Electricity and its similitudes; the analogy of phenomena, natural and spiritual [by] Charles H. Tyndall.

Tyndall, Charles Herbert, 1857-
New York, Fleming H. Revell company [1902]

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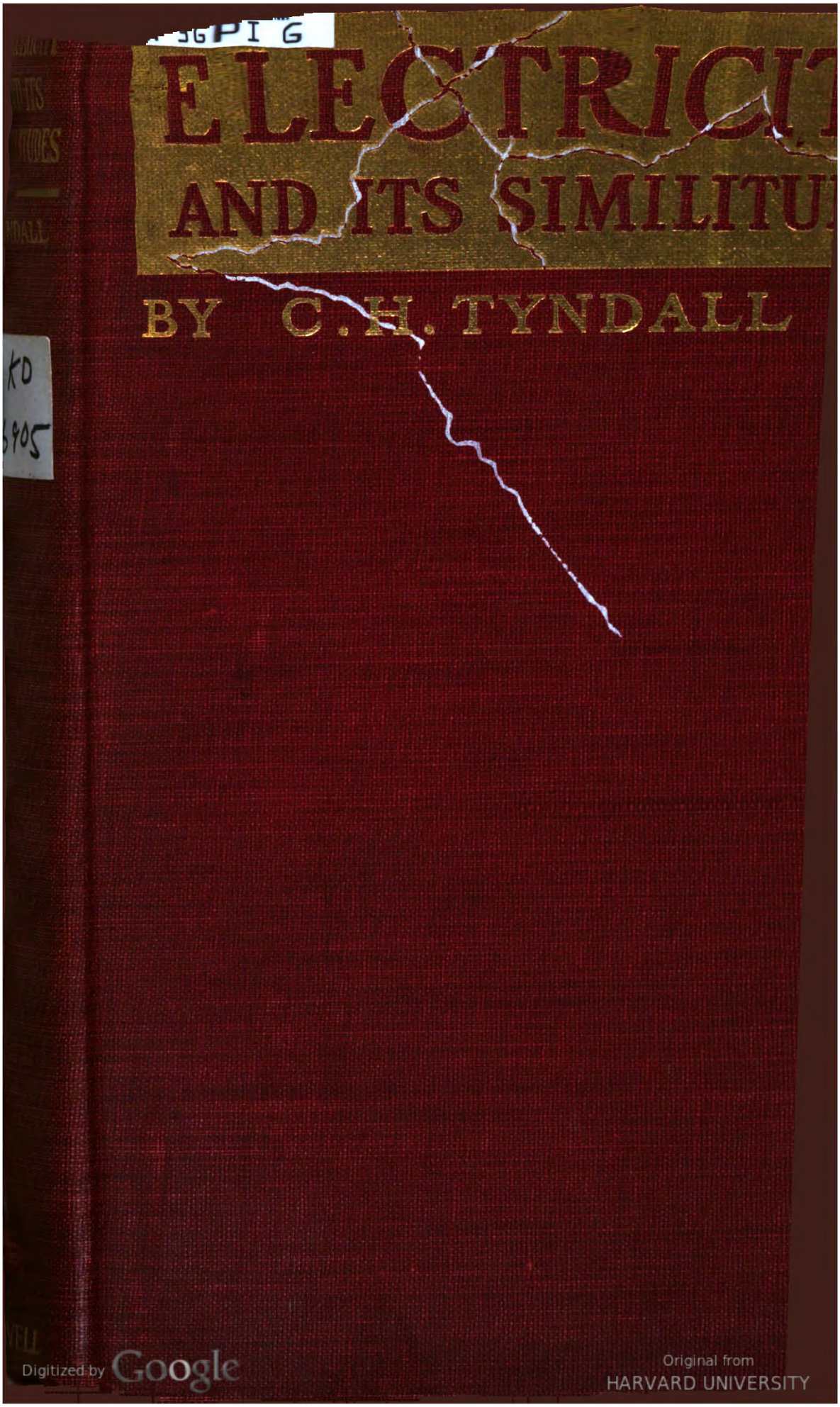

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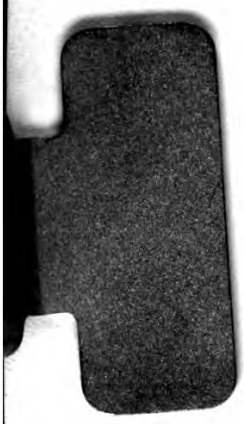

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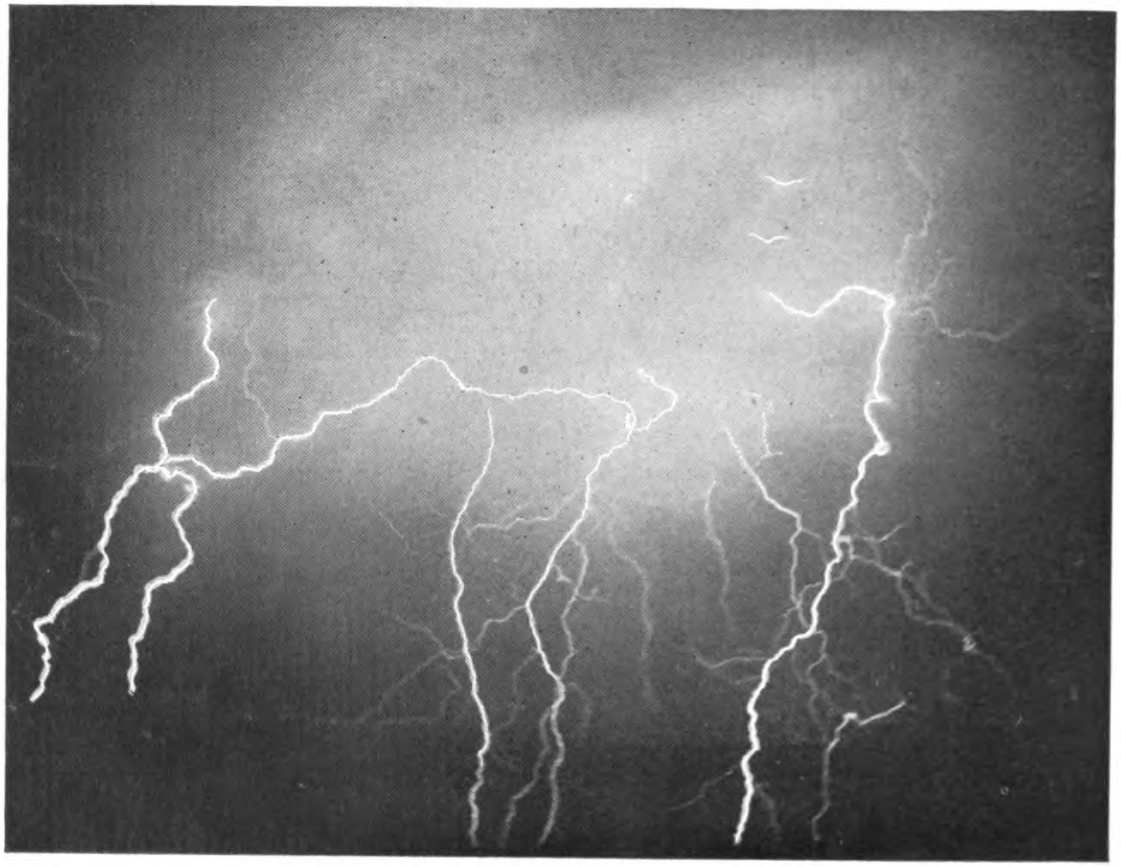

"Photograph of lightning, 1893. A good type of disruptive electrical discharges by condensation of aqueous vapor in the earth's atmosphere." *The Electrical Age.* The energy of lightning must be enormous.

(See pages 36 and 80.)

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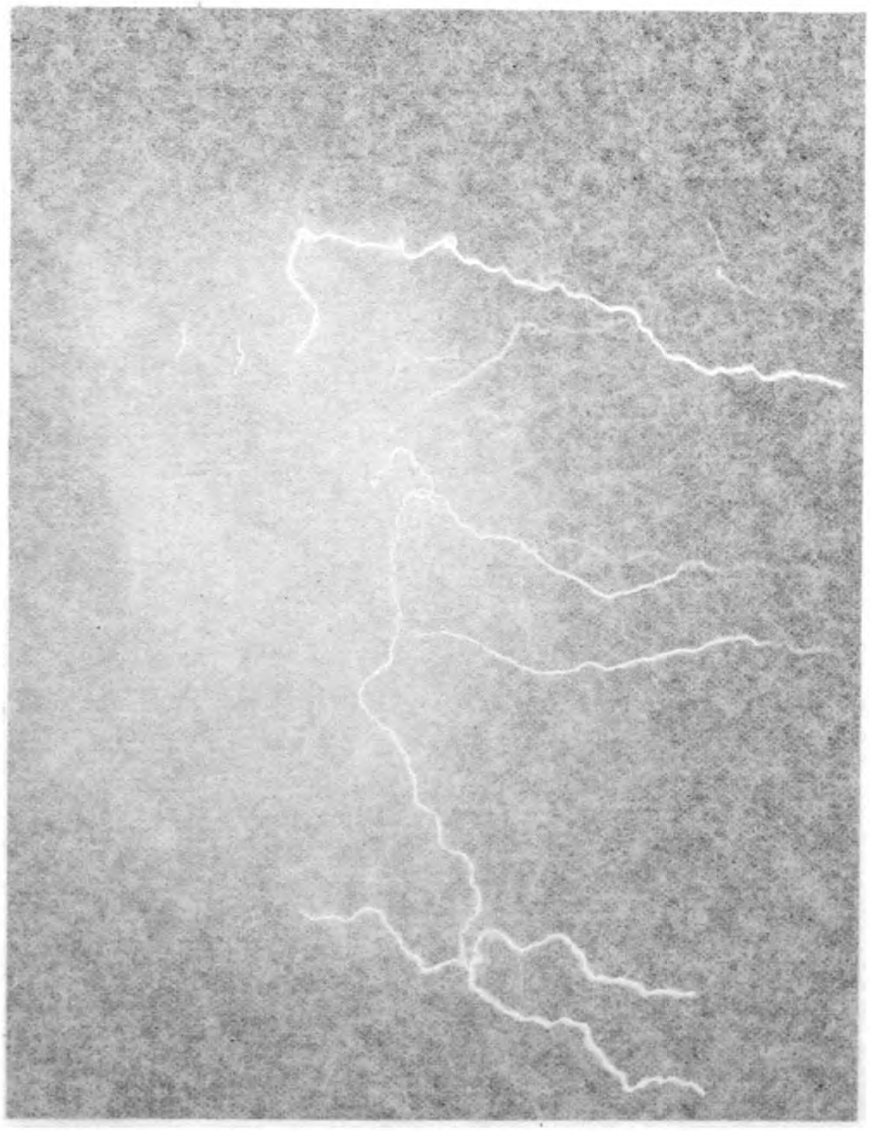

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ELECTRICITY
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SIMILITUDES

The Analogy of
Phenomena
Natural and Spiritual

Charles H. Tyndall, Ph. D., S. T. D.
Associate Member of the American Institute of
Electrical Engineers and Member of the
New York Electrical Society

NEW YORK CHICAGO TORONTO
FLEMING H. REVELL COMPANY
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I

INTRODUCTION

"THE invisible things of Him since the creation of the world are clearly seen, being perceived through the things that are made." It is possible, then, to see God through nature, which means that nature is symbolic, pointing to something beyond itself; and Tertullian was right, "All things in Nature are prophetic outlines of Divine operations, God not merely speaking parables but doing them." So was Bishop Horne, "The visible works of God are formed to lead us, under the direction of His Word, to a knowledge of those things which are invisible; they give us ideas by analogy of 'a new creation' and are ready to instruct us in the mysteries of faith and the duties of morality;" and Kingsley likewise expressed the truth, "This earthly world which we do see is an exact picture and pattern of the spiritual and heavenly world which we do not see."

God made the world tributary to our mind and spirit as well as to our physical necessities. He meant that it should teach us something as well as to give us our daily bread. He certainly did

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not intend that nature should furnish food for our intellect, and speak no message to our hungry heart.

Let him who feels that drawing comparisons is the fanciful fancy of imaginative minds, remember that the Saviour's teachings were largely the comparison of things spiritual to things physical. And the analogies He suggests were not manufactured for the occasion. Beneath them all is an eternal law of resemblance; one that was designed by the Creator, who had thoughts of our redemption in mind, during all the steps of creation, as truly as had Christ when He called our attention to the facts existing in nature which teach lessons concerning His kingdom.

Nature is undoubtedly a treasure-house of symbols, to which there must be a key; and that is found in a heart quickened by the life of God Himself, and eyes anointed by His Spirit, that they may see more than is on the surface, and a hand that holds His Guide-Book while wandering through the halls hung with His wonders, which, like so many productions of the "great masters," illuminate the Page while the Page in turn illuminates the works.

In his work on the "Parables," Archbishop Trench thus writes; "Analogies assist to make the truth intelligible, or if intelligible before, present it more vividly to the mind. But their power lies still deeper than this, in the harmony unconsciously felt by all men, and which all deeper

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minds have delighted to trace, between the natural and the spiritual worlds, so that analogies from the first are felt to be something more than illustrations happily but arbitrarily chosen. They are arguments, and may be called as witnesses, the world of nature being throughout a witness for the world of spirit, proceeding from the same hand, growing from the same root, and being constituted for that very end. All lovers of truth acknowledge these mysterious harmonies, and the force of arguments derived from them. To them, the things on earth are copies of the things in heaven."

And another has truly written to the same effect, " Deep in our nature there exists a tendency to seek amongst all interesting objects points of resemblance; and when some intuition keener than our own reveals that resemblance, we bow to its truth or acclaim its beauty. This tendency to metaphor, and the universal delight in parables, comparisons, and figures of speech are no mere freaks of fancy. They have their foundation in the mind and method of Deity, whose thoughts are all in harmony, and whose works and ways are all connected one with another; so that what we call the imagination of the poet, if his reading be correct, is really the logic of omniscience."

The Reverend Thomas Jones, one of those poet-preachers of Wales, in a published sermon well said, " There is a pre-ordained harmony between the things spiritual and things material. Material

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objects express spiritual truths, and are intended so to do. Nature is more than it seems."

In his work, "Nature as a Book of Symbols," the Reverend William Marshall says, "All natural phenomena are a Divine revelation—a revelation of God, a revelation of man, and a revelation of man's relationship to God in all its varied aspects and manifold possibilities. Nature thus becomes a great book of Symbols full of sublime revealings and harmonies, all of which when apprehended, tell him exactly the same ultimate facts and truths which are declared in the Bible."

And only as we walk in the light of the Holy Spirit which is shed upon the Word He has inspired, shall we see the spiritual meaning in the objects about us. The author of the "Typical Character of Nature" truly says, "The fleeting objects of Nature are in fact God's own hieroglyphics; and while many may have succeeded in making happy guesses as to the meaning to be attached to some of the most important of them, it is the Bible and the Bible alone which is the true Rosetta Stone, enabling us in our fallen condition to decipher with certainty their real significance."

In this work we have entered one field of nature and endeavoured to read here and there a message which the Creator has inscribed for us. The realm is inexhaustible, and we are aware that we have only touched the surface. Let any devout soul delve in this mine, and he will find

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the vein of precious ore widening and deepening as he goes below the surface.

Of one thing we are well aware. The present progress in electrical discoveries moves at so rapid a rate that what is new to-day may be old to-morrow. But this will in no wise invalidate the facts already known, nor their analogies to the spiritual truths herein suggested.

While this does not purport to be a text-book on the subject of Electricity, we believe that the reader will discover that numerous intensely interesting facts and laws regarding Electricity are mentioned, and are presented in language free from those scientific technicalities which so often bar the entrance to an interesting perusal of the subject by those who are not specialists in the science.

We are short-sighted; but God's Word is the magnifying lense, not to bring Him nearer, but to enlarge our own visual powers. If we will stand in His light, and look through that magnifier at this field open before us, as we peer through a microscope at nature, we shall behold wonderful forms moving with grace and beauty, and discover that we have chosen a path which leads us very close to the heart of the Eternal.

In His hands, may these pages prove a key which shall unlock to the reader, hidden treasures of creation, and make him the happy possessor of great mental pleasures and enduring moral wealth.

