velocity and under full control of the Natural Forces.

Fig. 3. Nebula in the constellation Orion, showing clearly the result of a catastrophy between two great bodies striking each other at great velocity, creating most intense heat and hurling heated masses into space for many millions of miles. The great quantity of highly heated matter viewed from the Earth gives it the appearance of clouds. It is here that Gravity shows its great power, for it was through the force of Gravity that these great bodies fell together and transformed their motion into heat.

Fig. 3.

The Great Nebula in Orion.

Fig. 4.

The "Trifid Nebula" in Sagittarius.

Fig. 4. The Great Trifid Nebula in Sagittarius. This great conflagration is also the result of impact, resulting from the force of Gravity, causing violent atomic vibration of the materials composing the bodies, and thereby generating great heat.

Fig. 5. The great Spiral Nebula in Andromeda, resulting from impact due to force of gravitation. In this case the two bodies did not strike fairly as in the two former pictures, and resulted in giving the entire mass a turning motion, distributing great quantities of heated matter many billions of miles into space. We are informed that the entire Solar System could occupy a position within the central body of this nebula without inconvenience. This Nebula shows signs of System formation resembling our own Solar System, and will doubtless reach our temperature state some time.

Fig. 6. Spiral Nebula in Ursa Major, the result of impact due to Gravity. This nebula is of great age, and shows a more advanced stage of system formation resembling our own Solar System.

The above photographs were taken from widely different parts of the heavens, and is a general condition prevailing throughout the universe.

Fig. 5.

The Great "Spiral Nebula" in Andromeda.

Fig. 6.

Great Spiral Nebula in Ursa Major.

UNIVERSAL FORCES

Newton's Laws of Motion

First. Every body continues in its state of rest, or of uniform motion in a straight line, except in so far as it may be compelled to change that state by forces impressed upon it.

Second. Change of motion is proportional to the impressed force, and takes place in the direction of the straight line in which the force is impressed.

Third. To every action there is always an equal and contrary reaction, or the actions of two bodies upon each other are always equal and oppositely directed.

Newton's Laws prove Universal Gravitation, or the attraction of gravity between all particles of matter within the universe. The operation of Newton's Law of Gravitation, however, depends on empty space, or vacuum, for the reason that: Two bodies of equal weight, but unequal shape and dimension, will travel at unequal speeds through a denser medium, with equally impressed force, so that Newton's Laws prove Universal VACUUM.

NEWTON'S 2d and 3d law also applies to magnetism, in that, "2d. Change of motion is proportional to the impressed force; 3d The actions of two bodies upon each other are always equal and oppositely directed."

Law of Magnetism:

Unlike poles attract each other,
Like poles repel each other.

The attractive force of Gravity and Magnetism therefore seem very similar, but from our viewpoint, both forces acting on terrestrial bodies are opposed by centrifugal force, and the maintained balance of the bodies in their movement gives little indication of the activity of Gravity and Magnetism on the bodies. However, the axis stability of all the bodies in the Solar System (in which Gravitation has no part) must be maintained by Magnetism. Supporting this is the Earth's Magnetic Permanency, as shown by the compass. The variations in the intensity of the earth's magnetism during the period of mag-

netic storms (or sun spots) on the sun can leave no doubt of the existence of Universal Magnetism.

Therefore, it must now be evident that the Stars form a great Universal System, and that this system of celestial bodies float in space and are controlled by Natural Forces, and finally that the Solar System (of which the Earth is a part) is a part of the great Universal System and subject to the same Laws and Forces, so that the successive process of system formation as shown in photographs from different parts of the heavens must be accepted as proof that the mode of action of Natural Forces throughout the Universe is the same.

PHYSICAL UNIVERSE

The physicial universe is composed of hundreds of thousands of burning suns or stars, also many dark or extinct stars whose heat has dissipated from age, and are noted only when passing before a burning sun. Many stars or suns are known to have dark bodies revolving around them, on the order of the planets in our own Solar System, and when one of these dark bodies or planets pass the face of the star, the light of the star is reduced during the transit of the body, after which the star again resumes its full brilliancy. All celestial bodies travel through absolute Vacuum at various speeds, under the influence of natural forces, and when two bodies get within their mutual influence, Gravitation causes them to fall together, with the result already explained.

Stars differ in temperature, brilliancy and size. The Sun has an atmosphere of heated hydrogen gas, and gives out a white light. Its temperature is about 9,000 degrees. Alpha (a), Taurus had a hydrogen atmosphere with a temperature of 3,870 degrees, and gives out a red light, while Gamma (7) Pegasus has a helium atmosphere with a temperature

of 720,000 degrees, and gives out a blue light.

The Sun is the only light-giving body in the Solar System. Owing to its great mass it still retains much of its original heat, and while it is slowly cooling, many million years will be required to reduce its temperature to a non-light giving body. However, the planets have long since reached this point. Many of the smaller bodies, such as moons and inferior plantes, have become absolutely cold.

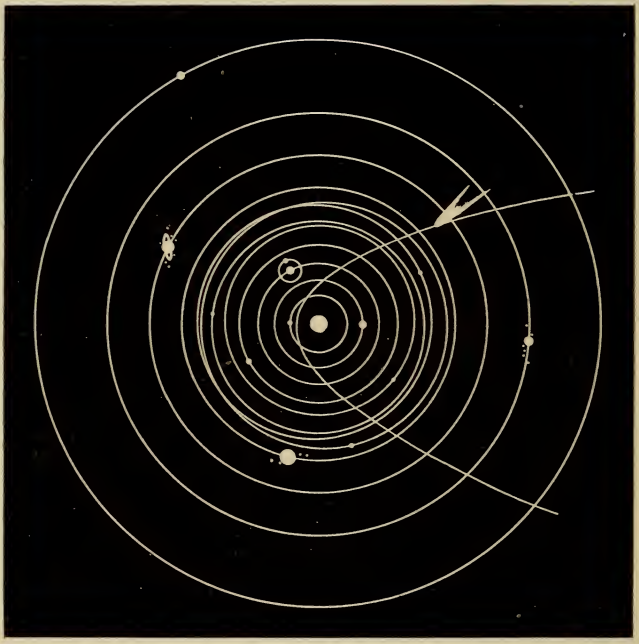
But in view of these facts, we must not lose sight of the fact that no matter what the condition of the body, Gravity and Magnetism are still in full control.

THE SOLAR SYSTEM

We are all very familiar with that great furnace in the sky, the SUN, its daily trips with its bright light and warmth, its unfailing punctuality, the father of rain and snow, the greatest friend of all living things on earth, respected by the Scientist and revered by the primitive tribes; in fact we have become so accustomed to the daily visits and conveniences that we accept the gifts without further thought, and it is only when we are in need of knowledge that we stop in our work to learn something about this great body. It is then that we are amazed at the wonderful size, movement, position, heat and light-giving capacity, its composition of many materials and capacity for governing Natural Forces, with which it controls the Solar System.

The Sun has a rotary motion, and as we view the face of the Sun, it revolves on its own axis from East to West, in a period of about 25 days (its South pole pointing to the North Star). All the Planets revolve around the Sun in the same direction as its own motion, but they vary greatly in the period of their journey around the Sun, owing to difference in size of orbit and speed of Planets.

Fig. 7.



Solar System Diagram.

The orbits of all the Planets in the Solar System are in the plane of a plate or disc, and all Planets and their Moons have their axis or center line pointing out of the plate formation of the System in the direction of the North or Pole Star. This is most important in our research, as showing the Magnetic inclination of the Sun and Planets in our Solar System. The Sun being the controlling body, it follows that it is the only body in this System that is controlled by an outside body or source. The North Star is not the controling body for our System, as it is in the wrong position in relation to the vortex formation and magnetic inclination of the Solar System, and therefore, only occupies the position of Pole Star, without influence on our System.

The Solar System occupies a space which measures five billions of miles across, and constitutes only a very small part of the Universe. The nearest fixed star to us is the Bright Star (a) in the constellation Centauri, and is 25 trillions of miles away from the Solar System, many stars being so distant that they cannot be measured with the best instruments on Earth.

From our viewpoint, the Solar System appears to occupy a central position among the

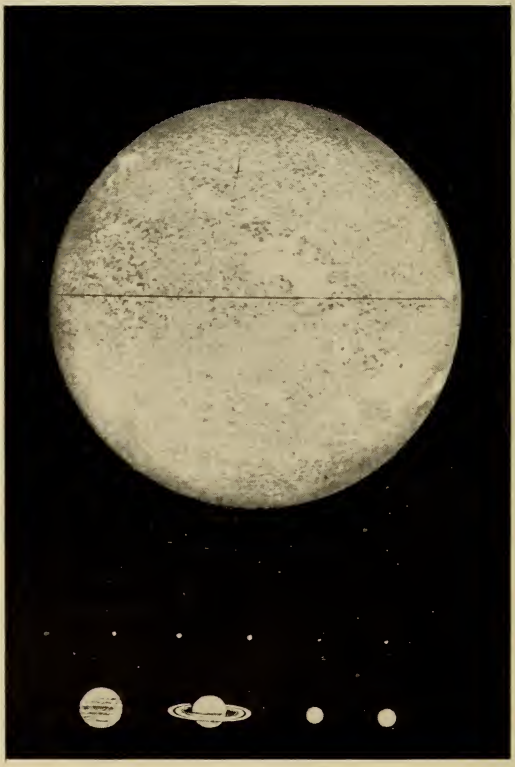
stars of the Universe. The stars as we see them, surround the Solar System, forming constellations of various shapes and groups, and it is by these constellations that our position in the Earth's orbit (or time of year) is ascertained during the year.

SUN AND PLANETS

Fig. 7. The Sun is a star and is the central and parent body of the Solar System. The Sun is accompanied by eight major Planets, each traveling in its own orbit around the Sun. Each orbit increases in distance from the Sun in the following order: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune. The closest Planet to the Sun is Mercury, whose distance is 35,000,000 miles. The farthest from the Sun is Neptune, whose distance is 2,746,000,000 miles. An aeroplane traveling at the rate of 200 miles an hour, would require 20 years to fly from Mercury to the Sun, and would require 1,500 years to fly from Neptune to the Sun, while Sun light reaches Neptune in about 10 days. These notes should give some idea of the vastness of the Universe which constitutes the workshop of Natural Forces. (See Table B.)

With its mighty mass and power, the Sun controls all the bodies in the Solar System, either directly or indirectly. The satellites or moons which revolve around the several Planets, are secondary bodies and are in turn controlled by the Planet around which they revolve, the Earth having but one moon, while Jupiter and Saturn each have eight. Uranus

Fig. 8.