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THE MYSTERY *of* ELECTRICITY

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"One touch of fire, and all the rest mystery."
—*Longfellow.*

"Is it said that mystery covers the junction of Divine influence with human power in the change of a sinner's heart? True; and the savage fled in terror from the artist's studio when he first saw his own portrait, because he could not understand the mystery of the artist's pencil, which could so represent him on the canvas without abstracting a part of him."—*Austin Phelps.*

"And without controversy great is the mystery of godliness.—I Tim. 3: 16.

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II

THE MYSTERY *of* ELECTRICITY

THE Diamond Jubilee of Queen Victoria was celebrated throughout the British Empire on June 22, 1897. As her Majesty left Buckingham Palace to take part in the magnificent procession which marched through the streets in her honour, accompanied by the enthusiastic applause of millions of her subjects, she touched an electric button, and forthwith there darted to every part of her dominions, "on which the sun never sets," to "glaring sun-scorched Aden, to the sweet green slopes of the Barbados, to the lands where the Southern Cross crowns the zenith, to the wide waste lands flushed by the Northern Lights," the tender greeting, "From my heart I thank my beloved people. May God bless them."

When the Eternal God moved by love, passed out of the solitude in which He had ever dwelt, He uttered the command, and forthwith, His words were transformed into light, and energy radiated from His being and took shape everywhere in the visible forms of creation. Now,

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messages quivering with His life lie all about us waiting to be read.

We can imagine the astonishment with which unlettered natives of India, Australia or Africa might have listened to the greeting of their sovereign whose face they had never seen. That those few ticking sounds, so readily interpreted by the skilled ear of the operator, were a real message from the Queen across the seas would seem most incredible to them.

With no less amazement would the savant of other days, could he return to these scenes, listen to the declaration that heat, light, magnetism and electricity are but different manifestations of one and the same force, and that under the deft hand of the modern manipulator, they are readily transformed from one into the other.

The old text books of a generation ago, defined electricity as a weightless fluid in the pores of all bodies.

And a learned work of half a century ago on Meteorology, by Professor John Brocklesby of Trinity College, Hartford, states that, "one of the most abundant sources of electricity is evaporation, which advances invisibly and in silence; and, for this reason, we might easily undervalue its agency in accumulating those vast stores of electrical *matter* which arm the storm with such power."

According to this theory, a body charged with positive electricity had an amount in excess of its

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normal state, and so of course, some other body somewhere had deficiency of electricity, or less than the amount nature had allotted to it, and hence was charged with negative electricity.*

In a letter from Nikola Tesla which lies before me, he says: "The older conception of electricity as something having an existence has been abandoned, and we now designate with the name 'electrical phenomena' a great number of manifestations, which have been before considered as having no intimate relationship."

"A school text book in use in the public schools of Boston in 1891, stated that the electric motor was an interesting philosophical toy, but that it could never find practical application because such power cost far more than it was worth." †

To-day we see this same motor, which twenty years ago served merely for a lecture room table model used in transmitting thousands of horse power of energy, driving horseless carriages about our streets, bearing its share in propelling the crowded electric cars and silent, smokeless electric boats; fanning us with cool breezes in the heat of summer, and utilized in numerous other convenient and necessary appliances, which are but a prophecy of its still greater usefulness.

Professor Elisha Gray says: "Something like fifty years ago a professor of physics in one of

* "Electricity and Magnetism."—GRAY.

† "Electrical Review," Jan. 12, 1901.

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our colleges was giving his class a course in electricity. The electric telegraph was too little known at that time to cut much of a figure in the class room, so the stock experiments were those made with the frictional electric machine and the Leyden jar. One day the professor had, in one hour's time, taken his class through a course in electricity, and at the end he said: 'Gentlemen, you were born too late to witness the development of this great science." *

Since his day electricity has marvellously diminished the size of the world. That which required months to learn concerning affairs in Europe, Asia and Africa, we now read the same day by our fireside. Not only has electricity given us a pen by which we can write a thousand miles away, but absent friends may recognize the familiar handwriting, and even the photograph of a loved one. It has given us a voice that can be heard and recognized from New York to Chicago, and doubtless Dr. Pupin's recent discovery will ultimately enable a friend to telephone his safe arrival from Europe to America.

Once our swiftest express was the lumbering relay stage coach of forty miles a day. But the electric telegraph has made possible the express which covers a thousand miles in twenty-four hours.

Electricity has given us the best artificial light the world has ever seen, and promises soon to

* "Electricity and Magnetism," p. 17

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well-nigh rival daylight. It makes the human body as transparent as glass, revealing diseases, and facilitating delicate and life-saving surgical operations. It is already little short of being an indispensable luxury to man. It warms and lights his home; rapidly facilitates the growth of his food products and cooks them; instantly announces his visitors, summons his servants, warns him of burglars and fires, and by it he converses on important affairs across seas without leaving his room, and listens to music hundreds of miles distant. It stimulates and promotes the health of his body, protects him from accidents, and transports him from place to place in any direction of his choice; refines his ore, analyzes his chemicals, manufactures his medicines, guides his ships, and lays at his feet the energy represented by the labour of an army of six hundred thousand men, and that transmitted silently and invisibly along six conductors less than an inch in diameter, represented in the twelve thousand horse power conveyed from Niagara to Buffalo.*

Not the least of its benefits to man is the aid it affords him in the solution of some of his most serious social problems. "Instantaneous and widespread distribution of knowledge accomplished by the telegraph has worked for the peace of the world. About half of the disputes of nations arise from misunderstandings."*

In congested portions of our cities, it is an aid

* "Electrical Review," Jan. 12, 1901.

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in suppressing crime and violence. "An arc light is often more valuable than a policeman in a bad neighbourhood."

A few years ago the great influx of country people to the cities threatened to depopulate farming districts, and to create industrial and social difficulties which would militate against the welfare of the state. But the electric telephone and trolley have proven to be most powerful decentralizing agents in the last decade; for the recent census shows that this centralizing tendency has ceased, and that people are going back into the country, and live as far as possible away from the places in which they work.

What is this which works such wonders for man? That is a question which men have asked for centuries, and which is as far from a satisfactory solution as ever. Its real nature is as truly shrouded in mystery as it was two hundred years ago. Scientific investigators have, with rapid strides, pushed back the mysteries surrounding it, but only to find it eluding their grasp and withdrawing further within the impenetrable vail of uncertainty.

This much is known, it is a tremendous energy, often stored up in an inconceivable amount, as in the coal beds of the earth, and in other vegetable products. These, as light and heat, are readily transformed into electrical energy.

Maxwell originated the theory that this form of energy, as well as all others, is transmitted to

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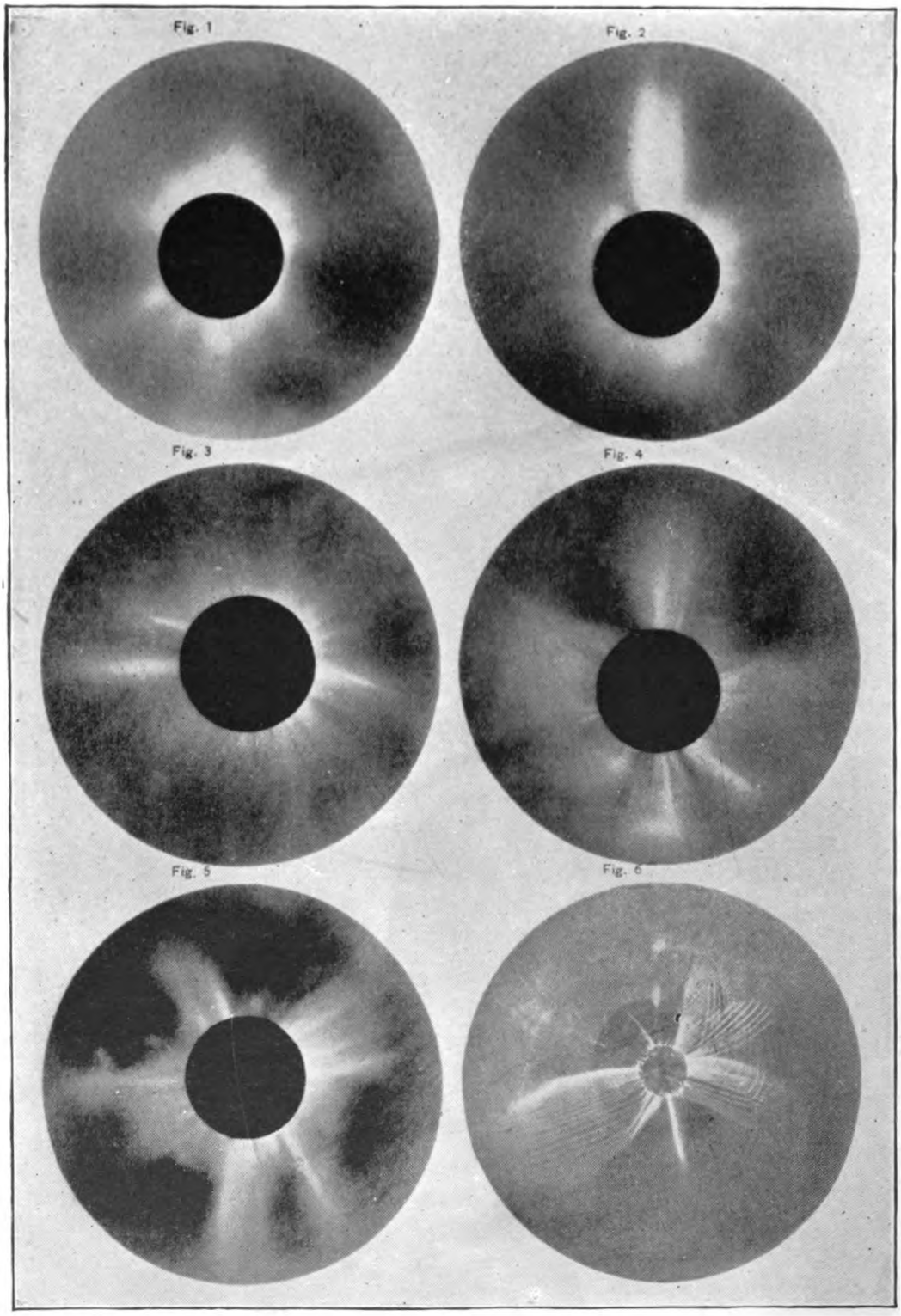

"Photographs of artificial coronæ obtained by Prof. Pupin, due entirely to electrical discharges in vacua." *The Electrical Age.*

(See page 23.)

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the earth from the sun in magnetic waves through an immaterial medium designated the ether.

"Untold millions of horse-power are being rained down upon us daily in the form of sunlight. Could this energy, somehow, be gathered up and saved for use, daylight itself would provide an inexhaustible source of power from which we could draw for untold ages to come." *

This storing up process has been wrought for us, and is now at work in all animate and once living organisms, as well as in numerous other ways. Tesla says: "All the force and heat in the universe are due to the falling together of lifted weights, and the same result is produced whether these weights have been lifted apart by chemical energy, and rest in the form of oxygen and hydrogen ready to combine chemically, or in the form of energy or moving molecules directed by the electric current." †

Henry A. Rowland says: "We come to the conclusion, then, that all electrification is originally produced by separating the atoms of bodies from one another, which can be done by breaking contact, by friction or by direct chemical action of one substance on another, or in some manner not so common. Take the case of sunlight: on the earth's surface illuminated by strong sunlight a horse power of energy falls on every seven square

* "Electrical Age," Dec. 25, 1897.
† "Electrical Engineer," p. 340, 1892.

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feet. At the surface of the sun the ethereal waves carry energy outward at the rate of nearly eight thousand horse power per square foot." *

But what it is that lifts these weights, pulls asunder the atoms of matter, or originates the marvellous energy rained down upon the earth in sunlight, no man can explain. And so in dealing with electricity we are dealing with an agency which no one has ever seen or can define, and whose possibilities are only yet dimly foreseen.

Professor John Trowbridge says, "To the philosopher this confession of ignorance of an agency which he can use intelligently, which is highly serviceable, but the origin of which is completely veiled from us, is most suggestive." †

The latest attempt to dissolve this mystery is by the theory of the existence of an ether filling all space. Rowland says: "The ether is the medium by which alone one portion of matter can act upon another portion at a distance through apparently vacant space. Not only must this ether account for all ordinary electrical and magnetic actions, and for light and other radiation, but it must also account for the earth's magnetism and for gravitation. . . . As quick as light, the ether sends its waves of energy to the distance of a million miles while the sluggard air carries it one. Thus, with equal strain on each, the ether carries away a million times the energy that the air would do."*

* "Scientific American," Jan. 26, 1895.
† "Evening Post," N. Y., Jan. 12, 1901.

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But instead of clearing away the mystery, this theory only deepens it; for, as Trowbridge says, "the mystery of the ether, though it has been made more fascinating by these discoveries, remains even more inscrutable than before. Of this all-pervading entity we know absolutely nothing except this one fact, that it can be made to undulate. And even its solitary function of undulating ether performs in an abnormal fashion which has caused infinite perplexity." *

The mystery of electricity finds its peer in the mystery of godliness. The history of the race bears testimony to the fact that there is a mysterious moral force in the world. Men who all their life have been under the tyranny of evil habits suddenly meet with a revolution, which is like the opening of prison doors to a captive.

A new force now seems to move the liberated soul, and to be manifest through him. He may be a most ordinary person, and there seems to be no adequate cause for such marvellous results as he effects in his own life and in others, and hence there is an earnest inquiry regarding the source of his power.

Like the undulations of ether, he performs the functions of life in an abnormal fashion, which causes infinite perplexity to those who are savants only in things material.

Truly, "great is the mystery of godliness." In the Greek, the word "godliness" is piety, and

* "What is Electricity?" p. 275.

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the mystery of piety in the next verse, is explained as being Christ. It is He in the life of one that renders it an enigma to those who are the willing victims of unbelief. The Spirit of Christ in the heart of a Christian is the one thing which the worldling cannot understand. It differentiates him from all that is natural and explicable by reason and logic.

Blessed are the men in commercial and ordinary affairs of life that they are not obliged to understand the mystery of electricity ere they can use it. Thrice blessed are men that they do not need to know the mysteries of the Spirit of Christ, which are manifest in the world, before they can enter into a living and joyous experience of those mysteries.

In the realm of science, had men waited to clear up mysteries before they had sought out and subjected themselves to her laws, that they might be clothed with her powers, we would be yet in the childish state of untutored barbarians. But men may link themselves on to a power before they know its mystery.

What folly that one should ever wait till spiritual things are made clear to him before he will share in their blessing.

During all the centuries from Thales of Miletus in 600 B. C., and earlier, till the days of Franklin, electricity was upon every hand waiting to serve and bless humanity. The Spirit of God is close to every man, waiting to enter into a part-

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nership forever with the weakest and most sinful one. From the earliest childhood He has been upon every hand waiting to be used for life and peace and rest, and He is waiting still.

The wonder is that men were so long discovering so many of the electrical phenomena which are now so well known, and in every home. They could not kindle a fire, or strike sparks from their flint, or cook their food or comb their hair without generating electricity. Yet they were blind for centuries to the energy in these things.

But this was nothing to the blindness concerning the things of the Spirit of God, which otherwise wise ones display continually. As the ether fills all space and pervades all matter, He is everywhere in every life, waiting to be God's power unto salvation upon the instant of surrender to Him.

The study of electricity affords a most fascinating field for the diligent searcher after truth, and the rewards are sure; but it cannot compare in attractiveness or in valuable returns with the mystery of piety—Jesus Christ in the heart. In the study of Christ and His relation to the soul there is an inexhaustible mine of wealth, and there are no weary days and nights of searching, to be anticipated by some one else, as was Gramme by four or five days in the announcement of the principle of self excitation in dynamos.

"Without controversy great is the mystery of godliness," but when one offers to God the sur-

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render of an honest trust, he is lifted up into realms where all becomes clear. It is somewhat as one climbing the Alps finds that as he ascends he leaves below him the clouds, and every other object which narrows the horizon of his vision, and finally arrives into a pure clear atmosphere above all about him, and has spread out before him the peaks and glaciers and lakes and valleys for a hundred and fifty miles in every direction.

He who is lifted up into communion with Christ, leaves the valley, with its fogs and uncertainties, and nestling there close to the heart of the everlasting Father, learns His secrets, for, "the secret of the Lord is with them that fear Him."

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CURRENTS OF GREAT FREQUENCY AND HIGH POTENTIAL

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"He hath no power that hath no power to use.
We love and live in power. It is the spirit's end."
—*Bailey.*

"Mightiest powers by deepest calms are fed,
And sleep, how oft, in things that gentlest be!"
—*Barry Cornwall.*

"Ye shall receive power after that the Holy Ghost is come upon you."—Acts 1:8.

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III

CURRENTS OF GREAT FREQUENCY AND HIGH POTENTIAL

ON Christmas day, 1821, a young assistant to Sir Humphrey Davy in the Royal institution of London, Michael Faraday, "late bookbinder's apprentice now turned philosopher," as he once styled himself, revealed to his young wife and her brother a discovery which he had made. He had succeeded in causing a wire in a voltaic current of electricity, to revolve around a magnet, and the magnet around the wire. His brother-in-law, who was with him on that day, said: "All at once he exclaimed, 'Do you see, do you see, do you see, George?' as the small wire began to revolve. I shall never forget the enthusiasm expressed in his face, and the sparkling of his eyes." *

In the year 1820 Professor Hans Christian Oersted of Copenhagen, noticed that a wire con-

* "Michael Faraday, Man of Science," by Walter Jerrold.

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veying a current of electricity held over a magnetic needle pointing toward the north, caused the needle to swing around till it became at right angles with the wire.

These two discoveries showed the possibility of converting the mysterious energy of an electric current into motion, or mechanical power. And in 1831, Professor Joseph Henry, then a teacher in the Albany Academy, by a series of original brilliant discoveries and experimental researches, constructed a small electromagnetic engine or motor. The electricity for this was generated by a voltaic cell, composed of zinc and copper plates immersed in a weak solution of sulphuric acid.

From these discoveries, which seemed so small in themselves, it was seen that the mysterious something called electricity, is a source of power.

A current of electricity flows from the copper to the zinc, at the point of metallic contact,* when they are immersed in the acid solution, because the potential of the copper is higher than that of the zinc. The electrical condition of a body, compared with some other body or bodies, is called its potential. It may be either of high or low potential. The tendency of electricity is always to flow from a body of high potential to one of low potential to equalize its distribution, much as water will flow from a higher to a lower level. In fact it is said that potential is to electricity what level is to water.

* "The Story of Electricity," Munro.

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We know that when water falls from a higher to a lower level it is capable of doing work, such as running a water-wheel. Likewise, electricity in passing from a higher to a lower potential, performs work, or manifests kinetic energy.

Whatever electricity may be, it is present in every object. And when two dissimilar liquids or metals come in contact they show a difference of potential, as do a liquid and metal, and a cold and a hot metal. Whatever the exciting cause may be, electricity is not produced by it, but only made to manifest itself.

Here is a most instructive analogy to the truth contained in the text. The source of power which Jesus promised His disciples should come upon them was the Holy Spirit, whom no one can see and whose mysterious being and operations are well illustrated by the mysteries of electricity.

Between Him and the human heart there is a vast difference in spiritual potential. As God does in nature so He does in grace. The higher, Divine potential ever tends to flow down upon and fill the lesser one. It is as much the nature of love to do this as it is of electricity to equalize itself, and God is never satisfied until He fills us with Himself.

And this passing of the plenum of God to the vacuum of the human heart is always attended with power. There are varying degrees of this power manifested, as there are degrees of electrical energy all the way from the feeblest cur-

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rent which moves the gold leaves in an electroscope or pulsates in a sensitive galvanometer—that microscope of electricity, to the current by Tesla, oscillating a hundred thousand times a second, giving twelve million volts, and producing a flame-like discharge sixty feet across, the energy of which represents the work of millions of men.

From the very inception of power imparted to the heart by the Holy Spirit, He presses for a fuller and completer reception of Himself. But still many Christians seem to be under the impression that if they have the life and power of God at all, they have all there is to be had, though the manifestations of that life may be like the feeble current of a single celled battery.

In the history of electrical science, it has ever been true that the electrical energy manifest to any person has been limited only by his knowledge of the subject and his ability to appropriate the power.

There was as much electrical energy in the world one hundred years ago as there is to-day. But then men limited it by their ignorance. And hence they appropriated very little of that force which was all about them waiting to be harnessed into willing service.

The savage that brought a spark from his flint had the same energy in his hand that Tesla has, and the only difference is in the knowledge of the force and in the manner of appropriating it.

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Even the savants in the subject have ever failed to realize the mighty force so close at hand.

"It is doubtful in my mind whether Faraday ever realized the powerful effects that could be obtained when the lines of force were made to quiver with great speed." *

For centuries men limited the electrical energy about them, even as they do to-day, because of their lack of knowledge concerning it, and a consequent subjection to its laws that it might be subject to them.

This is emphatically true of the Spirit of God. What He can do for and through men is limited by their knowledge of and their appropriation of Him. They, for the most part, have been content to smite a few sparks out of the old flint lock of human experience, never asking if there was anything deeper or fuller or more wonderful, and hence "they had not because they asked not," and so men continue to do.

The Holy Spirit, as a power in our lives, is limited only by our knowledge of Him, and our willingness to let Him become a source of strength to us. We have it in our power to let Him be only a spark to us, or the mighty power of God, which shall so possess us that we shall be ever under His control to the glory of God and to the good of men.

For centuries men continued to labour and to enslave themselves to perform by their physical

* Trowbridge in, "What is Electricity?"

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exertions what we now see done by the mysterious forces of electricity, and done so easily that even the finger of a child is sufficient to direct the power.

Professor Crookes has shown us that there is an immeasurable unused force in nature all about us; that the atoms of matter keep up an incessant hammering upon one another and upon everything in space; and that the forces contained in this bombardment are immensely greater than any forces we have yet handled, many millions of horse power being contained in an ordinary room.*

The great problem of the practical scientist of to-day is how best to so completely obey this force as to subject vastly more of it to the uses of man. Great results have already been accomplished. Professor Elihu Thomson several years ago obtained from 1,600 feet of wire, sparks or flames of over thirty-one inches between the discharging balls. And so far as can be estimated from available data, he thinks these sparks were due to potentials of not less than half a million volts,*

And Tesla has succeeded in producing currents whose potentials were twelve million volts. Were we able to harness this inconceivably great energy, physical labour would become almost wholly unnecessary. This is the goal toward which men are working.

Would that we might cease to struggle to do for

* "Electrical Engineer," 1892, pp. 340, 337.

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ourselves what the infinite Spirit of God is able and willing to do for us. Should we devote a tithe of the time and earnest attention toward the divine energy pressing in at our heart's door, that men devote to the study of the mysteries of electricity that they may make it serve them, the results in our lives and in those of others would be inconceivably great in spiritual power.

With millions of horse power all about us, we put our puny shoulders under the load of life, and by asceticism, or false religions or religious notions try to create energy where it does not exist, instead of receiving the enduement of power from the Infinite One.

The greater the frequency of the vibrations or oscillations of an electric current the higher becomes its potential.

For several hundred years it has been known that a magnetized steel needle will point north and south. This is due to the fact that the earth is a great magnet. Magnetic lines of force pass from the north pole to the south pole through the atmosphere, and every piece of steel or iron on its surface tends to turn so that these lines of force shall pass through its substance.

Whenever we move a wire back and forth on the earth so as to cut these lines of force, an electric current is produced in the wire.

" The earth is such a magnet that it would be possible to generate a current of electricity suf-

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ficient to light a room, by merely revolving a large coil of wire with great velocity, so that it should cut the magnetic lines of force of the earth at each revolution." *

It has been discovered, however, that when a wire is moved before any electromagnet, electricity is induced in the wire. If the motion of the wire to and fro in front of the pole of the magnet is kept up, momentary currents, first one way and then the other, are continuously induced in the wire. These are called alternate currents. The more rapidly they are permitted to vibrate, the higher the potential. In this way currents of low potential may be made to induce those which are very high. It was from one hundred thousand alternations per second that Tesla's electrical oscillator gave the twelve million volts mentioned above.

It is from alternating currents that so many astonishing phenomena have been recently made known to the world by electricians, such as sending messages without wires, the transmission of enormous energy, as at Niagara Falls, and all the startling experiments of Tesla.

These advances in electrical science have been due largely to the experiments of Professor Crookes, who "pumped out from glass bulbs or tubes nearly all the air or other gas that they contained, and the comparatively few particles left were free to travel in any course imparted to

* "What Is Electricity?" p. 129.

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them" by an electric current passed through the tubes.*

When a current of high frequency was passed through these tubes striking results were manifest. Either because the vibrations are too rapid to excite corresponding vibrations in the nerves of the body, or from some other cause, no shock is felt from the current; and that though an ordinary current at two thousand volts will kill, yet this current at two hundred and fifty thousand volts cannot be felt at all.

This is a principle which applies with striking emphasis to spiritual things. The more perfect freedom the Holy Spirit is given in our hearts, the higher the potential of our lives. If we see little manifestation of His power in us, it is due doubtless to the fact that we suffer many counteracting tendencies to nullify "the power that worketh in us." Our hearts need to be like Crookes' tubes, free from self-confidence and self-will that the Spirit of God may work in us "to will and to do of His good pleasure."

But there is one most encouraging fact in this for every one. The electricity in the lowest potential is of the same nature as in the highest. Only increase the frequency and freedom of oscillation and the feeble force becomes a giant. By this method one hundred and fifty thousand horse power of energy is to be transmitted from the power house in the electrical rapid transit sub-

* "Electrical Engineer," 1891, p. 340.

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way of New York now in the process of construction.

The feeblest spark of the Holy Spirit in the heart of the weakest Christian on earth is the same in nature as the greatest display of power in the most exalted saint before the throne of God. That spark indicates a possibility, and may be a prophecy of the glorious manifestation of His power and grace in the life. Let Him have His way and all things are possible.

Another noteworthy thing is that the display of electrical energy is altogether out of proportion to the medium through which it is transmitted. And nothing known can transmit so much force through so small an agency as electricity. A small copper wire, no larger than one's smallest finger can transmit thousands of horse power, so that dozens of electric cars may be drawing all their power from it by the mere touch of the trolley-wheel to the wire, as with heavy loads they ascend the steepest grades.

And a strange thing about it is that the current does not move through the wire, but in the air or in the medium surrounding the wire.

The most devout Christians have been at best imperfect transmitters of God's power. Yet what marvellous results some of them have accomplished. The power was not of themselves. To see this we need only to call to mind such men as the fishermen disciples of Christ, Moody, and Jerry MacAuley.

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In addition to the power within them, enabling them to live holy lives, they seemed to be surrounded by an atmosphere of power. As electric currents seem to exert a mysterious influence upon all neighbouring objects, and even upon the surrounding air, so one cannot come in contact with one filled with the power of God without having a similar energy induced in himself. The very presence of Finney, without a word, has been known to result in the deep conviction, and the final conversion of the unsaved.

All the power we see displayed in the world, whether electrical, chemical, or otherwise, originates from a single source, the sun. God sends us magnetic waves from the sun by means of these same to and fro or alternate currents. This electrical energy is stored up in coal, and all other objects about us, so that we behold one and the same force whether it be in an object which emits light, radiates heat or manifests electrical energy.

Whether physically or spiritually manifest, there is but one source of power in the world, and the mystery which men have never been able to find in electricity is God. Whatever grace or loveliness or power is manifest in any life is of Him, and whoever feels any need of a fuller equipment spiritually, can find it only in Him who said: "All power is given unto me in heaven and in earth."

The poor aged woman whom I know, who lies in her third-story room with very few of the com-

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forts of life and suffering intense pain, but says that she would not exchange places with the rich or great of earth because she is so filled with the joy of His presence, is a medium of the power and grace of God. Only He can enable one to rejoice in the midst of losses, privations and suffering. But He is able to reveal Himself in most unlikely ways, and under most unfavourable circumstances.

The energy which is radiated to us from the sun, does not appear in space as light or heat or electricity, but only as motion. "There is no light, as we understand it, except where the presence of gross matter modifies the action of the ether; the interplanetary and the interstellar spaces are dark. Neither is there any sensible manifestation of heat or electrical energy. But there is motion; and this motion is capable, under the right circumstances, of appearing as light or heat or electrical energy." *

The energy of God is not manifested except when it comes in contact with, to use the term of science, "gross matter." It was not to the ethereal, self satisfied spiritual natures that Christ manifested Himself. He declared that not they who were whole, but they who were sick need the physician, and to them He came.

When there is heart hunger for Him, the mysterious power which no man hath seen or can see, comes without observation to the soul, and the

* "Electricity," E. M. Caillard, p. 143.

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divine energy is immediately transformed into love, joy, peace, long suffering, kindness, goodness, faithfulness, meekness, self control, and in an atmosphere which ever tends to induce the same life and lovely characteristics in every heart it touches. "Ye shall receive power, after that the Holy Ghost is come upon you."

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INVISIBLE RADIATION

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"True happiness ne'er entered at an eye:
True happiness resides in things unseen."
—*Young.*

"For the invisible things of him since the creation of the world are clearly seen, being perceived through the things that are made, even his everlasting power and divinity."—Romans 1:20.

"And there is no creature that is not manifest in his sight, but all things are naked and laid open before the eyes of him with whom we have to do."—Hebrews 4:13.

"He giveth wisdom to the wise, and knowledge to them that know understanding; he revealeth the deep and secret things: he knoweth what is in the darkness, and the light dwelleth with him."—Daniel 2:21-22.

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IV

INVISIBLE RADIATION

IT is strange that notwithstanding the fact that for thousands of years the sun has been pouring its light down upon mankind, it is but recently that it has been learned that a large part, the major part of the sun's rays are invisible to the natural eye.

We speak of daylight as white light, but if a ray of sunlight be passed through a narrow opening, and fall upon a prism, we obtain a band of colors, ranging from violet, through indigo, blue, green, yellow, orange to deep crimson red, which band is called the spectrum.

"The molecules of luminous bodies are in a state of vibration. The vibrations are taken up by the ether, which fills all space, and transmitted through it in waves. These waves impinging upon the retina excite the sensation of sight." *

In passing from a rare to a denser medium these waves are retarded. For instance, the velocity of light in air has been determined to be about one and one half times its velocity in glass.

* "Light and Electricity," J. Tyndall.

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Suppose a wave, before its impact, "to be oblique to the surface of the glass; as it is when striking a prism, that end of the wave which first reaches the glass will be first retarded, the other portions being held back in succession. This retardation of one end of the wave causes it to swing round; so that when the wave has fully entered the glass its course will be oblique to its first direction. It is refracted." *

The prism being wedge-shaped, one portion will emerge from the glass first. This will move more rapidly in the air than the portions remaining yet in the glass; when the wave has fully emerged from the prism it will be refracted again, and spread out, fan-like, separating it into its component colours, which are seen in the spectrum, and in the rainbow.

But we do not see all there is in a ray of sunlight when we behold its colours in the spectrum. Just as certain vibrations of the air impinging upon the auditory nerves are recognized as sound, so extremely rapid vibrations of the luminiferous ether falling upon the retina are interpreted as light. "The vibrations which produce the impression of red are slower, and the ethereal waves which they generate are longer than those which produce the impression of violet, while the other colours are excited by waves of some intermediate length. The length of the waves both of sound and of light, and the number of shocks which they

* "Light and Electricity," Tyndall, p. 62.

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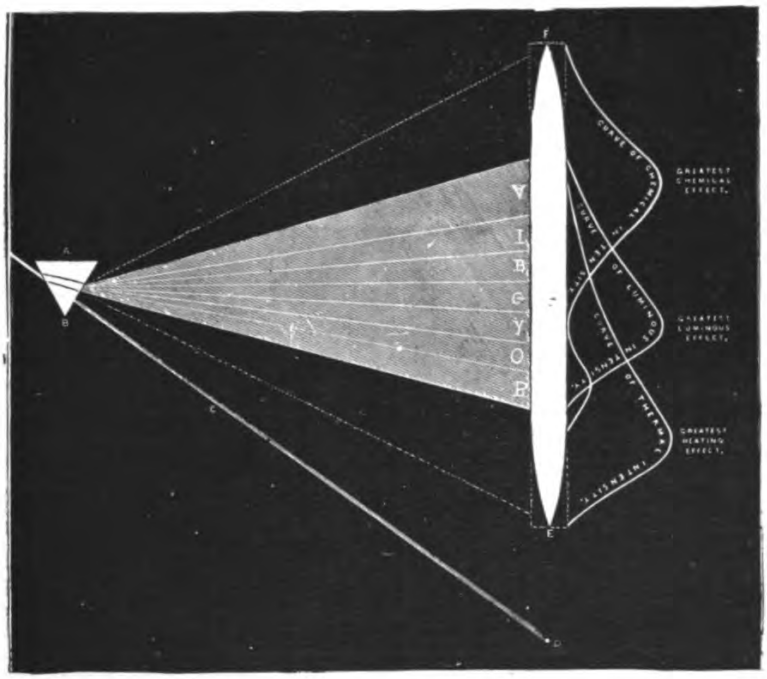

"We do not see all there is in a ray of sunlight when we behold its colors in the spectrum."