Spectroheliogram of Calcium Gas on the Sun.
(Comparative of Sun and Planets).

TABLE B—SOLAR BODIES

NAME	DIA. MILES	DISTANCE FROM SUN MILES	PERIOD OF REVO. IN DAYS	VELOCITY IN ORBIT MILES PER MIN.	NUMBER OF MOONS	DENSITY
SUN	825,586					0.25
MERCURY	2,962	55,000,000	88	1,755		1.24
VENUS	7,510	66,000,000	225	1,248		0.92
EARTH	7,912	92,000,000	365	1,092	1	1
MARS	4,920	139,000,000	687	884	2	0.52
JUPITER	88,390	476,000,000	4,332	479	8	0.22
SATURN	71,904	872,000,000	10,759	353	8	0.12
URANUS	33,024	1,754,000,000	30,687	249	4	0.18
NEPTUNE	36,620	2,746,000,000	60,127	199	1	0.17
MOON	2,153					0.63

has four and Neptune one. Comets, of which there are a number in the Solar System, are primary bodies and are controlled directly by the Sun. Comets have an elliptical orbit and do not follow the rule of plate formation of the Planets, but travel around the Sun at most any angle, one end of the elliptical orbit being close around the Sun. The other may extend beyond the orbit of Neptune.

A number of small Planets revolve around the Sun in orbits between the orbits of Mars and Jupiter. These small primary Planets are in direct control of the Sun and follow the same laws as the major Planets.

The Sun's magnetic field extends to all the bodies that have orbits around the Sun. Moons or Satellites which have orbits around a Planet are in the magnetic zone of that Planet and are not in direct control of the Sun, but in control of the Planet around which they revolve.

PROPERTIES OF SOLAR BODIES

A brief description of properties of Solar Bodies, showing their tendency to Magnetism.

Comparative Sizes

Fig. 8. This descriptive drawing shows the comparative size and mass of the Sun and Planets. The Sun is represented by the large figure. The smaller spots represent the comparative sizes of the Planets in their order: Mercury, Venus, Earth, Moon, Mars, Jupiter, Saturn, Uranus and Neptune. Some idea of the enormous size of the Sun may be had from the fact that it would require 1,250,000 Earths to equal the mass of the Sun.

Fig. 9.

Storms on the Sun.
By Prof. Fox Yerkes.

SUN

Spectroheliogram

The Sun as shown in the above picture is a Spectroheliogram of calcium gas in the Sun's atmosphere. The photograph was taken at the Lick Observatory, California. The broken or mottled appearance shows a very unsettled and disturbed condition of the heated surface of the Sun. (Note—This photograph was taken from that part of the prismatic light of the Sun that shows only calcium gas. Other heated gasses in the Sun's atmosphere are not visible in this picture.)

Storms On the Sun

Fig. 9. A group shutter photograph showing only the edge or atmospheric zone of the Sun, (the body of the Sun being screened by a circular shutter to cut off the bright light of the Sun's body, to bring the heated atmosphere into view). A violent storm of heated gas is in action. The four plates were taken between 10:02 and 11:35 A. M., May 21st, 1907, by Professor Fox, at the Yerkes Observatory, the flames having reached a height of 172,000 miles from the surface of the Sun, with a maximum velocity of 25 miles per

second. Sun storms are in action at all times, being more violent near the Sun's equator. Flames having reached a height of 500,000 miles from the Sun's surface are recorded.

Sun storms are the result of internal unrest of matter near the surface, and is due to contraction from loss of heat, such as cause earthquake and volcanic eruption on earth. These storms cause fluctuations in the Solar Magnetic Field, as is shown by the magnetic disturbance on Earth.

Heat of the Sun

The heat of the Sun (9,000 degrees Fahrenheit) is not due to combustion or the burning of materials as the fires on Earth, as the fires are not supported by Oxygen, but is the result of stored energy of Atomic Activity, having its beginning at the time of the Sun's creation, the Sun's creation being the result of a great catastrophe between two great bodies traveling toward each other at very high velocity, under the influence of Gravitation, the intensity of impact generated extreme heat in the matter composing the bodies. In fact, the extreme heat not only liquefied, but gasefied a great portion of the matter. Many large and highly heated parti-

cles were thrown far out into space at that time, which continued to revolve around the parent body for ages, undergoing the process of cooling, and shaping under the influence of Natural Forces, to form Planets, Moons and Comets, until now we find the smaller bodies extremely cold and the larger bodies retaining their heat according to their size or mass. The process of early development is clearly shown in protographs Figs. 1 to 6, showing in their order stars calmly moving in space and collisions between them; also the stages of system development, in which the smaller bodies are seen to be under the influence of the main body, as indicated by their vortex formation, being duplicates of the formation of the Solar System at the time of its birth.

In spite of its extreme heat, the Sun is a huge Permanent Magnet. A heated body containing magnetizable matter may be permanently magnetized when its solidity or rigidity is sufficient to prevent movement of its atoms. The center pressure of the Sun is about 646,382 tons per square inch, or 6,463 times that of hard steel, and therefore has a permanency of 6,463 times that of a permanent steel magnet on Earth.

Fig. 10.

Saturn.

SATURN

Fig. 10. Saturn is the sixth Planet from the Sun, and second in size. Owing to its large mass it has not cooled as fast as the Earth and still retains much of its original heat. Its dense atmosphere and dark belts which are continually changing in form indicate that violent volcanic action is still going on, making plant or animal life impossible on the Planet at this time. Saturn, however, has other features which place it in the first rank as the wonder of the skies. Its Rings, which are formed of small particles of matter and travel around the Planet at great velocity. The several Rings (one within the other) are absolutely cold and move in absolute vacuum around the Planet. The various shades of the several rings are due to larger or smaller size and number of particles composing the ring. The stability of the rings is due to Gravity attraction, Inertia and Centrifugal Force, and like the Planet itself, they receive their light from the Sun. The shadow of the Planet may be seen on the rings at the rear of the Planet.

In addition to the belts and rings of Saturn, eight Moons revolve around the Planet, their

Fig. 11.

Jupiter.

orbits being far outside the rings, but their plane of movement is the same as the rings.

The axis and stability of all the bodies composing the small Saturn System plainly show the magnetic permanency of the system, and its magnetic control by the Sun, following the same laws of movement as the Solar System. All rings and moons revolve around the Planet in disc fashion and in the same direction as the Planet itself. The axis or magnetic pole of the Planet is in line with that of the Sun, i. e., pointing towards the Pole Star. The rings and moons, however, are within the magnetic zone of the Planet and are magnetically controlled by Saturn.

Fig. 12.

Earth.

JUPITER

Fig. 11. Jupiter is the fifth and largest Planet in the Solar System. The atmosphere is very dense with smoke or vapor clouds. The high rotative speed of the Planet causes the clouds to form in streams, giving the appearance of belts, by which name they are known. The belts vary in form and number, indicating violent volcanic activity on the Planet, proving that Jupiter, like Saturn, has not as yet reached the cool state that would support life. Jupiter has eight Moons that revolve around the Planet in disc fashion or in the plane of the Planet's equator.

The axis stability of Jupiter and his Moons again prove the law of Solar Magnetism.

EARTH

Fig. 12. The Earth (OUR HOME) is the third Planet from the Sun and fifth in size, blessed with an abundant atmosphere, an ocean of air, estimated at 100 miles deep and surrounding the entire Earth, having a pressure of 14.7 pounds at sea level. It is in this air that we live and breathe. Without it life could not exist, and fires would go out for want of Oxygen, of which the air is partly composed. We are also provided with a moderate temperature and an abundance of water. With these advantages the Earth is the only body in the Solar System at this time capable of sustaining vegetable or animal life, and, therefore, the Earth is more susceptible to the actions of Natural Forces than any other body in the Solar System (or in the universe so far as we know). The Earth's magnetic and geographical North Poles, like that of all other bodies in our system, point to the Pole Star.

Fig. 13.

Moon.

MOON

Fig. 13. The Moon is the satellite of the Earth, and revolves around the Earth in about 28 days, its movement being from West to East (or contrary to its apparent movement across the sky). It turns on its axis once in 28 days and always presents the same side to the Earth. The axis of the Moon, like that of the Earth, points to the Pole Star. The familiar dark markings on the Moon give mute expression of its battles with heat at the time of its death many years ago.

Owing to the small size and great age of the Moon, it has lost all its original heat, and today is absolutely cold (or 460 degrees below zero). Like the Earth it receives its light from the Sun. The Sun-lit portions of the Moon may be seen from the Earth and that portion of light that is reflected to the Earth we know as Moonlight. The distance of the Moon from the Earth is 240,000 miles. The atmosphere of the Earth is 100 miles deep, so that the Moon is far outside our atmosphere and travels in absolute vacuum, but the Earth's magnetic zone extends far beyond the Moon and magnetically controls the Moon's axis.

In reviewing the bodies of the Solar System we must bear in mind that all bodies within this system are of the same age, all having their birth at the same time, as already explained, the present state of the bodies being due to their respective temperatures through loss of original heat energy.

FORCE

Force consists of two kinds—Base and Compound.

A base natural force is a single force acting alone, such as Gravity, Magnetism, Centrifugal, etc.

A compound natural force is a number of natural forces acting together, such as Electricity, which is composed of Magnetic, Electromotive, Atomic Vibration and Resistance.

There are many different Natural Forces, each distinct and separate from the rest, each having a duty to perform. Some are universal, some are local, some exist eternally, others have a period of life, but each follow on unchangeable natural law. Two rays of light existing a thousand miles or years apart will act just the same; nor can a force be lost, created or destroyed, the forces having a period of life are only dormant for a time and become active again when the conditions are proper. Gravity and Magnetism are Universal and Eternal Natural Forces, and every body in the Universe, regardless of its state or position, is under the full control of these mighty forces.

MATTER

Matter is anything which occupies space in three directions and prevents other matter from simultaneously occupying the same space.

The Atom is the ultimate particle of matter, or the smallest quantity of elementary matter that can exist.

An Element is any kind of matter which cannot be decomposed into simpler matter. We know of but 76 elements at this time. (See Table A.)

Nearly all of the known elements exist on Earth. Astronomers find many earthly elements in the heated surface of the Sun and Stars, being ascertained through the aid of the Spectroscope, establishing the proof that all bodies in the skies are formed of matter, and extremely hot.

TABLE A—ELEMENTARY SUBSTANCES

Element	Symbol	Wt.
Aluminum	Al	26.9
Antimony	Sb	119.3
Argon	A	39.6
Arsenic	As	74.4
Barium	Ba	136.4
Bismuth	Ni	206.9
Boron	B	10.9
Bromine	Br	79.36
Cadmum	Cd	111.6
Caesium	Ca	131.9
Calcium	Ca	39.8
Carbon	C	11.91
Cerium	Ce	139.2
Chlorine	Cl	35.18
Chromium	Cr	51.7
Colbat	Co	58.56
Copper	Cu	63.1
Erbium	Er	164.8
Flurine	F	18.9
Galolinium	Gd	155.
Gallium	Ga	69.5
Germanium	Ge	71.9
Gold	Au	195.7
Hellium	He	4.
Hydrogen	H	1.
Indium	In	131.1
Iodine	I	125.9
Iridum	Ir	191.5
Iron	Fe	55.5
Krypton	Kr	81.2
Lanthanum	La	137.9
Lead	Pd	205.35
Lithium	Li	6.98
Magnesium	Mg	24.18
Manganese	Mn	54.6
Mercury	Hg	198.5
Molybdenum	Mo	95.3
Neodymium	Nd	142.5
Neon	Ne	19.9

Element	Symbol	Wt.
Nickel	Ni	58.3
Nitrogen	N	13.93
Osmium	Os	189.6
Oxygen	O	15.88
Palladium	Pd	105.7
Phosphorus	P	30.77
Platinum	Pt	193.3
Potassium	K	38.86
Praseodyminum	Pr	139.4
Radium	Ra	223.3
Rhodium	Rh	102.2
Rubidium	Rb	84.8
Ruthenium	Ru	100.9
Samorium	Sm	148.9
Scandium	Sc	43.8
Selenium	Se	78.6
Silicon	Si	28.2
Silver	Ag	107.12
Sodium	Na	22.88
Strontium	Sr	86.94
Sulphur	S	31.83
Tantalum	Ta	181.6
Tellurium	Te	126.6
Turbium	Tb	158.8
Thallium	Tl	202.6
Thorium	Th	230.8
Thulium	Tm	169.7
Tin	Sn	118.1
Titanium	Ti	47.7
Tungsten	W	182.6
Uranium	U	236.7
Vanadium	V	50.8
Xenon	X	127.
Yttrbium	Yb	171.7
Yttrium	Yt	88.3
Zink	Zn	64.9
Zirconium	Zr	89.9

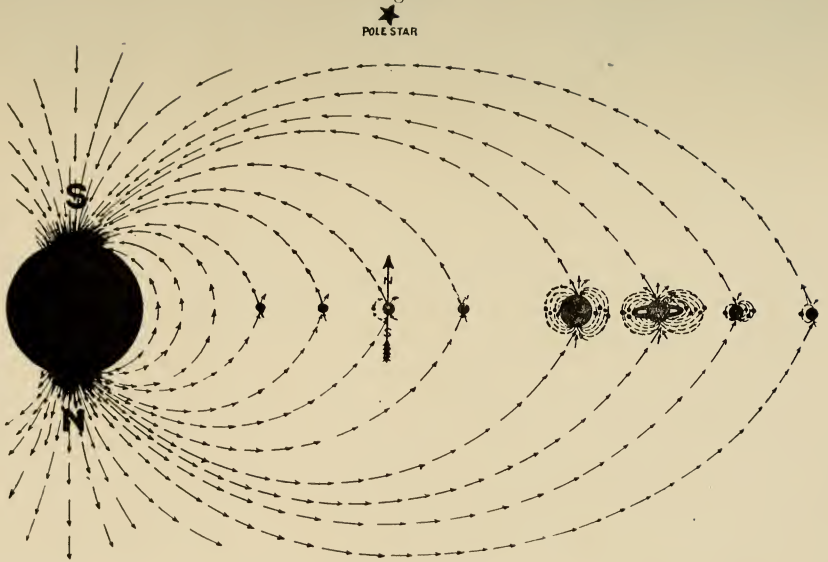
FORCE AND MATTER

Force is the life of matter, as matter without natural force must reduce to nothing. If force were removed from matter it would lose its heat; its temperature would fall to absolute zero (460 degrees below zero); it must lose the forces of Gravity and Inertia, and finally its loss of Cohesion must cause its disintegration to nothing, as even electrones could not exist under these conditions.

So that material is matter under the control of natural forces and may occupy three states, i. e., the Solid, Liquid and Gas, governed by temperature and pressure. For instance, Ice is a solid, Water is a liquid and Steam is a gas. This is true of all materials, whether the material be an element or a mixture. A material cannot change from the solid to the gas state without first passing through the liquid state, notwithstanding that a match will burn up without melting, for it is impossible to distill a gas from a solid material.

Many useful materials are compounded or alloyed by mixing or fusing together different elements in different proportions so that two materials may contain the same elements

Fig. 14.



Solar Magnetism.

but differ greatly in their characteristics, due to difference in proportion and method of manufacture.

Some materials may be magnetically polarized, others form better electric conductors, while still others form electric insulators, so that as we are more or less familiar with the adaptability of materials for electrical appliances. This branch will not be discussed here.

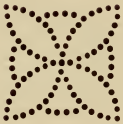


Fig. 14. Is a graphic description of the magnetic circuit between the Sun and the Planets, the arrow indicating the location of the pole star, to which the axis of all bodies in the Solar System are directed. As stated before, this condition is not maintained by virtue of the Pole Star, but by virtue of the Magnetic System controlled by the Sun. Gravitation, Inertia and Centrifugal forces cause the Vortex formation of the Solar System, and the Magnetic lines of force controls the axis stability of the bodies. Variations of magnetic intensity in the Sun (caused by violent solar outburts, or sun spots) effects the magnetic equilibrium of all the bodies in the Solar System.

Lines of force are seen to extend from the Sun to all the Major Planets, while the Satellites are within the magnetic controlling zone of the Major Planets. The resultant polarity of the Major Planets are opposite to the polarity of the Sun and Satellites.

It will therefore be noticed that the North Pole of the Planets, and the South Pole of the Sun and Satellites point in the direction of the Pole Star, which correctly follows the law of magnetism.

The condition shown here is the result of the Magnetic Permanency of the bodies, as proven by the compass on Earth, and it follows that a law proven on Earth is a truth with every other body in the Solar System. All bodies are therefore permanent magnets, possessing the quality of "Loadstone," and owing to the great mass of the Sun, it is the central and controlling magnet of the Solar System.

(Note.—Some writers attribute the action of the Solar System to Gyroscopic Action, but it is hard to understand how all the bodies within the system can act independently and all retain the same relative plane.)

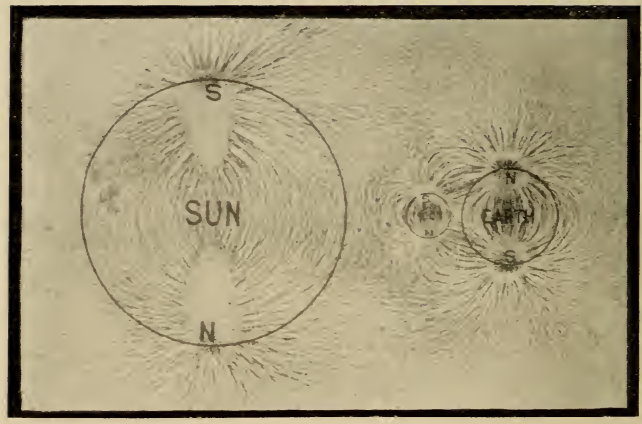
Fig. 15. Is a practical demonstration of magnetic action between three magnets, representing the Sun, Earth and Moon.

Law of Magnetism:

Like poles repel each other,
Unlike poles attract each other.

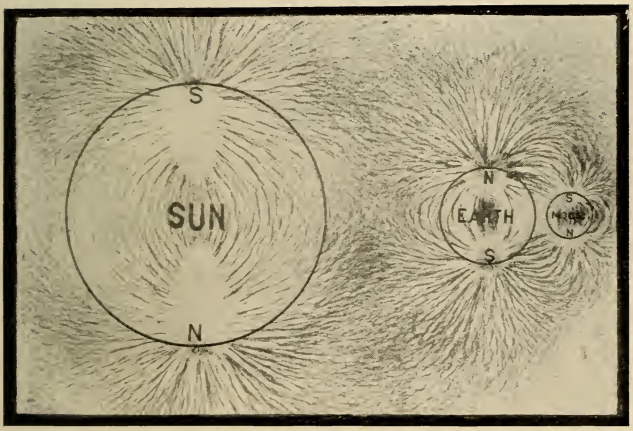
Three electromagnets arranged with their polarities as shown in the photograph, i. e., the North Pole of the Earth aligned with the South Pole of the Sun and Moon. Rings are drawn on the card to represent the three bodies. Iron fillings are distributed on the card and the current turned on. A slight jarring of the card permitted the iron fillings to assume the position as shown. It will be noticed that the lines of force from the Sun do not pass through the Moon, but are opposed by the Moon's own polarity. However, the magnetic lines between the Sun and the Earth are very complete. The lines between the Earth and Moon are also very complete. Each body being a magnet it must be clear that the Moon is within the magnetic zone of the Earth, while the Earth is within the magnetic zone of the Sun, so that even if the Moon be closest to the Sun, it is still with-

Fig. 15.



Solar Magnetic Control.

Fig. 16.



Solar Magnetic Control.

in the controlling zone of the Earth and cannot be influenced by the Sun, as clearly shown by the polarity of the bodies.

The demonstration clearly shows that the Earth cannot be alone, as a magnetic body, nor could it be magnetically controlled by any other body than the Sun.

Fig. 16. Is a duplicate of the former demonstration except that the Moon holds the position farthest from the Sun. The magnetic lines are seen to extend from the Sun to the Earth, but do not extend to the Moon, while the lines of force from the Earth extend to both Sun and Moon, correctly following the law of magnetism.

The Earth's magnetic zone being clearly shown as extending some distance toward the magnetic zone of the Sun, and it is within this magnetic zone of the Earth that the Moon travels. The orbit of the Moon around the Earth is on the same plane as the Earth's equator. The magnetic conditions as shown between the Sun, Moon and Earth is an exact counterpart of the magnetic condition throughout the Solar System, as the accompanying photographs are Magnetism's own answer.

Lines of force enter and leave the poles of all magnetic bodies in a spray or fountain formation. A portion leaving the Earth take a wide curve and return to the Sun; others complete their circuit through the Moon, while a large portion flows over and through the Earth's surface to the South Pole. The presence of magnetism may be detected at any point on the Earth's surface by the use of a compass.

It is this magnetic flow from North to South Pole over the surface of the Earth that makes Electrical Energy on Earth possible. It is this magnetism that guides the mariner and turn the wheels of industry. Its supply from the universal storehouse should dispel any fear of a shortage, as the supply is unlimited and the Universal System so well balanced that any demand made by humanity on Earth will be promptly furnished, with no inconvenience to the source of supply.