(See pages 47-51.)

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respectively impart to the ear and the eye, have been strictly determined."*

The colour red is produced by 474 trillions vibrations per second, while violet is nearly an octave higher, 699 trillions. The other colours, as already stated, rise gradually in pitch from red to violet.

But beyond the violet we have rays of too high a pitch to be visible, and below the red we have rays of too low a pitch to be recognized by the eye.

The ultra-violet rays of the spectrum, as they are termed, are rich in chemical effects, while the infra-red rays possess a high heating power, though incompetent to excite vision.

Photography, aided by electricity, has revealed the fact that the part of the spectrum occupied by the rays invisible to the eye, is twenty-five times as long as that part which we can see.

Professor L. P. Langley of the Smithsonian Institution, Washington, has devised an instrument termed a bolometer, by which he has been able to detect and map thousands of lines in the invisible red end of the spectrum where only a dozen were known to exist before his labours, and this because his instrument is able to detect such extremely minute variations of temperature.

"Its delicate wire, much finer than a human hair, through which an electric current constantly

* "Heat as a Mode of Motion," Tyndall, p. 226.

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passes, and sensitive to much less than the ten-millionth of a degree Centigrade, is moved by minute steps through the invisible areas of the solar spectrum; each indication of temperature, automatically photographed, comes out as a line which varies in depth of tone with the intensity of the thermal ray. When the device has finished its journey the large part of the whole breadth of the solar radiation rises to view,—in all fifteen times as extensive as the spectrum which Newton saw." *

It has been ascertained that at the violet end the spectrum stretches nine or ten times as far as that portion which we can see, and how much further we cannot say. And if we turn to the other end, the red, we find in the infra or invisible red region an extension fourteen times the length of the visible spectrum.

In his popular lectures in the Royal Institution, London, Professor Tyndall concentrated the invisible red rays from an electric lantern and in their focus fused and burnt many metals, while Captain Abney photographed, in an absolutely dark room, a kettle of boiling water, by the same infra red rays.†

Electricity and light being but different manifestations of the same energy, we are not surprised that similar invisible rays are found in the electric current.

* "Flame, Electricity and the Camera," Iles, p. 347.
† "Invisible Rays," Wall.

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Sir Wm. Crookes, the celebrated English chemist, by exhausting glass bulbs with an improved Sprengel air-pump, obtained an extremely high vacuum, which, when an electric current was passed through it, gave remarkable effects. The sparking points inserted through the ends of the tube became joined with a single luminous stream. The invisible now became visible, and was seen to be able to effect marvellous phenomena.

These are the famous cathode rays, so called because they proceed from the cathode, or negative pole of the electric machine. They may be considered as a radiation of electric energy, which is made visible in rarefied media and which can also be detected outside such media.*

Beside the invisible rays in the spectrum of sunlight above the violet and below the red, and these cathode rays, there are others equally wonderful and mysterious. They are the Becquerel rays, which we shall consider later, and the X-rays, discovered by Professor Wilhelm K. Röentgen of the Royal University at Wurzburg, November 8th, 1895.

Lenard, Crookes, Hertz and other investigators, had produced the X-rays, but they were not recognized till Professor Röentgen discovered them and brought the results of long years of patient scientific research into practical application of our daily life.

What a vast field of invisible radiation all

* "What Is Electricity?" Trowbridge, p. 283.

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about us! The words of Bryant in his Thanatopsis are true of visible and invisible rays:

> "All that tread
> The globe are but a handful to the tribes
> That slumber in its bosom."

They apply with even more emphasis to the powers which are upon every hand. Those which we see are but a handful to those which are invisible to the natural eye. The Spirit of God who is infinite in His being, wisdom and power, is in the world, the life of everything which lives; persuading and drawing every human heart.

Yet Christ informs us that the vast majority of people in the world cannot receive Him; for they behold Him not, neither know Him. He adds, addressing His followers: "Ye know him; for he abideth with you, and shall be in you."

Each one of His children is to be a kind of bolometer; able by his heart instinct, to detect vastly more of God than the world ever dreams exists. "He giveth wisdom to the wise, and to them that know understanding."

The scientific discoveries in the region of invisible radiation should teach us to expect the presence of spiritual powers about us, not detected by the indifferent heart, or seen by the eye blind to the things of the Spirit of God.

For many years even men of deep scientific thought handled exhausted glass bulbs and rare minerals without suspecting the presence of the marvellous properties which they possessed.

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It is possible for even Christians to be blind to much of the deeper radiation which the Holy Spirit flashes upon their hearts, and which they might recognize and in the joy of which they might live, were they willing to give Him the attention and obedience He desires.

While these ultra-violet, cathode, and X-rays are invisible to the natural eye, they are nevertheless, the most penetrating of any known. Substances once regarded as opaque are perfectly transparent to these rays. The properties of the ultra-violet rays are more searching than the sunlight, and the cathode rays more penetrating still, " and partnered with them " is a distinct emission which casts shadows of bone through flesh, of gold or lead through wood.

I was a student in the University of Berlin when Professor Röentgen of Wurzburg discovered the X-rays. There the excitement was intense, that the foot or hand could be made so transparent by means of this new light, but it was then thought that it would be impossible to secure X-rays sufficiently penetrating to illuminate the human body. But several months after that, by means of the fluoroscope, I saw through the shoulder and breast of a man as clearly as if he had been largely composed of glass, and now that is a common occurrence.

The time for exposure has also been wonderfully decreased. Professor John Trowbridge has found that a single discharge of three million

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volts, which is not now regarded as unusual voltage, through a high vacuum, will produce X-rays powerful enough to photograph the bones of the hand in one millionth of a second.

"Dr. C. M. Mouillin, addressing the Röentgen society of London, as its president, states that the flourescent screen has now reached such a degree of perfection that the minutest movement of the heart and lungs, and the least change in the action of the diaphragm, can be watched and studied at leisure in the living subject." *

This is strikingly illustrative of the searching of the Spirit of God, "with whom there is no creature that is not manifest in His sight; but all things are naked and open before the eyes of Him with whom we have to do." "He knoweth what is in the darkness."

There is no doubt but that the deepest secrets hidden in the heart of man; the sins that lie buried under the accumulated years of a lifetime, and covered with mountains of diversions and forgetfulness, still stand out before Him as they would in the clearest sunlight to us.

To beings ninety or a hundred miles above us, the objects of the earth must be perfectly transparent, because of the ultra-violet and cathode rays which are streaming through that rare atmosphere in an inconceivable volume upon the earth. The world is surrounded by one vast, but absolutely perfect Crookes' tube, and billions of

* "Flame, Electricity and the Camera," p. 353

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volts of electrical energy are passing through it from the sun.

What the material objects of the earth are, for transparency, in the presence of such energy, that the hearts of all men are in the presence of the Holy Spirit, who surrounds us as an atmosphere.

Numerous are the hidden things revealed by the X-rays. They are used to discover slate in coal, flaws in diamonds, and true and false gems, to detect concealed articles not declared in the baggage of those endeavouring to smuggle goods through the custom-house, and to disclose abnormal or internal defects of the body, the presence of irritating foreign objects, and dislocated or broken bones.

In an address recently given at the Orthopedic Hospital in New York, Bishop Potter stated that twenty-five years ago his right foot had been injured by the fall of his horse in the Yosemite Valley. The foot grew better, but has troubled him ever since, giving rise to various conjectures as to the cause. A few weeks ago the X-rays were turned upon it. It was then discovered that for twenty-five years he had been doing his work with a broken foot; for two of the bones near the ankle had been fractured, and had failed to unite because of a diseased condition known as Potts' fracture.

The Holy Spirit is the revealer of the secret condition of men's lives; "for he searcheth all things." It is hard to bear the burdens of life

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upon broken bones, or with some irritating thing in the heart. And yet that is what many people, for years, try to do, in consequence of which the world does not seem suited to them. They are ever in a state of discontent, and nothing gives them real peace, however bright their outward circumstances may be.

They feel that God has not given them the smooth road through life which He has granted to others. Their lot has been cast in a rough and thorny way. Little do they suspect that the whole cause of their trouble is internal; from a refusal to surrender the heart to God, or because of some secret sin cherished or ill-will harboured against another.

It may be after long self-deception, or years of sinful complaint against God, in some moment of true sincerity, the heart has the truth instantly flashed upon it by the Spirit of God. What a disclosure! Such a conception of the sin of self-righteousness, and the hideousness of moral deformities, never entered the mind before.

The soul now cries out: "Thine arrows stick fast in me, and thy hand presseth me sore. There is no soundness in my flesh because of thine indignation; neither is there any health in my bones because of my sin. Mine iniquities are gone over my head; as an heavy burden they are too heavy for me, my wounds stink and are corrupt, because of my foolishness." *

* Psalm 38: 2-5.

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This is a first and necessary step toward the eradication of the evil. Before it can be removed, its source must be localized and then disclosed, and this is the work of the Holy Spirit, who convinces the world of sin, that He may present the cure.

These invisible rays become visible to the eye when allowed to fall upon a fluorescent screen. It has been discovered that when the rays of a spectrum fall upon a sheet of paper saturated with a solution of sulphate of quinine, the previously invisible ultra-violet rays now shine out with a bluish-green light. This has been explained by Professor George Stokes as due to the fact that those rays which were too rapid to be visible, are now so slowed down when they come into contact with the quinine solution, that they are brought within the limits of perceptibility.

The same quality is possessed by fluorspar, whence the name " fluorescence and fluoroscope." " Edison has discovered that crystallized tungstate of calcium is highly fluorescent." So also is platino-cyanide of barium, and glass stained with uranium. The fluorescence continues only during its stimulation by an impinging ray.

Here we notice that when one assumes the correct attitude toward the unseen, and interposes the right medium, he is clothed with new visual powers, and the invisible becomes distinctly seen.

In his natural state, man is blind to God, and receives not the things of the Spirit of God, for

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they are foolishness to him, and he cannot know them for they are spiritually discerned. But when he takes an attitude of submission to God, and makes Christ the medium between himself and the light he seeks, he becomes spiritually enlightened and can "discern all things." But the continued ability to know Christ is conditioned upon the keeping of His commandments and loving Him. To such Christ reveals (φανερόω) Himself as He does not unto the world.

Professor Trowbridge says of the cathode rays: "We can, so to speak, see what may be termed an electrical candle through a wall." The one whose heart is spiritually enlightened may have clouds over him fully as dark as those over the unbeliever. There may be a wall of uncertainty before him, shutting out the way he is to take, but however dark the cloud or impenetrable the barrier, he can see a glowing candle through them; for God is a light who can and does reveal Himself to the eyes of those who trust Him. To such, the riddles of mysterious providences are easily solved; for the spiritually enlightened son, by divine instinct, knows His Father and His hand wherever seen. Where others see only stone walls, or insurmountable obstacles, he sees God.

The cathode rays have the property of rendering matter in general on which they fall brilliantly phosphorescent, and in course of time red hot; they also blacken photographic plates.

The presence of the Holy Spirit in the lives of

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some Christians, makes them glow with the love and power of God. Even their face mirrors the peace and holy calm which reign within their heart.

But the influence of the same Spirit upon other lives tends to blacken them, hardening their hearts, even as the same sunlight which melts the wax hardens the clay, and promotes the growth and beauty of the living plant, but hastens on to decay and disintegration the dead.

The gospel of the love and salvation of Christ to every one is either a savour of life unto life or of death unto death.

Among all the properties of matter there are none which are more wonderful, or are more mysterious than those first studied by M. Alexander Edmond Becquerel of Paris, and now termed the "Becquerel rays." These are phosphorescent rays which are emitted from certain bodies which have been exposed to light, but continue to glow long after the exciting beam has been withdrawn. Besides this, they possess the same penetrating qualities of the X-rays, which enable them to pass through objects opaque to sunlight.

Concerning them, the Electrical Review, March 21, 1900, says: "If it be admitted that we have some knowledge of the actual nature of the X-ray it seems fair that this name, which simply means the unknown quantity, should be given to the mysterious radiation that emanates from bismuth and other bodies without apparent source of

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energy. The extraordinary phenomena of this radiation that recently have been observed are apparently incompatible with the theory of the conservation of energy. To admit even for a moment the possible falsity of this foundation dogma of science is to invite a condition of chaotic bewilderment. Hence the main efforts of physicists engaged in investigating this question at present, are directed toward the discovery of the mysterious source of energy which supplies these emanations. So far there has been no indication of success in the search. What seem to be elemental bodies have been discovered, and their salts isolated, which possess a wonderfully high power of automatic radiation, but the cause of this extraordinary phenomenon is as deep a mystery as when its discovery startled the scientific world."

The thing which so puzzles students of science is the source of energy of these Becquerel rays emitted from rare minerals. They seem to glow without a cause. Men have tried in vain to explain the mystery.

Sir William Crookes suggested to the British Association in 1898, that in some way the energy might be supplied to these minerals from rapidly moving air particles. Messrs. Elster and Geitel took a salt of uranium into a deep mine, where it was kept by 2,785 feet of earth from the external rays, and the salt still glowed.

When kept in a high vacuum, the radiations

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were still emitted, the energy thus not being due to a mechanical or chemical action of the air. The impact of X-rays or cathode rays made no change in the radiation.

According to George Iles, Becquerel has discovered that uranium possesses this weird property to an unusual degree, emitting rays continuously, and with apparently undiminished intensity for more than a year.

The luminescent property possessed by many objects, and the mystery concerning them are deepened by the fact that they emit invisible radiations which, like the X-rays, easily pass through objects hitherto regarded as opaque, and produce images upon photographic plates.

With these rays "emitted by sugar, after they had pierced a block of wood two and one-half inches thick, Mr. A. F. McKissick has photographed coins, keys and pieces of glass." *

Concerning this property of these objects, Professor Silvanus P. Thompson says that it "appears to be due to an invisible phosphorescence of a persistent sort."

These Becquerel rays so strangely emitted by certain objects, forcibly remind one of the qualities which are sometimes possessed by disciples of Christ, who live in intimate communion with Him. They seem to be composed of rare metal, ever radiating the spirit of their Master which has been imparted to them; transparent alabaster

* "Flame, Electricity and the Camera," p. 355.

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has been imparted to them; transparent alabaster pillars are these in the church of God, through which His glory shines; rare old cathedral windows letting the rays of the Sun of Righteousness shine through them to reach other hearts with life and healing.

The tender and enlightening influence of the Spirit of God yielded to, softens one's heart and beautifies his life; for in proportion as one becomes partaker of His nature, he does of His characteristics.

But the one thing that the world can never understand about such persons is the source of their energy. They seem to glow automatically, and glow wherever you take them, and in whatever circumstances they may be. They rejoice in the flames, and pray and praise God in the prison house, and would not change it for a palace As with Madame Guyon, the stones of their cell are as precious to them as diamonds, because there has been such constant joy with only them as their visible companions. The source of this mystery is the mysterious God who dwells within the heart of the contrite one, and giveth songs in the night.

"Let it not be forgotten that these revelations took their rise in what was at first resented as an intrusion. When the ultra-violet ray impressed itself upon the earliest photographic plates, it so seriously deranged the translation of colour, that

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if possible, the photographer would have banished it at once and forever. Yet that intruding ray has proved to be a friend, not only generous in gifts of its own, but pointing to other and greater wealth fast being won from darkness to light." *

Words could not well express a closer resemblance to the way the persistence of the Holy Spirit is regarded by many. He interferes with their sinful plans and desires, and fogs their brightest hopes, and they fain would be let alone, and perhaps would banish Him forever from troubling them. But His intrusions are those of a friend, not only generous in gifts of His own, but pointing to other wealth in Christ.

There are but two courses open to each soul. One is to resist these intrusions of the Holy Spirit; to hold on to sin, and hide it in the heart, and so far as possible deceive your own soul into thinking that there is peace, peace when there is no peace of, or with God, and in this manner go to the judgment where the secrets of all hearts shall be disclosed; where the search-light of God's Spirit shall be turned upon every one of us, and when we shall see ourselves as we really are, and shall know ourselves even as we are known by God, directly, completely and forever.

The other method is to receive these loving intrusions of the Holy Spirit in your affairs, submit to His tender impressions, come to understand the

* "Flame, Electricity and the Camera," p. 357.

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mind of God, and joy in His partnership with you in life, and in all its affairs, and changed by Him from glory to glory, you at last awake perfected in the likeness of your Lord. May your heart now say: "This is my choice."

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"When the Master of the universe has points to carry in his government, he impresses his will in the structure of minds."—*Emerson.*

"Man cannot keep secret what God would reveal."—*Campbell.*

"For it is God which worketh in you both to will and to do of his good pleasure."—Philippians, 2: 13.

"As he spake by the mouth of his holy prophets which have been since the world began."—Luke 1: 70.

"Jesus of Nazareth, a man approved of God unto you by mighty works and wonders and signs, which God did by him in the midst of you, even as ye yourselves know."—Acts 2: 22.

"For I will not dare to speak of any things save those which Christ wrought through me, for the obedience of the Gentiles, by word and deed."—Romans 15: 18.

"We are ambassadors therefore on behalf of Christ, as though God were entreating by us."—2 Cor. 5: 20.

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V

ELECTRIC CONDUCTORS

IN each one of the Scripture passages on the opposite page there is the use of what is grammatically termed the instrumental dative. God is the actor, who employs the moral agents mentioned as instruments through whom He acts. In each case also the word translated "by" (διὰ) literally means *through.*

GOD spake *through* the mouth of the prophets; did signs and wonders *through* Christ; and entreats *through* His ambassadors. It is none the less His work because it is wrought through a free moral agent.

What God does in grace, that He has beautifully typified in nature, in electricity. And I believe that it is more than in type that He is manifest there. He Himself is the energy wherever seen in nature.

Bodies may be charged with two opposite kinds of electricity, positive and negative, and to neutralize one kind it is perfectly understood what must be done—produce the other, as we drive out darkness by letting in the light.

This is a law which maintains in the spiritual

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realm. If we wish to neutralize evil, it is not by suppression, but by producing its opposite. Unbelief is not so effectually destroyed by combatting it, as by presenting the truth. The sinful habits and tendencies of one's life are not destroyed by suppression and resistance, but by the coming of the Spirit of Christ into the heart. This is what Dr. Chalmers called the expulsive power of a new affection.

But in order that the light may neutralize the darkness, there must be a medium through which it can pass from the sun to the darkness of the earth.

In order that truth may neutralize error, faith unbelief, holiness impurity, life death, and the Holy Spirit the spirit of evil, there must be a medium. And that is what man, as a free being, is represented as being in these passages of Scripture, and that is what we propose to illustrate by electric conductors.

To Stephen Gray is due the honour of discovering electric conduction. In 1729 he was experimenting with glass tubes. As had long been known, when the glass was rubbed with a piece of silk, it would attract bits of cotton, paper or pith. In one end of the tube he placed a cork, and noticed that when the glass was rubbed, the cork would attract light bodies, at which he was much surprised, and concluded that "attractive virtues had been communicated from the glass to the cork."

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He put a fir stick four inches long into the cork, and found that it too would attract. He made the sticks longer and still found a power of attraction at their ends. He tied a thread around the glass tube, and let it fall from the upper window of a house. When the glass was briskly rubbed with the silk, the end of the thread near the ground attracted light bodies.

Whenever two bodies are at different potentials, electricity tends to flow from the body at the higher potential to the one at the lower potential.

Those bodies which permit electricity to "flow through them," to use a convenient phrase, are termed conductors. Those bodies which offer a considerable resistance to the passage of an electric current, are called insulators or dielectrics. All bodies are divided into two classes, conductors and non-conductors, or non-electrics and dielectrics.

There is, however, nothing which is a perfect conductor; for every body offers more or less resistance to the passage of an electric current. So also there is nothing that is a perfect insulator; for nothing offers a complete resistance to the flow of electricity.

If air were a conductor, no surface could be charged in it. There could be no thunder storms. As soon as electricity was generated it would pass unobserved to some other body.

Water, and particularly salt water, is a good

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conductor, and hence there are no electric storms or disturbances in the ocean, and its inhabitants only experience animal electricity, such as is manifest by the torpedo and gymnotus, but never from any other source.

All metals are good conductors, while dry air, glass, silk, oils and many other objects offer great resistance to the passage of an electric current, and are termed non-conductors.

Were it not for the fact that some bodies are conductors we should be totally ignorant of the transmission of energy by electricity.

A medium between God and man was a necessity. By no other means could we know Him, and in no other way could His life reach us. Christ is that medium, and by their union with or separation from Him, men are divided into two classes, conductors and non-conductors.

Those are conductors through whom God is able to speak, work, and in various ways influence the lives of others, as mentioned in the passages above.

No life is an absolutely perfect conductor of the life, love and power of God. While Jesus was a perfect being, yet even His human life was not an absolutely perfect medium for the transmission of the life and power of God to us; for He was in His human life limited. And so, in Him, God was veiled as well as revealed, manifested. That is the reason why He was such a mystery to His generation, and why He is to-

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day. He did not come simply to manifest God to men, that we might know God's heart, but to be such a medium between God and men that they should come into saving touch with God.

When the imperfections and limitations of humanity are removed, Christ will be a perfect revealer of the Father. We shall not then see God as in a mirror darkly, but face to face. His glories will be seen through the perfected and glorified Son. Not a cloud will obscure His face. While here, a body which could be wearied, which hungered, and could be killed, obscured the vision until many did not see God in Christ.

If in the humanity of Jesus there were limitations in transmitting the life of God to man, so that He must go away that He might send the Spirit, can we wonder that Christians are not perfect conductors of the divine life?

Conductors do not retain to themselves an electric current, but pass it on, and although not perfect, Christians do nevertheless transmit God to other hearts. And He does not wait till He finds perfect conductors before imparting through them His life and power to those in need.

Yet there is a vast difference in the conductivity of the lives of Christians, just as some metals more readily transmit an electric current than others. There are many reasons for this.

We know that electricity seems most partial, greatly preferring to manifest itself through some objects rather than through others, and even

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choosing some conductors in preference to others. This is a mystery, but in all cases the electricity has not changed, the difference being entirely in the conductors.

If the lives of some seem to be devoid of blessing; if God seems to work through others, and not through them, it is not because He is not the same loving Father to both, and would as gladly employ one as the other, but the difference is in the lives of the persons.

The partiality of the Holy Spirit is the partiality of an absolute necessity. If any one of us is denied the privilege of being used of Him in such a measure as we desire, it is only because, for some reason, we are not in such a relation to Him that He can work in and through us.

We may not have the natural qualifications of a good conductor, and added to this lack, there may be grievous spiritual defects. But what are we to do? The conductor cannot change itself. The glass has no power to change itself into silver or copper.

Just here the electric current affords us a striking, and I believe, a perfectly true parallelism. That which is lacking in the conductor may be made up in the electricity. For it is a strange, but certain fact, which but recently has become known, that with currents of very great frequency and high potential, glass and other objects, usually regarded as poor conductors, are really bet-

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ter conductors than copper and other metals, ever known as excellent conductors.

"With an extremely rapid rate of oscillation, far into the billions per second, the electrical current leaves the wire, and may be said to travel through the medium."

"The effect of increasing the to and fro currents of electricity is to drive them to the surface of metallic conductors. When the frequency or rapidity of vibration is enormous, a rod of copper may not afford any better passage than a rod of glass. Hertz, in one of his papers, points out that our present nomenclature is limited, and only applies to the special cases of steady currents. With enormously rapid to and fro currents, a piece of copper acts like an insulator and prevents any to and fro currents from passing through it, whereas a piece of glass transmits them unimpaired. A thick disk of copper properly placed between two coils of a set up transformer can completely stop the electrical oscillations from reaching a lamp connected with the secondary coil of the transformer, whereas a plate of glass allows them to pass on unimpeded. Glass, therefore, is a better conductor for electrical oscillations of high frequency than copper."*

For the greatest manifestations of His love and power to the world, God does not choose

* "What Is Electricity?" pp. 166, 190.

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those conductors which seem to men most fitted by nature to be used of Him. Human abilities seem to be in the way, and humbler instruments are chosen, even the foolish things and the weak things and the base things of the world, and the things that are not, "that no flesh should glory in His presence."

Hitherto it has been impossible to telephone by means of a submarine cable because the capacity of the cable is so great. "At the distance of about fifty miles nothing but a murmur is heard; the characteristics of the human voice are completely obliterated by the capacity of the cable. In order to speak under the ocean some way must be found neutralizing this capacity." *

Too great a capacity may prove a barrier to the Spirit of God. But He is most loving and gracious, and does not disdain to use the lowliest conductor. If then, we are not endowed by nature to achieve the great results for Christ's honour that we covet, let us abandon ourselves to Him in such humility and self abasement, that God alone may be glorified, and through us He will impart greater blessing to humanity than He could have done had we at the first been the recipients of ten talents instead of the one. In the plan of God's grace no one is barred from being a conductor of the greatest efficiency.

Certainly greater glory is given to the elec-

* "What Is Electricity?" p. 180.

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tric energy when it oscillates so rapidly and reaches so high a potential that it leaves the wire and travels in the medium always supposed to offer an impassable barrier to it. And in this manner the greatest achievements are accomplished.

"The electric energy which propels an electric car resides in the medium around the trolley wire. . . . The energy of the dynamo, thus, is not transmitted along the wire; it is manifested in the ether of space and in the insulating media about the wire. Lodge in his "Modern Views of Electricity," remarks: "The energy of a dynamo does not therefore, travel to a distant motor through the wires, but through the air. The energy of an Atlantic cable battery does not travel to America through the wire strands, but through the insulating sheath. This is a singular and apparently paradoxical view, yet it is well founded." *

Here we have the conductor surrounded by an atmosphere of energy. It is similar to the enclothing power of the Holy Spirit. We term those wires alive through which an electric current is passing. Christians may not only be alive with the life of God, but they may be surrounded by such an atmosphere of Divine power that whoever comes in contact with them shall feel that God is there. This is the enduement of

* "What Is Electricity?" p. 166.

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power for which Christ told His disciples to wait, and which it is the duty and privilege of every believer in Him to experience.

Without it the life is as powerless as is the Atlantic cable to transmit a message when it is not charged by an electric current. God cannot speak to hearts through a dead cable, or through one which has so much personal "capacity" that it "absorbs the energy" instead of passing it on. In such cases an electrician would say, "There has been a decay of energy in the copper." The temptation of Christians is to suffer the energy of God to decay in their own lives, instead of being enclothed with His power that He may touch and bless as many others as possible.

"Conductors need nothing more than contact at one point with electrified bodies to be electrified themselves over their whole surface. In the case of non-conductors, on the contrary, every part of the surface must be touched separately and excited." *

Real channels of the Spirit of Christ will manifest His love in every part of their life. Wherever you may come in contact with them Christ will be seen. It is not the one who is devout in religious meetings, or on Sundays, and then seems to be under the power of another life, called secular, all the remainder of the week, who is used of God.

* "Electricity," Caillard, p. 11.

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The world is looking for those conductors who show the temper of the Master everywhere. It is not sufficient to occasionally manifest a Christ-like spirit. Even the most worldly and sinful show some measure of good, which indicates that their hearts are not devoid altogether of the influence of God; for every good thing, wherever seen, is His work. Yet like the non-conductor, every part of them must be separately touched and excited by God. He has no free access into and through their lives.

Are they touched with tenderness for suffering humanity? They are unmoved at the slights and curses heaped upon Christ. Are they disposed to quickly acknowledge a favour, or to beg pardon for any slight infraction of the rights of others, or any negligence shown them? They will not thank God for His favours, nor request His pardon for a thousand insults, yea, for a lifetime spent in ignoring His rights. Are they interested in supplying the wants of the needy and destitute? They will not offer one morsel of comfort for the deeper needs of the soul. They cannot, for they are not real conductors of the life of God. While He is able to touch them here and there, He cannot manifest Himself to them nor through them, because of their resistance to Him.

It is to be feared that there are many in the church, and out of it, who conclude that because of these fitful or occasional manifestations of

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good in their lives, they are therefore, alive with the life of God, and are mediums through which He could if He chose impart His life to others.

While the characteristic which distinguishes a conductor from a non-conductor is that a current of electricity touching the one will be manifest through every part of its surface, but touching the other it will be electrified only at the point of contact, yet there are conditions in which the best of conductors may be rendered as utterly useless, as the most absolute non-conductor; suggesting a condition in which the actual Christian becomes as powerless to win others to Christ, as the one who openly avows hostility to Him.

"The thinnest sheet of paper placed under the trolley of an electric car will stop the car, provided it is not punctured by the mechanical pressure. Cut a copper wire carrying an electrical current, file the ends square, place a piece of writing paper between the ends and press them together: the current which was transmitting thousands of horse power is stopped; it is incapable of passing through the insulating substance of the paper.

Here we are brought to a realizing sense of one of the chief peculiarities of the method of transmitting power by electricity. No other agency for transmitting power can be stopped by such slight obstacles as electricity. A sheet of writing paper placed across a tube conveying compressed air would be instantly ruptured. It

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would take a wall of steel at least an inch thick to stand the pressure which is driving a 10,000 horse-power engine. A thin layer of dirt beneath the wheels of an electric car can prevent the current which propels the car from passing to the rails, and thus back to the power house." *

Yes, there is one other agency for the transmission of power which can be stopped by such slight obstacles as electricity; one which is vastly more sensitive to breaks in the conductor, or to opposing media. It may seem most strange, but it is true that the Holy Spirit is so sensitive to sin in the heart of a believer, that its presence there is a complete obstacle to the manifestation of His love and power.

Secret sins, however small they may seem, unkind criticism of others, selfishness or love of pre-eminence in the work of Christ or elsewhere, inattention to the whispers of the Spirit, or a refusal to comply with His directions as to duty clearly impressed upon the heart, giving one's own desires the preference to His, all or any of these grieve Him, and cut off the transmission of His power to others.

If you are a son of God, and are not a medium through which He is reaching and saving others, there is a break somewhere in your life. He would bless others through you, but is unable to do so because of that obstacle. It must be located and removed.

* "What Is Electricity?" p. 46.

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It would be a most difficult task to propel yonder electric car by hand, when the power is stopped by an obstacle on the trolley, or by a layer of dirt under the wheels. But it would be an easy matter compared with the Herculean efforts necessary for you to do something for Christ and others, so long as that sin, which seems so small to you, is in the way of the Spirit of God. While it remains in your heart, you will be powerless, and your labour a weariness to yourself, and useless to Christ and others. Let God now turn on His searchlight, and remove the obstacle.

Conductors which are free from obstructions, however diverse their composition, if they are made to touch one another, are by that contact brought into unity when an electric current is passing through them. Electrically they have become one.

"Small drops of water charged with electricity, if they unite to form larger ones, will present a smaller total surface, and hence will raise the potential of their charge. This is supposed to be one of the causes of electric disturbances in thunder showers, where the electric charge of the atmosphere seems to be increased in potential enormously."*

This suggests the value of union in the things of Christ. If the union be real, brought about by the Holy Spirit, the power is vastly increased.

*"Electricity Simplified," Sloane, p. 22.

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And this is the only Christian union which has any actual value, because it is the only kind that avails with God. Such a union in prayer is signified by Christ in the words, "If two of you shall agree on earth as touching anything that they shall ask, it shall be done for them." This is not simply an arbitrary, outward agreement, such as is entered into when believers agree to pray for the same thing, a mere contact of conductors, so to speak, but an agreement because the one Spirit moves all hearts in the same manner, bringing them into harmony of desire and purpose. Such agreement never fails in its asking or doing. This is the union with God and with man which enables one to chase a thousand, and two to put ten thousand to flight.