The magnetic North Pole of the Earth is situated at King Williams Island, in Northern Canada, about 1,400 miles south of the geographical North Pole. At this point the dipping needle points down to the center of the Earth. The compass is neutral at this point.

The Earth's magnetic permanency is conclusive proof that magnetism is not a manufactured or transformable force, but is an unerring and unchangeable Natural Force that traverses the Universe. Its use by man constitutes only a borrow. It is not ours at all. Its nature does not even permit us to return it, but insists on returning to the Universal Field of itself when released.

The most discussed question in Electricity by writers has been the source and nature of Magnetism; that it was a local dormant energy and only required waking up, or that it was active in material at all times and only needed to be straightened out; even its generation has been strongly advanced. However, the source and nature of magnetism now seems firmly established (as shown in the magnetic demonstrations 15-16) and it will be our ambition to analyze and apply all the natural forces that contribute to electricity.

The Earth's magnetic South Pole is situated about 1,250 miles north of the geographical South Pole, and on almost a direct line south of Melbourne, Australia. The North and South Poles are not diametically opposite to each other. The exact positions are:

North Pole, lat. 70′ 5.2, lon. 96′ 45.8 W., located by Capt. James Ross in June, 1831.

South Pole, lat, 72′ 23. S., lon. 154′ E., located by Prof. Edward Davis and Mr. Douglas Marson, January, 1908.

ELECTRICAL DEVELOPMENT

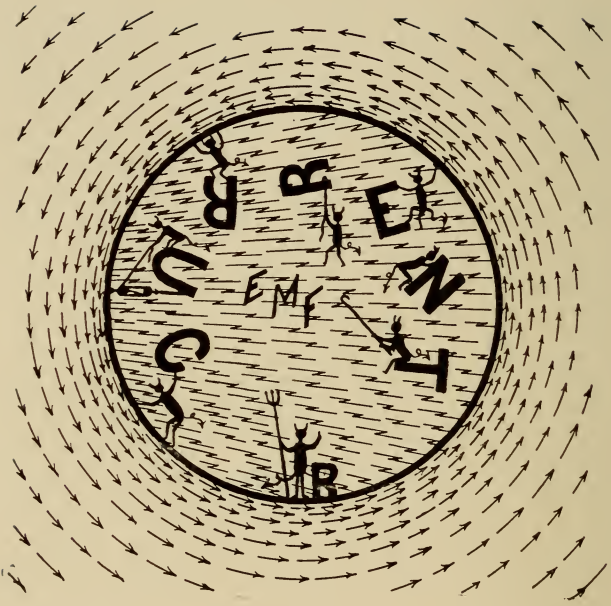
Commercial electricity is comparatively new to the people of the world. Commercial development dates from 1831. By this time all the elementary facts and principles upon which the science of electricity is founded had been discovered. In 1752, Benjamin Franklin discovered the electric spark. In 1779, Alessandro Volta laid the foundation of electrical science. In 1802, Sir Humphry Davy discovered the electric arc. In 1831, Michael Faraday invented the electric dynamo.

With the exception of the invention of Telegraphy by S. F. B. Morse, there followed a period of 47 years of electric inactivity, when the real work began by the invention of the Shunt winding for Arc Lamps by Charles F. Brush in 1878. This was followed by the invention of the Incandescent Lamp by Thomas A. Edison in the same year. In 1880 the first trolley patent was taken out by S. D. Field, and in 1887, the first trolley road was operated in Richmond, Va. Numerous investigators and inventors have contributed to electrical progress whose identity have been swallowed up in the current of electrical events. However, through persistent ex-

perimenting, invention and practical application, electrical appliance has become standardized throughout the world, the advance having been so rapid that in 40 years, from mere experimental toys, electrical appliance has become the most practical and efficient means of light and power generation and transmission on Earth, supplying not only the comforts and conveniences, but establishing a real necessity to humanity, while the business has grown to be the most powerful commercial giant in the world, and today gives employment to over five per cent. of the population of the nation.

Electricity recommends itself for its efficiency, cleanliness, flexibility, adaptability, generation and transmission, in which it is in a class by itself. No other form of energy can be adapted to so many varied uses. Telegraphy, Lighting, Power, Heating, Plating, Welding, Traction, Bleaching, Medical and many other uses, and while the fundamental principles of electricity cannot and will not be altered or changed, we may look for further practical application of electricity in the future.

Fig. 17.



Forces of Electricity.

FORCES OF ELECTRICITY

Electricity is a name used to express electrical phenomena, which consists of a combination of four Natural Forces. The absence of any one defeats the others and renders electricity void (expressed in the Electrical Cartoon Fig. 17.)

Electricity consists of:

(Flash)—Electromotive Force, or Voltage, or Potential (ENERGY).

(Letters)—Current, or Amperes (PHYSICAL ACTION).

(Arrows)—Magnetism, or Lines of Force (POWER).

(Demon)—Resistance, Ohmic and Inductive (COHERENT OPPOSITION).

In the use of electricity for producing power, magnetism is the most prominent factor.

In the transmission of electricity, electromotive force is the most prominent factor.

In electric lighting, heating and welding, current is the most prominent factor.

Resistance is the common electrical barrier that must be overcome to secure electrical activitiy.

Electricity requires a conducting medium or a material on which to act.

Magnetism alone requires no conductor, as it is a Universal Force and travels freely between magnetic poles.

Current is atomic vibration of material and could not be present in absolute vacuum.

Electromotive Force is active only in closed circuits of matter.

The constituent forces of electricity may be active separately, under which condition they are not electrical.

ELECTROMOTIVE FORCE

Fig. 17. Electromotive force is a purely local natural force and is the real life of electricity. It is the electrical vitality set up by the generator to overcome the cohesive resistance of the material circuit, and is the energy of electrical atomic vibration.

Electromotive force may be set up by different means: Dynamically, Chemically, Frictional and Thermostatic, but can exist only in closed circuits, even if only the air form the circuit, electromotive force cannot be set up through a perfect vacuum. Geissler tubes, or X-ray tubes became inactive when discharged too far, and a perfect vacuum is impervious to electric discharge.

Notwithstanding the success of Radio Telegraphy on Earth, the possibility of electrical communication with celestial bodies, through other means than magnetism, seems very remote, in view of a Universal Vacuum.

The function of electromotive force is to overcome resistance of and excite electrical atomic vibration in the material of the circuit, in proportion to its applied energy, and may be understood as an agitating stress or pressure.

Electromotive force has a direction of travel, within a conductor, the reversal of which reverses the magnetic polarity of all parts of the circuit. It acts with the speed of light, or 186,000 miles per second. Variation of voltage in the circuit will affect its energy but not its speed of action; is not a Universal force, but local, and confined to its own circuit, which may consist of matter in the Solid, Liquid or Gas state.

The presence of electromotive force is detected only through manifestations of electric current, and may be raised to unlimited strength. Its direction of flow may be caused to pulsate or alternate with extreme rapidity. It cannot be measured except through its product (current) and is entitled to the term "Spirit of Electric Power."

Fig. 17. Electric current is a purely local natural force, which consists of electro-atomic vibration of matter, induced by electromotive force within a circuit.

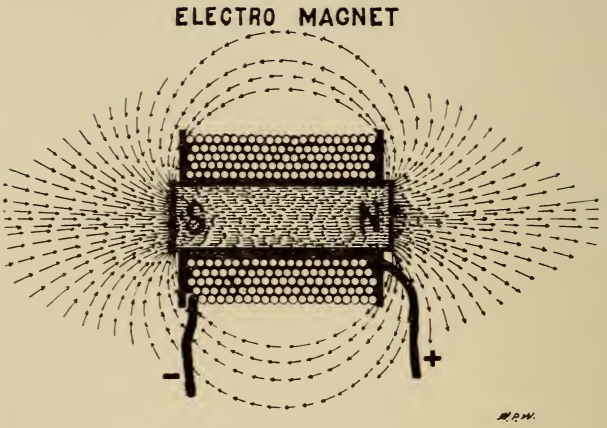
The atoms of the material are caused to vibrate in such a manner as to cause friction or impact between them, resulting in heat and magnetic attraction.

Current is more active in some materials than others; that is, there is more atomic activity in Iron or German Silver wire than in Copper wire of given size and length, with the same current strength, owing to the higher resistance of the former. Electric light and heat is the result of current, or atomic vibration, the effect being proportional to the current activity at that point.

Current is the electric factor which produces the Incandescent, Arc and Glow Lights. Electric Furnaces, Heaters and Welding are its products, and in every case where heat manifests itself in an electric circuit, it is the result of current, or electro-atomic vibration set up by electromotive force.

The heating of electrical appliances such as Dynamos, Motors, Transformers, etc., is due entirely to atomic action or current, and not

Fig. 18.



Magnetism.

to magnetism as thought by some; magnetism possessing no power to cause heat, having a separate and distinct function from that of current.

Current has also the peculiar inherent power to attract magnetic lines of force from the Universal Field. Lines of force gather about and circulate around the conductor in which current is active. The quantity of lines of force collecting around a conductor is always in proportion to the atomic activity or current strength, no matter what the size or resistance of the conductor may be.

Fig. 18. Magnetism is a Natural Energy that traverses the Universe and is known as lines of force. The lines are the paths in which the force travels, and may be straight or curved, but always extend from a north to a south magnetic pole when free; they may be explained as lines in which imponderable parts or Rays of Force travel. Each ray possesses North and South Polarity. Their movement is always in the direction of their North Polarity. A bar of soft iron, one inch in area, is said to be saturated when 200,000 lines of force are passing through.

Magnetic lines of force travel at the speed of light, or 186,000 miles per second; a respective line of force may circulate in a magnet for a long time or may make one circuit, pass off and be taken up by another magnet at a great distance from the first. The lines leaving the magnet at acute angle will describe a small circuit through the air to again reach the other pole of the magnet, but lines leaving the magnet in line with the axis of the core, may never return to that magnet again. Lines of force separate or repel each other when free, and concentrate when passing through an iron core; this is due to the

better magnetic conductivity of the iron than the air.

Magnetism is the chief component in electric power, or the ability of electricity to do dynamic work, and is directly responsible for our many power conveniences: Electric Traction, Factory Power, Magnetic Hoist, Dynamic Generation of Electricity, Transformation of Alternating Current and many others.

Lines of force are attracted mostly by ferro metals, in which it concentrates and produces magnetic polarity, but passes freely through all other materials; we know of no magnetic insulator. Magnetic screens, used about watches and electrical instruments, are themselves magnetic conductors, and simply conduct the interfering magnetism past the instrument.

Magnetic lines of force may be intercepted for use but cannot be stored in any way that would stop their activity.

Magnetism may be localized in a permanent magnet, but by heating the magnet to a point where the cohesion between the atoms is destroyed, will release the magnetism which returns to the Universal Field. Magnetism may also be localized in a Dynamo, Motor,

Transformer, Electro-magnets or appliance of any kind, but will promptly return to the Universal Field again when the current is shut off.

So that no matter, how or where magnetism might manifest itself, it is not fixed or permanent at that point, but is only a local concentration of lines of force which return again to the Universal Field when released; it follows that magnetism is not a local or generated force, but simply a borrowed Natural Force, unstintingly supplied to fulfill the requirements of electricity on Earth.

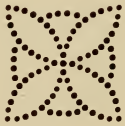


Fig. 17. Resistance is the Atomic Repulsion of Matter, or the lack of Cohesion. When the atoms of a conductor are at rest the resistance is zero. A disturbance of the atoms causes resistance.

Vibrations of the atoms of matter may be caused by applying heat, or electromotive force, either of which weaken the bond of cohesion between the atoms and cause movement between them. In their movement they repel each other and cause resistance to the applied force.

An increase of force causes an increase in atomic vibration and repulsion between the atoms, further increasing the resistance.

Therefore any force which tends to increase atomic action in matter, increases the resistance of that matter. The intensity of application determines the extent of resistance.

However, all metals differ in physical structure, and at normal temperatures a metal may have a very high atomic action, and a correspondingly higher resistance than other metals. For instance, the Specific Heat of Cast Iron is 0.1298, and that of Copper, 0.0951. Cast Iron therefore contains 26%

more heat than Copper at normal temperature and therefore has a greater normal atomic action and resistance.

The resistance of liquids is higher than solids and extremely high in gases.

Atomic Repulsion is therefore the resistance to Electro-Atomic Vibration or Current, and must be overcome by Electromotive Force in order to induce a current in the circuit.

The value of resistance is determined by Ohms Law:

Resistance equals Electromotive force divided by Current.

Having reviewed the constituent parts of Electricity it must be concluded that:

First. Electromotive Force is the prime energy of electricity, and is a local natural force.

Second. Current is the atomic vibration of matter and a local natural force.

Third. Magnetism is magnetic lines of force and belongs to the Universal Field of magnetism.

Fourth. Resistance is the atomic repulsion or hindrance to current and is a local natural force.

It will, therefore, be seen that with the exception of magnetism, Electricity is purely a local affair. A generator sets up an Electromotive Force in a circuit, which in turn sets in motion the atoms of the material of the conductor, against the resistance of atomic repulsion. Magnetic lines of force collect from the Universal Magnetic Field and are set to work. This combination of forces and conditions forms ELECTRICITY.

HEAT

Electric action will be better understood by a short review of the Specific or Heat State of materials as used in electrical appliances.

Heat (like Electricity) is a name to express a compound of Natural Forces, which consist of Atomic Vibration and Radiant Energy, which act only in conjunction with each other.

Heat appears in two states, viz.:

First. Heat of Atomic Vibration, set up by Radiant Energy.

Second. Heat of Radiant Energy, set up by Atomic Vibration.

In the first case, applied heat sets up atomic vibration in the material, which continues to grow more violent so long as energy is being absorbed.

In the second case, the atomic vibration generates heat, which continues to discharge so long as the atomic vibrations are above normal for that temperature.

Therefore the heating of a bar of iron, is of the first state, as the applied heat causes atomic vibration, while electrical heat is of the second state, as atomic vibration causes the heat.

At ordinary or normal temperature, all materials have a fixed atomic vibration, due to their Specific Heat capacity and belong to the first state. But a further agitation of the atoms, as by Electricity, will place the material in the second state.

As stated before, a material may occupy three states—the solid, liquid and gaseous. Now, if all heat were removed from a material, it would have a temperature of 460 degrees below zero. At this temperature all materials, including Air, Gas and Liquids of all kinds and consistency, would become Solid and the atoms would be at rest. But when heat is applied (as in first state) cohesive attraction would be reduced and the atoms begin to vibrate, as more heat is applied to the material, the atomic vibration increases, until our normal terrestrial temperature is reached. At this temperature we find that different materials have different physical states, due to their nature and specific heat capacity. For instance, Water becomes a liquid at 32 degrees above zero; Copper is still a solid and will liquefy at 2,000 degrees above zero; Air becomes a gas at 312 degrees below zero. (The solidifying point of Air is unknown.)

From the above it will be understood that the materials used in electrical appliances (and with all other materials) already possess atomic vibration at normal temperatures, due to their Specific Heat capacity, and any additional atomic vibration induced by electricity, above their normal activity, is known as Electro Atomic Vibration, which begins at the normal state of the material.

DYNAMIC ELECTRICITY

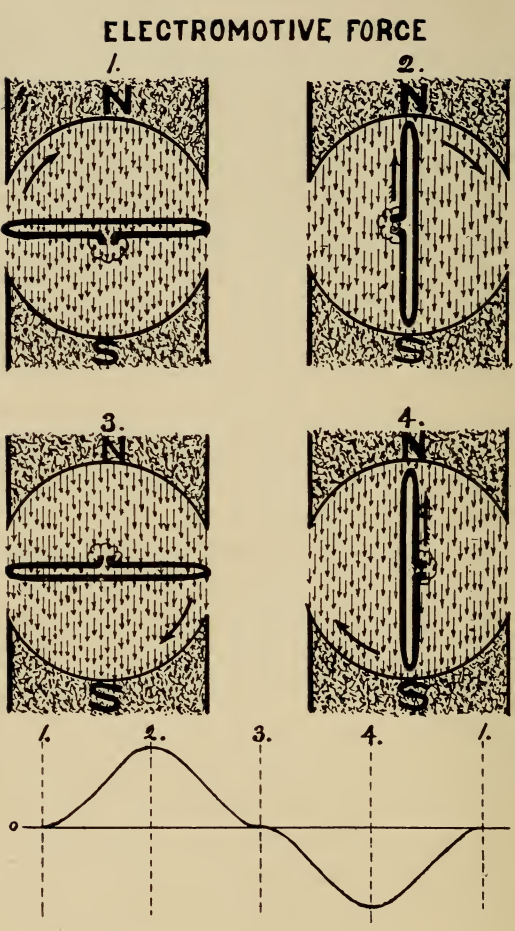
With the foregoing understanding of electricity it will be interesting to review the mode of Dynamic Electro Generation.

We are told that "Cutting of lines of force produce electromotive force in a wire," the act of cutting lines of force being likened to the "Linking and Unlinking of a chain."

Let us assume that magnetism consists of a single line or thread of force, wrapped through the magnet many thousand times, or that each line of force form a single circuit of its own, then the cutting process would seem to destroy a link and open the magnetic circuit. The repair of the link and line would seem unnatural to a natural force. Again if we assume that the lines of force are made up of countless small magnetic DARTS or RAYS (as explained above) then the unlinking process would seem to disintegrate and brake up the magnetic flow and destroy the function of magnetism.

The fact is that magnetic lines of force cannot be cut or unlinked by a conductor moving across their path, and any deviation from their path of travel can be affected only by magnetism's own law of Attraction and Repulsion, or by Electro Atomic Vibration. For

Fig. 19.



Process of Generation.

these reasons electromotive force is not generated by cutting or linking and unlinking of lines of force.

Dynamic Electromotive Force is generated by Magnetic Undulation within a closed circuit, i. e., Increase and Decrease in the quantity of magnetic lines through a closed circuit or loop. The mere moving of a wire through a field of magnetism generates nothing. The wire must form part of a closed circuit or loop, in which the quantity of magnetic lines of force must vary or alternate in direction to secure electromotive force within the wire.

It will be understood that magnetic lines of force cannot be distorted or interferred with except through the course of its own law or Electro Atomic Vibration. Therefore, the wires passing through a magnetic field would not cut or unlink the magnetic lines of force, but the lines of force will pass through the wires as freely as the space occupied by the wires.

In Dynamos the loops of wire are arranged on an armature core, arranged to revolve in a magnetic field, in such a way as to cause the quantity of lines of force through the loops to alternate from one polarity extreme to the

other. During this process the quantity of lines of force passing through the loops gradually build up to full capacity, and then fall off again to zero. By the turning of the loop on its axis the lines of force enter the loop from the other side and build up in quantity through the loop (in the reversed direction from the first) to full capacity, and fall off again to zero, as in the first instance.

It is this undulation of quantity through a closed circuit or loop that generates electromotive force, and is minutely explained under the head of Process of Generation.

PROCESS OF GENERATION

The process of electromotive force generation is clearly shown in Fig. 19, in which a loop of wire is arranged to revolve in a magnetic field between the North and South poles of a dynamo.

The loop is shown in four positions. In the first all the magnetic lines of force are passing through the loop. In the second no lines are passing through. In the third, all lines are again passing through the loop, but in the opposite direction from the first. In the fourth no lines pass through the loop.

The loops form a closed circuit through the small connecting wire as shown.

To gain a better understanding the following rules are offered:

First. In the generation of electromotive force the strength of electromotive force varies with the RATE of INCREASE or DECREASE in the QUANTITY of magnetic lines of force leaving or entering a closed circuit.

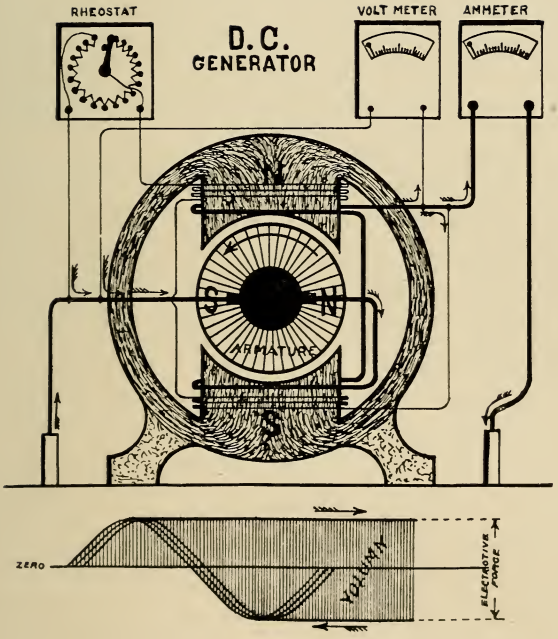
Second. The DECREASE of magnetism of ONE polarity, and the INCREASE of magnetism of the OTHER polarity, through a closed circuit or loop, generates electromotive force in the SAME direction.