You may know all the requirements requisite to a good conductor of the energy of God, and yet fail to be one, simply from a lack of making that the purpose of your life. "A pointed conductor both collects a far greater quantity of electricity than one with a flat or round surface, and the discharge from it is much more rapid and powerful." *

If we would be a medium through which God may bless others and glorify Himself, we must concentrate our lives upon that one thing. It is worth our while. That has been the aim of Christ through all the ages, and it is also of the angels, and of the glorified prophets, apostles

* "Electricity," Caillard, p. 13.

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and saints. The same privilege is accorded us on earth. And by it we may become links in the golden chain which binds heaven and earth together, and through which pulsates the life, love and power of God.

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WIRELESS TELEGRAPHY

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"The Father spake! In grand reverberations
Through space rolled the mighty music tide,
While its low, majestic undulations,
The clouds of chaos slowly swept aside.

"And wheresoever in His rich creation,
Sweet music breathed—in wave, or bird or soul,—
'Tis but the faint and far reverberation
Of that great tune to which the planets roll!"

—*Frances S. Osgood.*

"For this people's heart is waxed gross, and their ears are dull of hearing, and their eyes have they closed; lest haply they should perceive with their eyes, and hear with their ears, and understand with their heart, and should turn again, and I should heal them. But blessed are your eyes, for they see; and your ears, for they hear."—Matt. 13: 15-16.

"If any man hath ears to hear, let him hear."—Mark 4: 22.

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VI

WIRELESS TELEGRAPHY

NATURE is the supernatural articulated. And in nothing does God speak more clearly than in electricity.

It was the marvellous intellectual acumen of Maxwell which wrought out the theory of the identity of luminous and electro-magnetic propagation,—that light and electricity travel by means of undulations in the ether.

It is to the genius of the lamented Hertz, of Bonn, Germany, whose philosophical career was as brilliant as it was brief, that we owe the demonstration, by experiment, of this hypothesis. One of the most important conclusions from this theory is that any disturbance of the electrical equilibrium at any given place must be propagated as waves through space, with a velocity equal to that of light.

These electric oscillations are found to obey the law of radiation, which is none other than the corresponding law of light.

Professor Oliver Lodge has shown that they can be reflected by plain sheets of metal, contracted by parabolic reflectors, refracted by prisms, and concentrated by lenses made of

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pitch. They can also be made to show the phenomenon of interference, and thus have their wave lengths accurately measured.

We live and move in an atmosphere of electrical energy, at the bottom of a vibrating sea which is as limitless as space, and which, with its etherial medium, constitutes the nervous system of the universe.

Here and there a few of these waves are converted into sound, light and motion. We speak into a telephone, and the vibrations of the voice are transformed into electrical energy, and carried forward to the distant point by the waves in the ether, to be again resolved into sound waves of the air, entering the ear as speech.

Some of these undulations are changed into light to illuminate our homes and our streets, while others are manifest in the immense force of the electric car which transports us from place to place.

Although we bathe in the depths of this ocean of energy, and its countless waves sweep over us, and even through us, we are for the most part, entirely unconscious of its existence. This is because we have not an electric sense by which we can detect these vibrations.

We have the senses of hearing and of seeing. By the former we detect the slower vibrations of the air, which are from eight to forty thousand per second, and term them sound. By the sensitive nerves of the latter we perceive the very

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rapid vibrations of the ether, which are from 474 trillions, extreme red, to 699 trillions, extreme violet, per second, and call them sight.

Between the highest note which the human ear can detect, and the slowest light ray which the eye can see, lies a vast territory, which hitherto has been almost wholly unexplored. The vibrations have ever been there, waiting for us to detect them. They are sound waves of too high a pitch to be heard, and light too slow for the retina to be competent to respond to them.

This enormous gap between the highest audible, and the lowest visible vibrations, is now known to be largely filled with electric vibrations. Lodge states that the vibrations when a Leyden jar is discharged are from a hundred thousand to a million per second, which are too slow for the retina, and too high for the auditory nerves to recognize, but that he has succeeded in getting electric oscillations slow enough to be heard. The lowest one he secured was one hundred and twenty-five per second, and for some way above that the sparks emitted a musical note. He has secured an electric oscillator which vibrates three hundred million times a second, but no one has succeeded yet in producing electric oscillations which are visible, though indirectly every one does it by lighting a candle.

Had we another sense by which to perceive these electric oscillations, we should have a world of mystery become clear to us. We should dis-

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cover new scenes as rich and varied as a gorgeous sunset. Every movement of the body, every touch of the hand, even the friction of the clothing, would awaken a play of effects analogous to those of light and shadow in the eye, or music in the ear.

But what we lack in the intensifying of our physical senses, in some measure has been accomplished by the deepening and widening of our mental faculties which has enabled us, through research, to discover what Sir William Thomson calls Hertz' receiver, "an electric eye," by which these electric waves become recognizable.

Our physical and intellectual deficiency which makes us insensible to the electric energy which is all about us, is analogous to our spiritual inability to detect the presence and power of God. Only a fraction of that which He communicates to us are we able to recognize and receive. It is not that He does not speak to us in myriads of ways, but our capacity is so limited. We are so unlike Him that we seldom see or hear Him. We need the spiritualized vision, and the divinely quickened ear.

Because we hear no voice and perceive no shape, we should not be so illogical as to conclude that therefore God is not near us, or does not speak to us. Blessed are those who have discovered that the vast unexplored territory which lies just beyond the ken of the natural vision is filled with God, who is waiting to make Himself

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known to every heart that will have the eye to see or the ear to hear.

But these electric oscillations do not stop at our ignorance. They knock at every door, and enter unbidden. Many media which are opaque to light are transparent to them. The earth itself seems to be no bar to these penetrating waves of energy. It has long been a known and utilized fact that the earth can take the place of a return wire in telegraphing.

For instance, in a telegraph line running between New York and Boston, instead of being obliged to use two wires all the way to make a complete circuit, the earth could be used instead of the return wire, thus halving the injurious resistance of the circuit; for it has been found that the earth does not offer any appreciable resistance to the passage of an electric current, when compared with the total length of the telegraphic circuit.

"We can find no analogy between the flow of steam, gas or water and the case of the return circuit through the earth. In the case of steam, gas or water, and of all fluids forced through pipes from a power-house, nothing returns to the power-house if we should connect the pipes to the ground; for the steam would be condensed, the air pressure lost, and the water would soak into the ground. In the case of electricity, however, nothing is lost by connecting the wires leading from the power-house or battery to the

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ground. Indeed, in certain cases a great deal is saved, for the energy of the current is not dissipated into heat along the return wire." *

Numerous instances also might be given where electric currents have passed through the earth for long distances, and have been indicated and detected by means of a telegraphic recorder, or a telephone, without wire connections. These subtle waves are capable of penetrating the air, water, earth and mineral substances, as is done by no other known agent.

In this they afford a striking analogy to the penetration of the Holy Spirit. Nothing hides from His searching power, or separates from His benevolent presence. The deepest recesses of the soul are transparent to Him. He likewise seeks out the inscrutable things of God, and makes them known to the heart. Mountains of human frailty are no barrier to Him. Seas of separation from God He crosses, and hearts of stone He penetrates, that the message of life and love may be heard and welcomed.

Long ago David sang of His ubiquitous presence in the 139th Psalm. One might mount into the heavens, or bury himself in the shades of sheol, or fly to the extreme limit of the seas, or seek to overwhelm himself in darkness, and still he would be in the presence of that Spirit, from whom nothing separates, and to whom the night shineth as the day.

* "What Is Electricity?" p. 67.

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Lodge says that light is transmitted by means of electric oscillations, and that this is not only a possibility, but that doubtless we shall soon see the views and pictures they carry.

This interesting suggestion is paralleled by the vision which the Spirit of God presents to every heart from which the veil of resistance only needs to be drawn to see God in His beauty. By His presence He would make a "Holy of Holies" in every breast. He would illuminate the soul with the beauty of heaven, and radiate from every life, as the sun shines through old cathedral windows, converting the gloom into glory, and magnifying the sun through inferior bits of broken glass.

Since the demonstration of Hertz, the propagation of energy through space by means of waves, has formed the unquestioned basis for all the rapid progress in electrical achievements.

When an electric circuit is completed, etherial waves are sent throughout space, but after the first shock the current flows steadily without any more waves. Such are the vibrations produced by the sparks of a static machine, the discharge of a Leyden jar, or a Hertz radiator, which is essentially an induction coil with two brass balls so attached, that when a key is pressed down, the circuit is closed and sparks pass between the brass balls, creating electric waves, the length of which is proportionate to the distance between the balls and the rapidity of the sparks.

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It will be seen that if the circuit in such an exciter be alternately closed and opened, the shocks will transmit through the ether a series of vibrations, as is done in telegraph lines by making and breaking contact.

If now we had an instrument sufficiently delicate to detect these electric oscillations, we should be able to transmit and receive messages through the atmosphere without wires, or in other words, we could use the atmosphere for wires in telegraphic communication.

Such an apparatus is found in the Branly coherer, named after Professor E. Branly of the Catholic University of Paris. Concerning the variations in the conductivity of certain substances under electrical influence, he says: "The substances which up to the present have presented the greatest variations in conductivity are the products or filings of metals. The enormous resistance offered by metal in a state of powder is well known; indeed, if we take a somewhat long column of very fine metallic powder, the passage of the current is completely stopped." *

It has been found, however, that the resistance of metal filings is greatly reduced when they are subjected to pressure, or to the influence of an electric wave. For instance, if they are placed in a small glass tube, and from the ends of the tube wires connect them with a single celled battery, their resistance is so great that no cur-

* "A History of Wireless Telegraphy," Fahie, p. 276

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rent can be detected passing through them in the circuit, even by a very sensitive galvanometer. But, if now a Leyden jar be discharged near the tube, or a spark be sent between the brass balls of a Hertz exciter, the resultant electric wave produces "an abrupt and permanent deflection of the galvanometer needle, showing that an immediate and permanent reduction of resistance has been caused. The resistance is no longer measured in millions of ohms, but in hundreds. The conductivity increases with the number and intensity of sparks." *

Before the electric wave fell upon the metal filings they were practically a non-conductor, offering many megohms resistance. The powdered particles lightly touched one another, in a disordered or chaotic manner or as Mr. Preece says, "they lay higgledy-piggledy;" but the electric wave impinging upon them, they became polarized—order was established, and they being marshalled into serried ranks pressed upon one another; in a word, they were made to cohere, establishing electric conductivity, "the resistance falling from practical insulation to a few ohms." *

It has been discovered that the conductivity which is imparted to the metal filings by the falling of the electric oscillations upon them, is at once destroyed by shaking or tapping the tube in which they are.

In the glass tube of metal filings we see a non-

* "A History of Wireless Telegraphy," Fahie, p. 277.

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conductor transformed by an electric current into a sensitive conductor; and the conductivity persists until a modification is brought about by a shock, or a rise of temperature.

Similar transformations of non-conductors into conductors by electrical influence are mentioned by Professor Branly. For instance, a sheet of platinized glass, which offered a resistance of seven hundred ohms, became highly conducting after a current of one hundred and fifty sulphate of mercury cells had been applied to it for ten seconds.

Here is a perfect analogy to the transformation which occurs in the lives of men under the influence of the Holy Spirit. You might truthfully say of some that they offer complete resistance to the truth of God; they want nothing to do with it, and possibly they are open and bitter opposers of it. Their spiritual nature is in a chaotic condition; disorder reigns.

But the truth which was so resisted is suddenly given free access in their lives, and all opposition ceases. The reason for this is clearly apparent to any one versed in the teachings of the Bible. Invisible energy from Heaven's battery has come into contact with the soul; disorder has vanished; spiritual continuity with God is established, and resistance has given place to conductivity of the tenderest sort, and it is one which also persists.

Such transformations, by the renewing of the mind, are frequent in the spiritual realm, and

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they are the blessing which we are all entreated to receive, that we may prove what is the good and acceptable and perfect will of God.

The Hertz transmitter and the Branly receiver are the brick and mortar of the Marconi system of wireless telegraphy. They are its foundation. The electric waves sent out by the transmitter roam through space seeking for an electric ear to hear them. Such an ear is the Branly detector.

The method by which the detector is made to respond to the electrical oscillations is made more clear by well known experiments with tuning-forks.

Two tuning-forks, tuned to exact unison, are mounted on sounding boxes, and placed near to each other. A violin bow is drawn across one, and its vibrations are distinctly heard at some distance. If the sound is stopped by placing the hand upon this fork, the other fork is heard in vibration, caused by the waves of sound in the air between the two, beating upon the second fork until it vibrates in sympathy with the first. If the unison between the forks be destroyed, by placing wax upon one of them, however much the other may vibrate, it will create no sympathetic vibrations in the other.

Here is an exact analogy to what occurs in wireless telegraphy. Just as the first tuning-fork excites aerial waves, so the sparks passing between the two brass balls of the Hertz exciter produce etherial waves. And as the sound waves

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produced by the tuning-fork excite sympathetic vibrations in the other fork which is in unison with it, so the electric oscillations produce etherial vibrations in the Branly receiver when it is electrically in tune with the length of the waves sent out by the transmitter. That this may be the case, the glass tube of nickel filings, with about four per cent. of silver filings, has connected to either end metal plates, both of which are of suitable length so as to cause the receiving instrument to resonate electrically in unison with the electric oscillations transmitted to it.

In sending a message, the key of the transmitter is alternately pressed down and released, as in ordinary telegraphing, causing sparks to pass between the brass balls, exciting electric waves which move in all directions through space with the speed of light. Some of these waves fall upon the suspended metal plates attached to the receiving instrument, and are transmitted to the tube of metal filings transforming it from a non-conductor to a conductor, and then pass on to the receiver or sounder which converts the electric waves into sounds or dots and dashes to be interpreted by the operator.

As each electric wave passes through the metal filing in the tube, a tiny hammer automatically taps the glass tube, the jar of which breaks the current and makes the filings a non-conductor again, only to be converted into a conductor once more, so soon as the next electric wave shall fall

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upon it. This process is repeated, by a succession of electric waves, which are read as dots and dashes, until the entire message has been received without the necessity of intervening wires.

The relation which exists between the transmitter and receiver is a perfect analogy to the relation which must exist between God and the human spirit in order to spiritual communion.

As the receiver must be electrically in tune with the transmitter before it can respond to the electric waves, so the heart must be brought spiritually into tune with God before it can recognize or receive messages from Him.

This is in accordance with the plain teachings of the New Testament. "The natural man receiveth not the things of the Spirit of God, for they are foolishness unto him; neither can he know them, because they are spiritually discerned; but he that is spiritual discerneth all things."

Blessed are those whose ears hear and recognize the voice of the heavenly Father because they are gladly willing to be brought into tune with Him.

Sin means discord. And however small the sin may be, it is sufficient to throw the sinner's heart out of harmony with God, so that he cannot hear God, and is out of sympathy with Him.

There is perfect harmony in the Infinite One, and He would produce the same harmony in us, by bringing us into spiritual unison with Himself.

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This He would accomplish by the removal of all discord, or sin, from our lives; and by His own indwelling He would charm us into perfect acquiescence with Him in all things.

To every willing heart His word pledges the perfect accomplishment of this in the world to come; and the beautiful earnest of this heavenly harmony He wishes us to realize even here, where we are so prone, through the weaknesses of the body, and our manifold temptations, to be thrown out of harmony with Him. "Tune my heart to sing Thy praise."

How strange and unnatural it seems to stand by a Marconi wireless receiver, and see it draw messages out of space; and then by means of the transmitter to send messages for many miles, and receive a reply at once, though you know that there are houses and hills and forests and a broad expanse of water intervening between you and the one with whom you are in communication. Such a thing would be most incredulous to one unacquainted with the discovery, or to one not previously prepared by his faith in the possibilities of science to accomplish mysterious and almost unthinkable results.

This is like the incredulity of those who have not a spiritually enlightened eye to see God, and a quickened ear to hear Him. That Jesus was in communion with one whom He called the Father, and from that unseen source He actually drew energy to meet the needs of life, was beyond the

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comprehension of the people who thronged Him. He seemed to be a man like themselves. How then could He draw on hidden powers more than they? To them there was but one known way of access to God, and that by the temple sacrifice, the visible and tangible spiritual wire connecting earth with heaven. But here was one who persisted in claiming that He was in communion with God without any such intervening agencies.