It will now be seen that in turning the loop from 1 to 2 all the lines of force are expelled, and from 2 to 3 all are again received within the loop. But as the loop has moved one-half turn the lines of force pass through in the opposite direction, the rate of decrease and increase being highest when passing to and from the position 2, and lowest when passing 3 (as shown in the curve below).

During the first half turn (from 1 to 3) the generated electromotive force is in the direction shown by the arrow in (2). During the last half turn the electromotive force is in the opposite direction shown in (4). It will be noted that the direction of electromotive force during the first and second half turns respectively, are contrary or alternating in the loop. This is true with all armatures, and in all electric generators or motors, but in Direct Current Dynamos or Motors a commutator is provided on the shaft to commute the electromotive force to flow in the one direction.

During the above process the lines of force are not cut or unlinked by the movement of the conductor through its field, but the lines of force pass as freely through the conductors as the space occupied by the conductors. The maximum electromotive force is generated

Fig. 20.



Direct Current Dynamo.

when the flow through the loop is zero, or when the magnetism through the loop is changing direction, and minimum when the loop encloses the full field of magnetism. During a short period at this point (1 and 3) the number of lines of force passing through the loop undergo no change, and no electromotive force is generated in this particular loop during this period, as shown by the characteristic curve.

It will be understood from this that an armature with many turns or loops of wire connected to a commutator, and provided with collector brushes, will generate a direct electromotive force in a Dynamo, better known as Direct Current.

DIRECT CURRECT DYNAMO

Fig. 20. The most simple form of electric generator is the Bi-Pole Direct Current Generator, as it is the least complicated and at the same time embodies all the essential features included in the generation of electricity and forms the ground work of all electric generators, no matter what their design or purpose.

Our object now is to learn the electric action within a dynamo during its operation, and in order to get a full understanding the dynamo will be examined at rest.

The stationary field frame consists of Cast Iron. The field poles are provided with field coils, made up of many turns of fine wire. A Rheostat (resistance) is connected in the field circuit. A few turns of main circuit wire is wound on the field poles in addition to the field coils (which constitutes compounding).

The armature consists of a soft iron core, made up in thin sheets or discs of soft iron or steel. Slots around the face of the armature are provided to receive the winding. The winding forms loops with their ends connected to the segments of a commutator that is fixed to and revolves with the shaft.

A Volt Meter is connected to the main wires leaving the machine. The Ampere Meter is placed in the main circuit leaving the dynamo. The main wires extend to the floor posts and a main switch is not shown.

Now, owing to the magnetic permanency of Cast Iron, the field frame retains a small quantity of Residual Magnetism, which remained in the frame from the last run of the dynamo. (New dynamos or dynamos that have lost or changed their magnetism are charged with Residual Magnetism by passing a current through their field winding.)

At this point it will be noticed that the field winding (containing the Rheostat) is in circuit with the armature and ready to be excited by the armature.

The engine is now started and the armature brought up to speed. The residual magnetism in the field frame which is passing through the armature core, from the N to the S pole of the field frame, induces a small electromotive force in the armature coils which is conducted to the commutator, from which it is collected by the brushes to which the main wires are connected. As the field circuit is connected to the main wires, this small electromotive force passing through the field

winding, sets up atomic action (or current) in the armature and field wires, which atomic action attracts magnetic lines of force from the surrounding media to the dynamo, which are added to the residual magnetism already there, the effect being to strengthen the field magnetism. The armature now responds to the stronger field magnetism and generates higher electromotive force, which is conducted to the field winding, causing additional atomic vibration and building up of magnetism until a balance results between the armature speed and the generative power against the resistance of the field circuit. At this point the Voltmeter may show only a few volts, which is an indication that the dynamo is O. K. and ready to build up.

To build the voltage to the required point, the Rheostat is moved to second notch. This action cuts out a section of resistance and lowers the resistance of the field circuit, permitting a further building up of electromotive force in the armature, which acts to further strengthen the field magnetism, as explained above. The Rheostat is further advanced and the building up process continues until the required voltage is shown by the Voltmeter.

From the above we find that the resistance of the field winding is adjusted to admit sufficient electromotive force to the field coils to secure proper field magnetization to generate the required electromotive force, with a constant speed of the armature.

The conditions now are: The armature is at full speed, the field is at full magnetic strength, the Rheostat has nearly all resistance cut out, the Voltmeter shows the required voltage.

The main switch (not shown) is now thrown in, thus connecting the external circuit to the dynamo. The Ampere Meter and the Series field winding are now in circuit.

Now as the load was put on the dynamo a very heavy current demand is made on the armature. The armature current sets up a strong armature polarity of its own (as shown in Fig. 20), the North and South pole positions of which are such as to act as a brake on the forward rotation of the armature, causing the engine to work harder and drop slightly in speed, causing a drop in the voltage. To compensate for this drop in speed more field resistance is cut out by the Rheostat and the voltage brought to normal.

However, as every fluctuation of load affects the voltage, requiring constant attention and readjustment of the Rheostat, a few turns of the main circuit are added to the field, which has the effect of strengthening the field magnetism by the increased current demand, and compensate for the drop in engine speed, thereby automatically maintaining a constant voltage through all phases of load.

It will now be seen that during the process of electric generation, the magnetic field poles remain stationary, while the magnetic polarity of the armature is constantly changing. Without this alternating magnetic action in the armature, dynamic electricity would be impossible. It is the secret of dynamic generation of electricity.

The dynamo generates nothing but Electromotive Force, which in turn has but one function, "The generation of Atomic Vibration."

With a steady load on the dynamo, the electromotive force is in constant process of generation. The current or atomic vibration within the dynamo and external circuit is in a constant state of activity. The lines of force in the dynamo and all parts of the circuit fluctuate with the demand, while per-

forming their function, while resistance holds the system within bounds.

When prepared to shut down, the main switch is opened, the electromotive force in the external circuit stops, followed by the stopping of atomic activity in the circuit, and releasing the magnetic lines of force which dissipate to the Universal Field.

At this time the maximum speed and voltage of the dynamo is still maintained (if the load was high when taken off, then the voltage will be somewhat higher, owing to the increased engine speed on light load). The field magnetism is as strong as when first started, the Rheostat is now moved back to first notch, the voltage now falls to a low point. During this fall of voltage the atomic activity throughout the dynamo falls to a very low point, releasing nearly all the lines of force in the dynamo, which dissipate to the Universal Field. As the dynamo is finally stopped all electromotive force and electro atomic activity ceases, all magnetic lines of force have dissipated with the exception of a small quantity that remains in the field frame as Residual Magnetism, due to the permanency of the cast iron, and this furnishes the means to again start the dynamo, as explained.

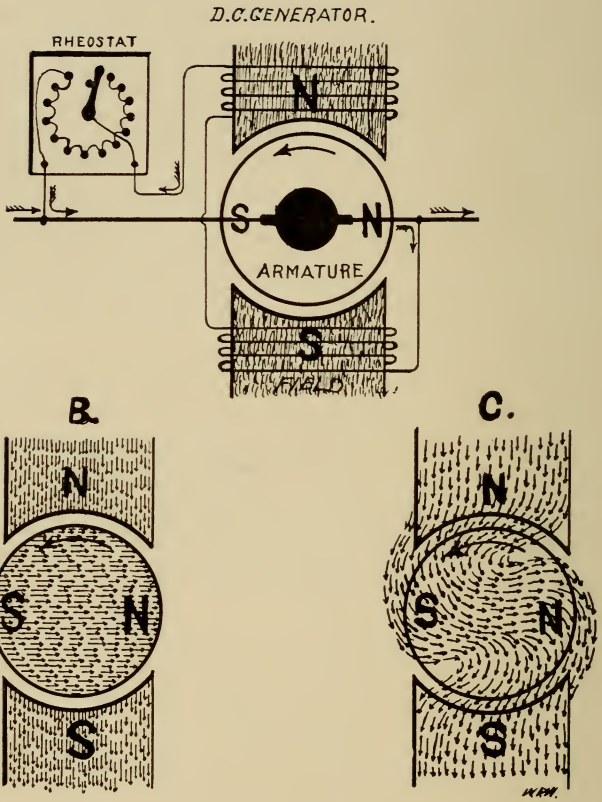
DIRECT CURRENT MOTOR

In reviewing the action of a direct current motor, two sets of diagrams are necessary to illustrate the characteristics of both the dynamo and motor, separately for the reason that the magnetic conditions of the dynamo are present in the motor and act to automatically regulate the speed of the motor, by inducing a counter electromotive force in the armature of the motor, which has the effect to regulate the supply of current to the armature, and thereby regulate the power of the motor through all phases of load.

The field or stationary part of the machine, whether used as dynamo (21) or motor (22), is magnetically charged to present North and South magnetic poles to the armature. The magnetism passing from the North pole of the field to the South pole of the field through the body of the armature is known as the magnetic field.

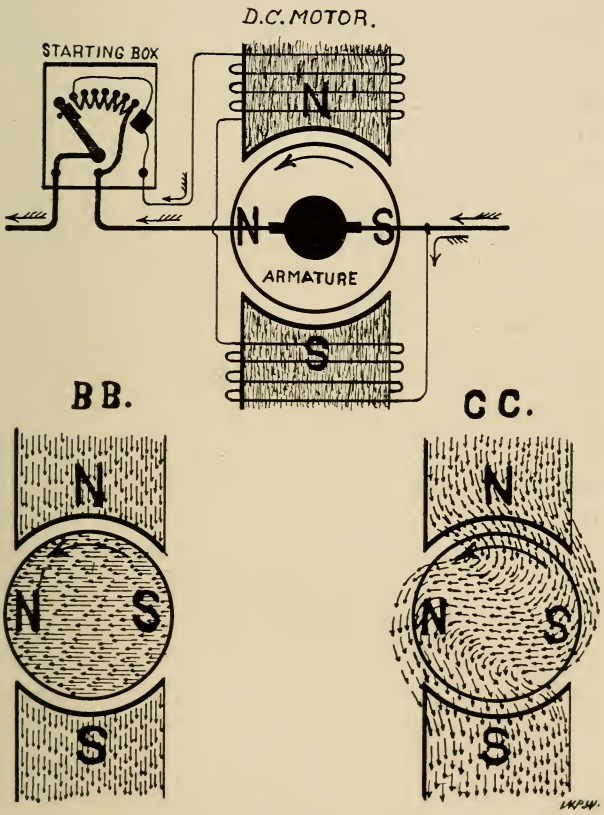
The direct current motor (22) is the same in general construction and winding as the direct current dynamo (21), in fact a generator may be used as a motor or vise versa, the difference being in the regulating appliance. The dynamo requires a regulating resistance in the field circuit (21). The motor requires

Fig. 21.



Direct Current Generator.

Fig. 22.



Direct Current Motor.

a starting resistance in the armature circuit (22).

The field frame of a motor retains Residual Magnetism, but it is not essential in starting the motor, but it very necessary should the machine be used as a generator.

Volt or Ampere Meters are not used with motors.

To start the motor (22) the supply switch (not shown) is closed, the starting box lever is on first or blank contact. At this point no electricity is being furnished to the motor, but when the lever is moved to the second contact the motor is in circuit. The field current and magnetism are now at full strength and any further advance of the starting lever does not effect the field strength. However the resistance of the starting box being in the armature circuit, permits only a small current in the armature, or just enough to cause the armature to revolve slowly. Resistance is now cut out by further advance of the lever and more current is supplied to the armature, which causes stronger armature polarity (22-BB) and greater magnetic torque (or pull) between the armature and field magnetism (22-CC) and consequently increased speed of the armature. This process is continued

until all resistance of the starting box is cut out, and the motor is up to speed. The small magnet on the starting box which is connected in the field circuit, now retains the lever in the running position.

(The motor will now be examined from the standpoint of a dynamo.)

Operated as a dynamo (21) the armature is revolving in a magnetic field, the field strength and armature speed being constant, the generated electromotive force in the armature will be of fixed strength and direction, but the current within the armature in the process of generation, sets up a magnetic N. and S. polarity of its own (21-B) at points midway between the field poles N. and S., their relative positions being such as to cause a reverse motion of the armature as shown (21-C), which acts as a magnetic brake against the power of the engine. This generated electromotive force in the armature is present by virtue of the armature's motion in a magnetic field, whether the armature be revolved by the power of an engine or by an electric current supplied to it.

Therefore, the electromotive force in the armature of a generator is COUNTER electromotive force in the armature of a motor.

(Now taking up the motor again in the running position.)

In order to retain the same field polarity (22), the electromotive force is supplied to the motor armature in the opposite direction shown by arrows to that which it would generate (the field conditions being the same in both cases). This causes North and South poles in the armature (22) contrary to that of the dynamo (21). The torque (or pull) now rotates the armature in the same direction as when used as a dynamo, but the fact that the armature is revolving in the same magnetic field, in the same direction and at the same speed, carries into the motor the same generating power as when used as a dynamo, which is known as Counter Electromotive Force, its effect in the motor being to oppose or resist the entrance of supplied electromotive force to the armature.

With the losses due to friction and other causes, the speed of the motor is not so high as that of the dynamo with the same electromotive force, so that the counter electromotive force must be lower than the supply to permit a sufficient amount in the armature to operate the motor. The effective electromotive force supplied to the armature is there-

fore the difference between the supplied and counter electromotive forces.

It will now be understood that when load is added, the speed lowers, the counter electromotive force decreases, the greater activity of the supplied electromotive force strengthens the armature magnetism to carry the load. The reverse is true when reducing the load. The regulation is purely automatic within the armature of the motor, and is a mutual balancing between the supplied and counter electromotive force and the speed of the motor.

With motors of the above class, the variation in speed is execessive, but is overcome by placing a few turns of main circuit wire around the field pole, which has the effect of strengthening the field magnetism when load is added, or vise versa, to maintain a more regular speed of the motor.

To shut down the motor (22) the switch is opened. The small magnet on the starting box retains the lever in the running position for a short time for the following reason:

At the instant the switch is opened the supplied electromotive force falls off. The armature is still revolving at speed in the magnetic field (22) which has not yet dissipated, and

while the supplied electromotive force is in the process of falling, the counter electromotive force proceeds to build up to full strength in the armature, supplying the field (which is seen to be still in circuit with the armature) with current. The motor is now operating as a generator (21), but as there is no means to keep it running, the speed quickly falls until the counter electromotive force is sufficiently low to release the starting lever, which is thrown back to zero by a spring.

Without this control there would be a heavy arc formed at the switch and motor commutator, due to the strong counter effect, which would burn and destroy these parts in a very short time.

ALTERNATING CURRENT GENERATOR

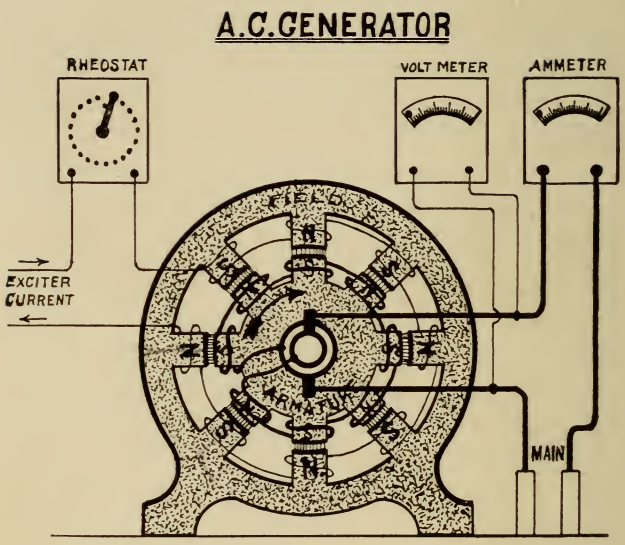
Alternating current differs from direct current in that the electromotive force reverses in direction through the circuit of flow, an impulse being generated in one direction and followed by an impulse in the other direction. Each impulse builds up from zero to full strength and falls to zero again. Each impulse constitutes an alternation, while a direct and an inverse pulsation constitute a cycle or phase.

In the alternating current dynamo (23) there are an even number of field poles and a corresponding even number of armature poles (known as single phase machine).

The field coils are arranged on the field poles and are connected to each other in series in such a way that the magnetic poles will be alternately North and South. The field winding is supplied with Direct Current from a Direct Current generator or exciter. The output of the armature depends on the magnetic strength of the field and is regulated by the quantity of current in the field winding. An adjustable field resistance or Rheostat is used for this purpose.

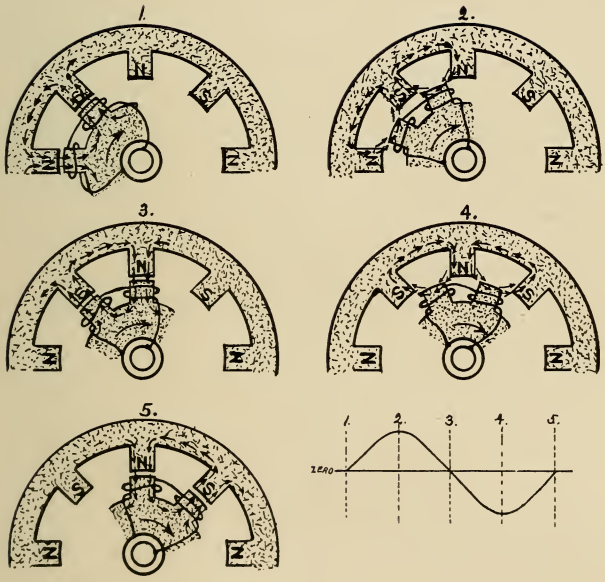
The armature coils are connected in the same manner as the field coils, the final ends

Fig. 23.



Alternating Current Generator.

Fig. 24.



Process of Generation. (A. C. Current).

being connected to collector rings arranged on the shaft of the armature, and from which the alternating electromotive force is collected from the armature.

The process of alternating current generation is the same as with the direct current (19). In the drawing (24) the segment of the armature contains two poles with coils, moving in a section of the field frame.

Position 1—The armature and field poles are in line. A full charge of field magnetism is passing through the armature poles and coils. No electromotive force is generated at this point (as in 1, Fig. 19).

Position 2—The armature poles are midway between the field poles, and no magnetism is flowing through the armature poles or coils. The maximum electromotive force is generated at this point (as in 2, Fig. 19).

Position 3—The poles are again in line and a full charge of magnetism flows through the armature poles and coils, but in the reverse direction from (1). No electromotive force is being generated at this point (as in 3, Fig. 19).

Position 4—The armature poles are again midway between the field poles, and no magnetism is flowing through the armature poles

or coils. The maximum inverse electromotive force is generated at this point (as in 4, Fig. 19).

Position 5—The conditions are the same as in position 1. During the movement from one field pole to the other (1 to 3) a direct current is generated in the armature. During the movement (3 to 5) an inverse current is generated, and completes the cycle of Single Phase Alternating Current, as shown by the characteristic curve.

Note—We can find no cutting, linking or unlinking of magnetic lines of force, by the wires, as the armature poles extend beyond the armature coils in all alternating current generators; and at no time are the wires in a position to cut or be cut by lines of force.

Alternating current is not commuted (as the direct current), but collected from the armature and delivered to the external circuit in its generated form. Alternating Current may consist of one, two or more phases, and may be of any desired frequency or intensity, by change in the number of poles, speed and winding.

ALTERNATING CURRENT MOTORS

Alternating current motors are of two general classes—the Synchronious and Induction. They are manufactured for different phases and frenquencies.

In the Synchronious type, the motor is brought to speed by local means. When the speed synchronizes with the alternations of the supplied current, the motor is connected to the line.

In the Induction type the motor is brought to speed by the supplied current, through special winding and switch control.

But with motors of all kind the fundamental principles are the same as with the direct current motors, as already explained.

ALTERNATING CURRENT TRANSFORMER

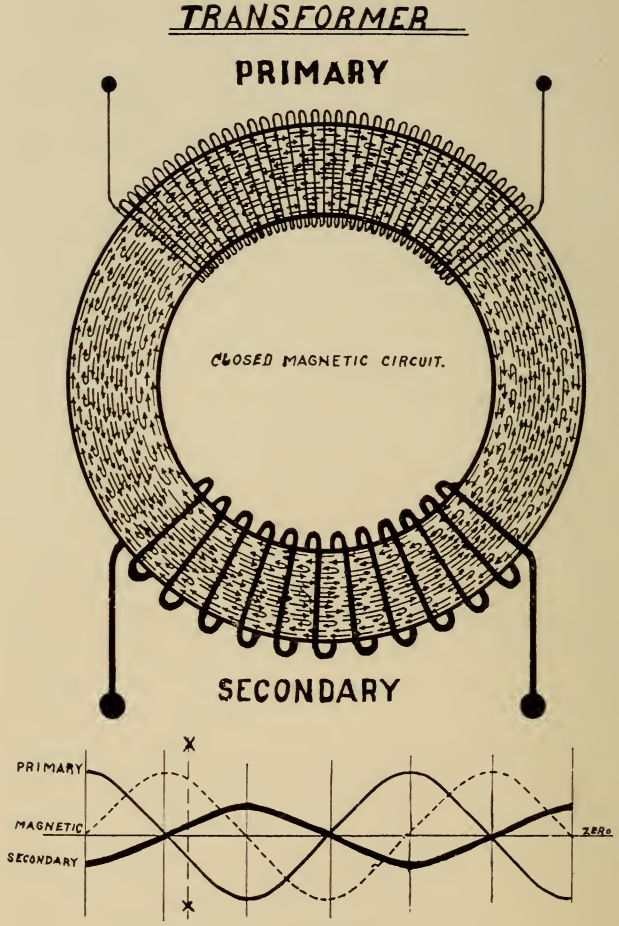
The great advantage of alternating current is its property of transformation, which is accomplished through the medium of induction or Counter Electromotive Force.