It was no less an astonishing thing that a woman could so touch the hem of Christ's garment, that her diseased and crippled body should be made to thrill with life and health, because of the virtue received from Him. By her faith she was brought spiritually into tune with Christ, so that His energy became hers, supplying all her need.

Such is the law of spiritual life in every age. There were many widows in the days of Elijah, but to only one did the unfailing supply of need come, because she was the only one whose faith brought her so into harmony with God that His abundance could find response in her need.

Being thus in tune with Him, she was doubtless, as much a mystery to her neighbours, as she afterward became to the dwellers of Nazareth, when her response to God and its reward were mentioned to them by Christ.

The one who is in tune with God is a mystery to every one, especially to those who are not ac-

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quainted with the law of spiritual resonance. "He that is spiritual discerns all things, yet he is discerned by no one."

Your spiritual nature is like no other in the universe, and no one but God understands it, and can fit into its needs. Upon this point, the words of Dr. Hugh Macmillan are so *apropos* that I give them. "The reason why God has made you a person separate from all others, different in your nature, your wants, your feelings, is that He may deal with you in a different way from all others. If you long to be yourself and no other, then He longs to be to you the complement and completion of your being. If you abide in Him, He abides in you; if you sup with Him, He sups with you. It is not a one-sided experience, it is full of that mutualness which gives so much warmth and richness to all life. You need Him, and He needs you. He fits into your being as no other can, and you fit into His being as no other can. You have often seen one of the common shells on the sea-shore with ribs radiating out like a fan from the bottom to the edge. It is called a clam or scallop shell, and used to be often worn in the hats of pilgrims when they returned from the Holy Land. It is a bivalve, that is, it consists of two valves or halves united together. And you notice at the edges of these two halves a zigzag line formed by the ribs and hollows of the shell, made so as to fit into each other; the ribs of one locking into the hollows of the other, and

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the hollows of the one locking into the ribs of the other. Each pair of valves is made for the one shell-fish; the two halves correspond exactly. But if you were to try to make the half of one shell fit into the half of another and different shell, you would fail. Only the valves of the same shell that have grown together can correspond. And though you were to examine thousands and thousands of shells, if you lost one valve of your shell you would not find among them all another to match it exactly. There would be some difference which would prevent them closing together and forming a united whole. Now so it is with God and yourself. You and He make one. He made you for Himself, and only in Himself can you find completeness and satisfaction. Every one else is strange to you, even your nearest and dearest. Only God can fit into all the wants and peculiarities of your being; and therefore each soul has a different knowledge and experience of God from every one else.

"God finds you out at first, in very much the same way as the faithful Blondel, in the touching old story, found out his master. Richard Cœur de Lion of England was taken prisoner by the Duke of Austria, when passing through his dominions on his way home from the Crusades. For many months the king pined in his dungeon, and no one knew where his prison was. His confidential servant wandered in search of him

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all over Palestine and Germany in vain. When about to give up the search in despair, he heard one day that there was a prisoner of rank in Lowenstein Castle. He hastened thither, and placing himself under a grated window began to sing one of the French songs which he and his master used often to sing together. Scarcely had he finished the first stanza when a voice from the window of the dungeon responded, and continued the song in a low and plaintive tone. Thus he discovered the king, to his great joy, and had the satisfaction of getting him restored to his country and throne. Now that is the way in which God discovers those who are prisoners of Satan, and shut up in his dungeon. His song of salvation finds an echo in their hearts. The Lord's song is of the same air and dialect as the longing that is within their own bosom; and so they respond to each other, strain for strain. The heart's gates fly open at the magic sound, and the Lord becomes their song and their salvation. It is a striking thought in connection with this illustration, that the word in the original for the *feeling* of the heathen after God if haply they may find Him, means literally groping among the strings of a musical instrument till the right note is found and struck. Every soul feels after God in this way until the lost chord is found, and the right note sounded, and the harmony between the soul and God, for which it was made, is re-

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stored. And the key-note thus found, the whole life becomes musical." *

This secret and mysterious harmony between the heart and God finds a further parallel in wireless telegraphy. At first the possibility of one or more stations reading a message intended for another was keenly recognized by Mr. Marconi. "He has been endeavouring for a long time past to successfully synchronize his messages—that is, to construct a transmitter, the message sent from which can only be received by the apparatus which had been tuned to receive it. He has successfully solved the problem by means of variable conductors and capacities, by the use of which certain instruments can only receive certain messages. By his latest system, he can dispatch from a certain point any number of messages, and each message will be received only by that receiver which has been synchronized to the transmitter, so that jamming of words and confusion of messages upon various receivers is obviated." †

Professor John A. Fleming of the University College, London, forcibly says: "When it is realized that these visible dots and dashes are the result of a train of intermingled electric waves rushing with the speed of light across an intervening space of thirty miles, caught on one and

* "The Daisies of Nazareth," p. 131.
† "Scientific American," Sept. 8, 1900.

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the same aerial wire and disentangled and sorted out automatically by the two machines into intelligible messages in different languages—English and French,—the wonder of it all cannot but strike the mind. The importance of this practical solution of the problem of independent electric wave telegraphy, in which each wireless circuit is as private as one with a wire, is obvious without comment." *

A very important consideration in electric wave telegraphy is the glass tube of metal filings, termed the Branly coherer. Its sensitiveness to electric influence increases pro rata as the proportion of silver is increased in the filings, and also as the powder space in the tube is diminished and the filings are compressed. If the detector be made too sensitive, it responds to atmospheric and other stray currents about it. It must be so adjusted that it will distinguish the waves intended alone for it, and will respond to no others.

The nature which is in tune with God, does not respond to every spiritual influence. He has an instinctive discernment of spirits, and the more sensitive he is to the impressions of the Holy Spirit, the less likely he is to be deceived by the stray forces about him. "Blessed is the people that know the joyful sound." Children know the voice of their father. "They know not the voice of strangers."

"No state of the atmosphere, and neither

* "The London Times," Sept. 28, 1900.

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darkness nor storm, interrupts, so far as yet found, the freedom of communication in wireless telegraphy."

The communion which the believer may hold with Christ through the Holy Spirit, is not subject to caprice. It is not dependent upon circumstances. Clouds and storms do not break it. It is superior to poverty or riches, success or failure, sickness or health, wisdom or ignorance, life or death.

As the electric waves sent out by the transmitter are exactly reproduced in the receiver, dots and dashes at the key coming out dots and dashes at the Morse sounder, so God designs that the beauties of the life of Christ shall be reproduced in the lives of His people on earth. The same Spirit who dwelt in Him without measure, and even now lives in Him, dwells in them, moving them to deeds of love, and moulding them into a character like His own, so that one day they shall be like Him, and so be able to see Him as He is.

It behoves us to pay good heed to the influence to which we subject ourselves, since we reproduce the same in our own natures. "I once heard a most interesting conversation between two gentlemen, one of whom was a Russian violinist. A young Italian had been entertaining a company by playing upon a violin. The Russian asked to see the instrument, and said to the gentleman sitting near him, 'This is a very old violin, probably

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a hundred years old.' The other replied: 'I suppose it must be very valuable then, for we are told, the longer a violin is played upon the better it becomes.' 'Ah, my friend,' continued the Russian, 'that all depends what kind of music has been played upon it. The tone of this violin indicates to my mind that it has deteriorated in value in consequence of its having been compelled to discourse music of an inferior quality.' What a revelation is nature! The molecules that compose the wood of a violin can be marshalled into harmony by the music played upon it. If in the mind of the violinist there are melody and harmony of a high order, it finds its way through the fingers into the bow that touches the strings, and all the molecules of the resounding wood waltz into harmonious forms. What a spectacle for the eye of reason to see all these molecules begin to form into line and step out to the chord of sweet sounds born of the mind of the musician!" *

If this be true of wood, what of the sensitive soul of man! Shall we suffer the discordant notes of selfishness, anger, revenge, or other sins to play upon our hearts, when we may be transformed receivers resonant with the music of Heaven?

Great improvements will be made in the methods of transmitting messages by the Hertzian waves. Even at the present time several in-

* Dr. Emerson in "Psycho Vox."

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ventors are competing with the Marconi system. The Branley coherer may be discarded for some more sensitive receiver, as Professor Fessenden is doing; earth-currents may be utilized in place of those propagated through the air, but it will forever remain a necessity for the receiver, or "wave detector," whatever it may be called, to be electrically attuned to the length of the waves sent out by the transmitter.

"No doubt the day will come, maybe when you and I are forgotten, when copper wires, gutta-percha coverings, and iron sheathings will be relegated to the Museum of Antiquities. Then, when a person wants to telegraph to a friend, he will call in an electro-magnetic voice, which will be heard loud by him who has the electro-magnetic ear, but will be silent to every one else. He will call, 'Where are you?' and the reply will come, 'I am at the bottom of the coal mine,' or 'Crossing the Andes,' or 'In the middle of the Pacific,' or perhaps no reply will come at all, and he may then conclude that his friend is dead." *

To the one who now hears the voice of Christ, the time will come, it may be but an hour hence, when he shall be perfectly attuned to the Divine nature. Then, whether he be on a mission of love on the earth, or on some distant world lying beyond the ken of the most powerful telescope, or out of reach of the loftiest stretch of human con-

* Professor Aryton.

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ception, he will still be near to Christ, and can hold ready converse with Him, and with the other dear ones, who like himself are resonant with the life of God.

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INSULATION

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"These are in the world, and I come to thee. . . . They are not of the world even as I am not of the world."—John 17: 11 and 16.

"He that is begotten of God keepeth him, and the evil one toucheth him not."—1 John 5: 18.

"And to keep himself unspotted from the world."—James 1: 27.

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VII

INSULATION

THE mysterious something which we call electricity, is exceedingly partial in its choice of media through which it manifests itself. It can traverse some objects with ease, and hence when they become electrified in one part the electrification instantly spreads over their whole surface. This is true of all metals, water and animal bodies. They are, therefore, called conductors.

If we take a glass tube, and fit a cork into its end, and then suspend a bullet, or bit of other metal from it by a yard of dampened linen thread, we will find that when the tube is rubbed with a piece of dry silk, the bullet acquires the property of attracting light bodies, such as cotton or tissue paper. The electricity generated by the friction of the silk on the glass passed down the thread to bullet.

Stephen Gray, who, in 1729, discovered the electrical conduction of certain bodies, succeeded in transmitting a charge of electricity through a hempen thread over 700 feet long. And later, Du

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Fay succeeded in sending it through moistened thread more than 1,250 feet, thus proving the conducting power of moisture.

But if in our experiment, we substitute a dry silk thread for the dampened linen one, no electricity will flow down it to the bullet. This is because the silk is a poor conductor of electricity. In fact it offers many millions times greater resistance to the flow of electricity than the moist cotton thread.

Those bodies which offer great resistance to the passage of electricity are called non-conductors, insulators or isolators. Some of the best insulating substances are dry air, ebonite, shellac, resins, glass, oils and furs.

That water may be retained in a reservoir its walls must be of sufficient strength. In order that a body may become charged and retain its charge, it must be surrounded by something which will offer sufficient resistance to the escape of the electricity. The capacity of a reservoir for holding water is only limited by the height and strength of its walls. There is no limit to the quantity of electricity with which a specific body can be charged, provided the charge can be retained.

The entity which represents the walls of the reservoir is termed a dielectric, from the Greek διά across, which is an insulator across which electric action takes places. The walls of a reservoir containing water are subject to strain. Simi-

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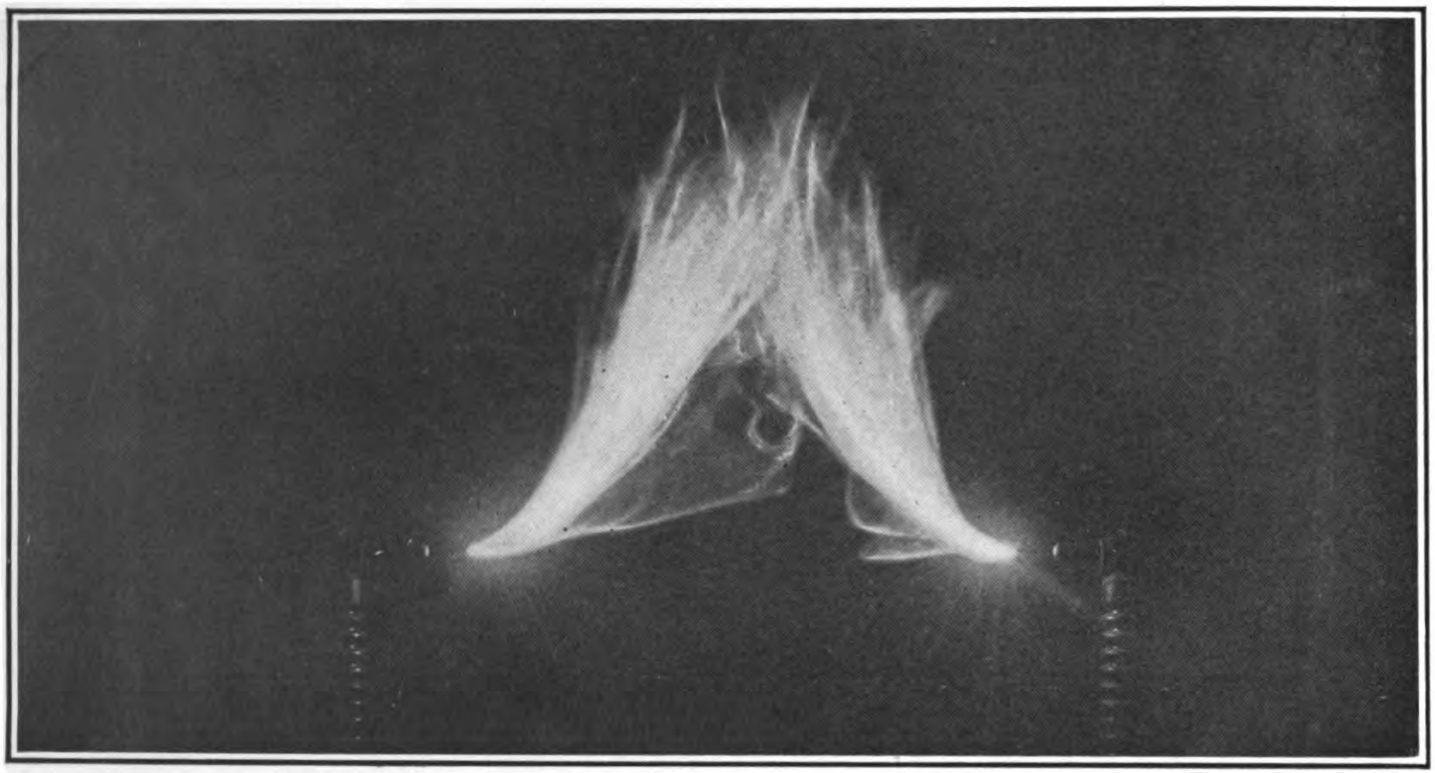

The 120,000-volt Arc Just Before Rupturing. *R. D. Lillibridge.*
(See pages 112 and 113.)

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larly a dielectric is brought under stress by an electric current. As the walls of a reservoir may be broken down by the pressure of the water upon them, so the stress upon a dielectric may become so great that it gives way, and then a discharge is said to occur. This is often the case in electric storms. When a cloud becomes so heavily charged that it subjects the dielectric, or surrounding air, to a greater stress than it can sustain, it becomes ruptured, and there is an electric discharge to a neighbouring cloud, or to the earth.

A conductor which is thus surrounded by a non-conductor, or dielectric, is said to be insulated.

Were the air a conductor of electricity, no body could be charged in it; for the electricity would be dissipated as rapidly as generated, without affording any indication of its presence. There could be no such thing as thunder storms.

Were it not for insulation, man would probably never have known of the existence of electricity. Notwithstanding all our present knowledge of and attainments in electricity, were the ability given to any person to do away with the possibility of insulating a conductor, he could with a single blow, as completely annihilate every electrical invention, as the waves of the sea obliterate the writing in the sand on the shore.

The telegraph would cease to click its message over the land and under the seas. The familiar

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call of the telephone would die into silence and be forgotten. The paraphernalia of the electric railroad, with tens of thousands of other useful and ingenious inventions would soon be relegated to the museum of antiquities.