The transformer consists primarily of a closed magnetic circuit (25), which is built up of thin iron plates, capable of rapidly magnetizing and de-magnetizing. Two separate coils of wire are arranged on the core. The primary coil is of many turns of fine wire. The secondary coil of few turns of heavy wire.

We will first examine the primary coil and core alone.

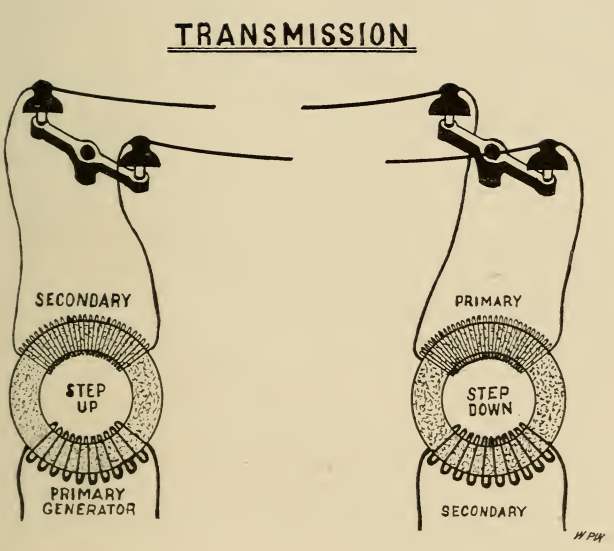
The high tension electromotive force supplied to the primary coil from the power house sets up an alternating magnetic polarity in the iron core, changing from one polarity extreme to the other. The effect of this alternating magnetism in the core is to set up a Counter Electromotive Force in the primary coil, which is in opposition to the phase of the supplied electromotive force (see curve). This has the effect of preventing or opposing the entrance of the primary electromotive force. The counter electromotive force (due to

Fig. 25.



A. C. Transformer.

Fig. 26.



A. C. Transmission.

losses) is slightly lower than the primary electromotive force, which permits the passage of a small fraction that keeps the effect alive.

The secondary coil arranged on the same core receives the alternating induction set up by the primary current, and when a lamp in the secondary circuit is turned on, a portion of the counter electromotive force in the primary coil at once finds an outlet (through the medium of induction) through the secondary coil, thereby relieving the primary coil of an equal amount of counter energy and permitting more activity of the primary current. The reverse is true when turning off lights, the whole regulation being automatic and self-contained through the medium of the closed magnetic circuit.

Disregarding transformer losses, the product of the primary current is equal to the product of the secondary, i. e., if the primary coil has 10,000 turns of wire, and the secondary 100 turns (or 100 to 1), the primary 10,000 volts and 1 ampere, the secondary output will be 100 volts and 100 amperes. The product of each is 10,000 Watts. This ratio is maintained through all phases of the transformer load.

It will be noticed here that the secondary current is generated in the same way as with the direct or alternating current generators, that is by magnetic undulation within a closed circuit. The lines of force in a transformer core do not leave the core during steady load, but simply alternate in their direction or flow within the closed core. All lines of force in the core do not reverse direction at the same time, but change in quantity with the current strength. The progress of magnetic change is slightly behind the current phase, and is known as a Lag.

With a properly constructed transformer there is no leak or external magnetism with steady load. The secondary electromotive force in the coils is induced by the alternating magnetism within the core, and not by cutting lines of force, as the lines of force do not reach the coils, but are confined to the transformer core. Lines of force are seen in the act of changing their direction in the magnetic circuit, and are indicated at X-X in the curve diagram.

TRANSMISSION

In the transmission of currents over long lines it has been found impractical to use Direct Current, owing to losses from ohmic resistance and high cost of heavy lines, and finally its inability of transformation with stationary appliance, so that alternating current is used exclusively for long distance transmission, as it can be transformed to any desired voltage of ampere, and for either heat, light or power.

Fig. 26. The alternating current is generated at the power house at low voltage and passed through a step-up transformer, in which a very high electromotive force is induced, in which state it passes over the transmission lines. On reaching its destination it passes through a step-down transformer, where it is again transformed to low tension for commercial use.

With this arrangement, electromotive forces of 50,000 volts are transmitted for distances of 200 miles, with very small inductive losses, owing to the very small current strength on the transmission lines.

ELECTRICAL TERMS

A. C. (Alternating Current)—An electromotive force which alternately flows in opposite directions.

AMPERE (Current)—Unit of atomic vibration that will be caused by electromotive force of one volt against a resistance of one ohm.

AMPERE TURNS—The number of turns of wire, multiplied by the number of amperes in the coil.

ARMATURE—A soft iron core joining two poles of a magnet; specifically, the roter of a dynamo or motor.

ATOM—The smallest particle of matter that can exist.

COMPOUND WINDING—Composed of two separate coils on the same core.

CONDUCTOR—A substance that will permit the passage of electromotive force.

COMMUTATOR—A ring of insulated segments, to which the armature coils are attached, to commute electromotive force.

D. C. (Direct Current)—An electromotive force which flows in a constant direction.

DYNAMIC ELECTRICITY—The electrical cause or effect of motion.

EARTH MAGNETISM—A part of the Universal Magnetic System.

ELECTRIC ARC—The electric atomic vibration of matter in the gaseous form.

ELECTRIC CIRCUIT—A conducting path for electricity.

ELECTRIC FURNACE—A furnace in which heat is generated by electric atomic vibration.

ELECTRICITY—The phenomena of electro natural force.

ELECTROMOTIVE FORCE (E. M. F.)—A force which excites atomic vibration in matter.

ENERGY—The power to do work.

FORCE—Anything which changes or tends to change the condition of rest or motion in a body.

GAS—An aeriform electric matter, tending to expand indefinitely.

HEAT—Radiant energy, due to atomic vibration of matter, or vise versa.

HYSTERESIS—The ratio of magnetic induction to the magnetizing force producing it.

INCANDESCENT LIGHT—The glowing of a substance by means of electro atomic vibration.

INDUCTION—Electromotive force set up by magnetism.

KILO-WATT (K. W.)—1,000 Watts (or volts times amperes).

LINES OF FORCE—Magnetic lines or rays of force possessing polarity.

LOADSTONE — Permanently magnetized iron ore.

MAGNET—A magnetized iron bar or core.

MAGNET COIL—A coil of wire which surrounds a magnet core.

MAGNETIC FIELD—The region traversed by magnetic lines of force.

MAGNETIC AXIS—A straight line drawn through a magnet, joining its poles.

MAGNETIC CIRCUIT—A complete magnetic path.

MAGNETISM—Lines or rays of magnetic force possessing polarity.

MATTER—Anything that occupies space.

MOTOR—A device for transforming electrical energy into mechanical power.

NATURAL LAW—The cause of all natural phenomena.

OHM—The unit of resistance that will permit a current of one ampere with an electromotive force of one volt.

OHMS LAW—Current equals electromotive force divided by resistance.

POLARITY—The resultant concentration of magnetic lines of force passing through a magnetized body.

POWER FACTOR—The ratio of actual watts to the volt-amperes in alternating current.

RESIDUAL MAGNETISM—Magnetism remaining in the core after the current has been shut off.

RESISTANCE—The expansive state, or enlarged sphere or field of atomic action.

RELUCTANCE—Capacity for opposing magnetic induction.

RHEOSTAT—An adjustable resistance.

SPECIFIC HEAT—The capacity of a substance for heat, or atomic vibration.

TERMINALS—The positive and negative ends of a circuit.

TORQUE—The turning force of an armature.

TRANSFORMER—A device for increasing or decreasing the electromotive force and ampere of an alternating current.

VACUUM—Space from which all traces of residual gas has been removed.

VIBRATION—A to-and-fro motion of the particles of matter.

VOLT—Unit of electromotive force, that will cause a current of one ampere against a resistance of one ohm.

WATT—The unit of electric power, the volt-ampere.

ZONE (Magnetic)—The controlling area of a magnet.

SUMMARY

The foregoing review offers the following conclusions:

1. Magnetism is a Universal Natural Force.
2. The Solar System is Magnetically controlled by the Sun.
3. Magnetism is Imponderable Lines or Rays of Force, Possessing Polarity.
4. Magnetism cannot be Generated, Transformed or Stored.
5. Magnetism responds only to the Law of Attraction and Repulsion and to Electro Atomic Vibration.
6. A Magnetic Circuit cannot be Opened, Cut or Unlinked.
7. Electricity is a Combination of Natural Forces.
8. Electricity does not Flow in a Circuit.
9. A Dynamo Generates Electromotive Force only.
10. Electromotive Force acts only on Matter.
11. Electromotive Force excites Atomic Vibration.
12. Electro Atomic Vibration attracts lines of Force.

13. Electric Light and Heat is the product of Electro Atomic Vibration.

14. Electromotive Force is the Vitality of Electricity.

In addition it should be stated that Electricity, no matter by what means it may be generated, or in what form, or under what condition it manifests itself, is but one and the same, and possesses all the fundamental elements of Dynamic Electricity.

CONCLUSION

In conclusion it must be evident that electricity is a combination of Natural Forces, part Universal and part Terrestrial, part having a period of life and part being perpetual; all combining to form ELECTRICITY, the most powerful, controllable and as understandable as any of the mysterious works of the Natural Forces, notwithstanding the various conflicting theories and hypothesis advanced by scientists in the past.

There can be but one function for each Natural Force, and each force stands alone to do its part, and in this great natural power the

failure of any one part defeats ELECTRICITY.

It has been the ambition of the author throughout the review of Fundamental Electricity, to submit an explanation based on practical facts, to simplify and make plain to the reader such points that have made Electricity a mysterious and unfathomable monster, by the wrong teachings of its fundamental principles and at the same time to avoid friction with the well established art and science of electricity.

And it is with the desire that the knowledge so gained would stimulate further practical effort to fathom the mysteries of Natural Forces, for the benefit of mankind.

Most sincerely,

W. P. WIEMAN.

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