For thousands of years there lay before man all the possibilities of insulating an electric current, and so of confining it within certain bounds, and of directing its energy into a definite channel, and yet the thing never dawned upon his mind until the time of Stephen Gray. And since his day the development of electrical science has been proportionate to the progress made in the knowledge of insulation.

In all the advance made in the arts and sciences by the nations of antiquity, we have no evidence that any one of them ever discovered that a wire could be so covered that it would be insulated, and so retain and transmit a current; and without this knowledge of insulation no progress in electricity is possible. An induction coil could not be constructed, and so there could be no dynamo or electric motor. In short, there could be no transmission of electrical energy in any form.

Insulation is as much a matter of necessity in things spiritual as in things electrical. This does not mean, however, the insulation which is found in isolation, so much as that which is the product of life. It is not secured by separating

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one's self from his fellows, whether in the cell of the monastery, or in the religious retreat.

It is rather the possession of life which shields one from his hostile environment, and enables him to triumph over it, as the lily lies upon the surface of the stagnant pond, surrounded by impurities and all manner of unsavoury odours, and yet retains its purity and exhales its sweetness, because of the life which throbs within its bosom.

As we go on we shall see that as the life within the Christian predominates, it not only insulates him from the world, antisepticizing him from contaminating contact with the sin by which he may be surrounded, allaying the heats generated by the friction of his secular employments, and keeping untarnished the lustre of his devotion in the midst of corroding cares, but that it renders him a channel of divine energy to others.

Suspend a wooden rod, or ruler, by a silk thread. Rub a rubber comb with a woolen cloth, or draw it a few times through the hair, if dry, and hold it near the end of the ruler; the ruler will turn toward the comb. Let the ruler touch the comb. It now has received an electrical charge, which does not escape because it is insulated by the silk thread, which is a non-conductor. Rub the comb again with the woolen cloth and present it to the rod. It now moves away from the comb. It repels the comb, and the comb

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repels it. Hold the comb over bits of tissue paper; the papers quickly jump to the comb, stick to it for an instant, and then leap energetically from it. The papers are first attracted to the comb, but when they acquire some of its electrification, they are repelled. If you pull the papers off from the comb, they will cling to your hand.

Suspend a cork, or ball of elder pith, by a silk thread. Electrify a glass rod with a dry silk handkerchief, and present it to the ball. At first, attraction occurs, followed soon after contact by repulsion. Insulate a dozen or two long strips of tissue paper by suspending them from a glass rod, or by a silk thread. With a piece of silk, rub a stick of sealing-wax, or a glass rod. If it be presented toward them, the papers will fly out toward it. So soon as they are electrified by contact with it, they are not only repelled from it, but from one another also. If these insulated strips of paper are attached to a frictional electric machine, as they become electrified, they spread out like an opened umbrella frame. Present your hand to them, and they leap toward it.

We have seen that a suspended cork after being electrified by contact with a rubber comb, is repelled. But if now we bring near to it, an electrified glass rod, it will be attracted toward the rod.

We may lay it down as a principle then, that when an insulated object becomes charged with electric energy, it has imparted to it the virtues of

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attraction and repulsion. Some objects it attracts, and is attracted by them, while others it repels and is repelled by them.

This is a well known law of life. Plants are attracted by certain soils which are congenial to them. Some seek the darkness, or shade of the forest, while others climb up to the sunlight.

Some localities are attractive to certain animals, while they are inimical to others. And the food eagerly sought by some is regarded as most atrocious by others. The life within these plants and animals makes the difference.

The like holds true with reference to man. When he becomes possessed of the life of God, he manifests the virtues of attraction and repulsion. The initial process by which he becomes a recipient of the Spirit of life in Christ Jesus is beautifully illustrated by the simple electric experiments which have been considered above.

We saw that the ruler turned toward the electrified comb. That was due to the fact that there was a deficiency of electrical energy in the ruler compared with what was in the comb; and it is a law of electricity that it tends to equalize itself between bodies brought near to one another. The electrical energy flowed from the comb to the ruler until they were both of the same potential.

This is precisely similar to the relation between the human spirit and the Spirit of God. When they are brought into contact, the plenum of God tends to flow down into the vacuum of man, and

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continues so to do, until there is no more emptiness. They become mutually attractive, and this attraction continues until man has a sense of his own fulness, and then there is repulsion.

To a person who feels that he has all the spiritual life he needs, there is nothing more repulsive than God; and doubtless there is nothing more repellent to the Spirit of God than a soul that is already full; that feels that he has no further need of the quickening and sanctifying energy of God.

Two insulated objects equally charged with electricity repel each other. At first this might not seem to afford any parallel to spiritual things; for it is well known that nothing is more beautiful than the mutual attraction between Christians; than the fellowship of those possessing the one life of God. They do not repel one another. Yet this attraction is doubtless due to the fact that the potential of their lives is so different at different points. They are mutual givers. Divine energy is ever flowing from the one to the other and vice versa.

That in which the one is more abundant, he imparts; while that in which the other excels he likewise bestows. Whatever difference there may be in the potential of lives, there is no doubt that where Christians have true communion, there is a mutual impartation. Paul recognizes this in his letter to the Romans. "I long to see you . . . that I with you may be

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comforted in you, each of us by the other's faith, both yours and mine." Romans 1:11-12. Conductors are able to transmit electrical energy in any definite direction only as they are insulated.

Probably the greatest plant known for the distribution of power is the one at Niagara Falls. Besides being the source of power for a considerable number of important chemical industries, and furnishing the energy to a prosperous and rapidly growing manufacturing community, it lights Buffalo, a city of nearly five hundred thousand inhabitants, and supplies the power for the entire street railway service of that city. It also lights Tonawanda, Lockport and Niagara Falls, and operates the electric railway system in those cities and towns.

At the present writing, the transmission of energy to the above places is equivalent to what would result from the consumption of over eight hundred tons of coal per day, or two hundred thousand a year. And yet this is only a fraction of the power residing in that mighty cataract, waiting to be harnessed, that it may become the willing servant of man.

But all the results which have been accomplished thus far, as well as those anticipated, are dependent entirely upon insulation. And so, in the construction of the works of the Niagara Power Company, Lewis B. Stillwill, the electrical director, states that the most painstaking

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care was used to insure as perfect insulation as possible.

The porcelain insulators upon the poles, which were to carry the insulated wires, were every one subjected to a puncture test of sixty thousand volts of alternating current before it was put into place. And so carefully were these insulators made that, "under this very high potential, only about three per cent of those furnished by the manufacturers proved to be defective. And of the last lot of over four hundred, not one failed under the test.*

Similar care was used in the construction of every part of the apparatus designed to transmit the electrical energy, and even then some of it proved faulty. For example, the coils of wire in the first three alternators were covered with cotton insulation. "But after the machines had been operated for a time, it was found that the exciting current was increasing from week to week and from month to month. Investigation showed that it was caused by the excessive heat in the middle of the coils, which was gradually charring the cotton insulation, and causing a part of the current to leak across from one layer to another, instead of following the conductor.

"The ability to reach more remote markets for power,—as, for example, the cities of New York and Chicago,—will depend upon the practicabil-

* "The Electric Transmission of Power From Niagara Falls," L. B. Stillwill.

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ity of properly insulating the conductors for the transmission of currents. Recent progress in this direction has been such as already makes our available radius of transmission greatly exceed the distance between the power station and the city of Buffalo, and it is desirable that the system selected should be such as will lend itself to future transmission over very great distances."*

All the millions of horse power of energy of Niagara Falls is at the disposal of man, and waiting to be transmitted to any distance, so soon as he shall sufficiently perfect the insulation of the conductors.

We have seen that God desires to impart His saving and sanctifying energy to the world, but He has chosen to do it through those who are already the recipients of His life. To them is granted the inestimable privilege of being the conductors of the unspeakable blessings of God.

But ere such can be the channels of His life and love, they must be insulated from the generation in which they live. While in intimate contact with an unbelieving age, they must be separate from it. There must be something about them that will isolate them from their environment, and from the spirit of their contemporaries.

This finds a further illustration in the old and oft-repeated experiments with static electrical machines. If one stands on a stool with glass

* "Electric Transmission," L. B. Stillwill.

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legs, and holds a chain or rod connected with one of the poles of a frictional machine, which is being turned, he soon becomes so charged with electricity that his hairs stand on end, or spread out; and if you present the knuckle to him anywhere, a spark will leap into it from his person. But no one can draw a spark from you, unless you too are insulated. And so soon as he steps from the insulated stool to the floor, he ceases to be charged with electric energy, except in the feeblest manner, although he may be still receiving the current from the machine. The reason for this is apparent. The energy leaks away to the earth as rapidly as it is received by him.

Is not this a most impressive picture of many? They are sincere Christians, and pray to be used of God, and yet are devoid of power. They are gifted, even brilliant, but souls are not saved from sin by their lives. If they would look into the matter, they would doubtless discover that somewhere there is a secret break in the insulation, and until that fault is remedied, the power of the Spirit upon them is all to no purpose; for it is lost as fast as it is imparted. Or, it may be, they have so stepped down into the spirit of worldliness about them that all the divine energy is dissipated, instead of being transmitted to the accomplishment of the will of God in the lives of others.

The results of the best electrical friction machines are nullified almost entirely by the pres-

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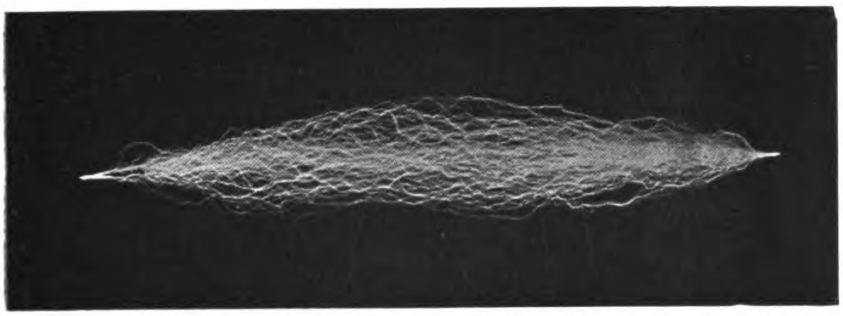
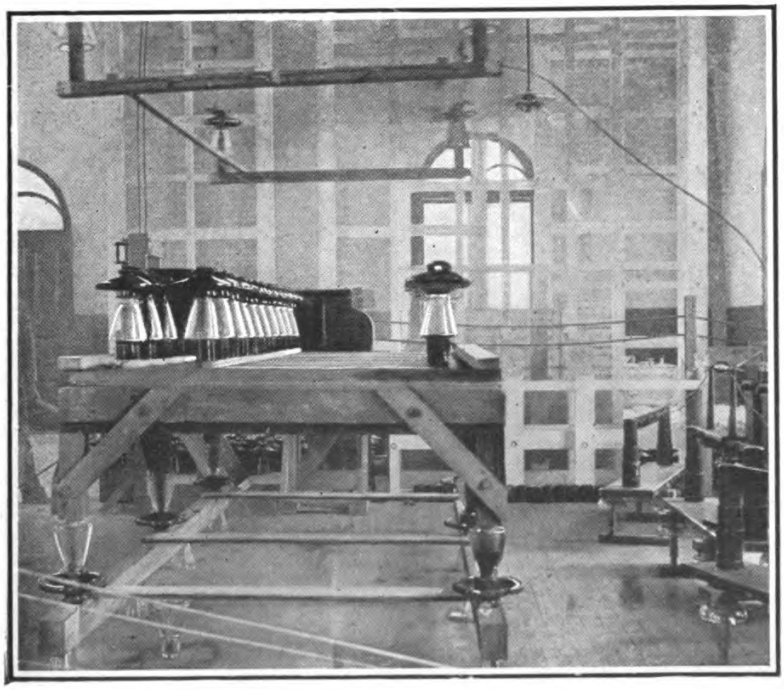


A 120,000-volt Arc between the Needle Points of a Spark Gap in the Testing Room at Electra. *R. D. Lillibridge.*
(See page 125.)



High Potential Testing Outfit at Electra. Every insulator must withstand a strain of 120,000 volts. *R. D. Lillibridge.*
(See page 121.)

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ence of a damp atmosphere. The Wimshurst electrical machine is regarded as one of the best, because it is less likely than any other to be affected by atmospheric conditions. And yet this machine, which is giving a spark several inches long in a dry atmosphere, if removed to a room where a large number of people have been breathing for a time, becomes very disappointing in its results. The moisture imparted to the air by the breath has rendered it a good conductor, and the electricity is dispersed into the air as rapidly as it is generated by the friction of the brushes upon the sectors of the machine.

And hence it is that such static machines, when intended for medical practitioners, or other constant and reliable use, are enclosed in a moisture-proof case.

This finds a forcible parallel in the life of every Christian. There is an atmosphere which is so detrimental to one's spiritual life, that he is enfeebled by every contact with it.

So true is this, that even of Christ it is said that in the presence of some, He was unable to do many mighty works. Their unbelief presented an atmosphere so hostile, that somehow, it rendered the divine energy nugatory.

It is because of the debilitating effects of an adverse atmosphere, that God gave the Hebrew nation the strictest injunctions that they must not upon any account intermarry, or form other alliances with the idolatrous peoples about them,

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but to continually maintain the strictest sort of religious quarantine regulations in all their dealings with them. And where this was forgotten, or ignored, it never failed to result disastrously to those who were guilty of the breach.

Solomon, and his royal successors, are emphatic examples of the deleterious effects of a virulent religious atmosphere. Abraham in Egypt, and Lot in Sodom, and in fact the whole Hebrew race afford an impressive illustration of the dangers of an infectious moral environment.

The New Testament is no less explicit in its warnings regarding the contaminating contact with evil associations. "Be not unequally yoked with unbelievers: for what fellowship hath righteousness and iniquity? or what communion hath light with darkness? And what concord hath Christ with Belial? or what portion hath a believer with an unbeliever? . . . Wherefore, come ye out from among them, and be ye separate, saith the Lord." 2 Cor. 14, 15, 17.

Perhaps this is the lesson contained in the old Greek story in which the touch of Circe's wand transforms the twenty-two men of Ulysses into swine. There was some seductive influence which her presence exerted upon them, and a transforming effect in the food which she gave them, that brought their lower animal nature so into the ascendency, that when she touched them with her wand, their human life receded into the

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background, and the swine-nature came to the front.

A poisonous religious amosphere not only enervates the soul by frittering away its energy, but imparts to it hideous deformities.

In his experiments with alternate currents of high potential and extreme frequency, Mr. Tesla states that the smallest break in the insulation of the induction coil, not only impairs it, but is fatal to its usefulness.*

The electrical energy instead of gradually leaking away, as weaker currents sometimes do, seems to break through the opening, much as water under great pressure above a dam will quickly force egress for the whole body, causing a flood, so soon as the first tiny opening is made for its escape.

"Just as sure as a weight will fall if let go, so the insulation will give way if a single gaseous bubble of some size be present, whereas, if all gaseous matter were carefully excluded, the condenser would safely withstand a much higher difference of potential. A main conveying alternate currents of very high tension may be injured merely by a blow hole or small crack in the insulation." *

Perhaps this may serve to explain the sudden collapse of some useful Christian lives. The higher the spiritual potential the more serious

*"Experiments with Alternate Currents," Tesla.

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the break. Instead of becoming careless to little imperfections, the one most filled with the Spirit of God, needs to use the greatest caution, and to cultivate the most delicate sensibility to sins; for breaks are more fatal in his life than in others.

In alternate currents of high voltage and of extreme rapidity, Mr. Tesla says that pure oil is one of the very best insulators.

The smallest breaks are so serious in their consequences, "and as it appears almost impossible to completely obviate such little imperfections, I am led to believe that in our future distributions of electrical energy by currents of very high tension, liquid insulation will be used. . . . If we employ an oil as an insulator, the distribution of electrical energy with something like a hundred thousand volts, and even more, becomes, at least with high frequencies, so easy that it could hardly be called an engineering feat. With oil insulation, and alternate current motors, transmissions of power can be effected with safety, and upon an industrial basis, at distances of as much as a thousand miles."

"Once the coil has been immersed, it should never be taken out of the oil for more than a few hours, else the gutta-percha will crack, and the coil will not be worth half as much as it was before." *

It is a well known fact that in the Scriptures,

* "Alternate Currents," p. 36.

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oil is symbolic of the Holy Spirit. He is the most perfect spiritual insulation for the soul. We are upon earth, for the most part in an environment which is hostile to our spiritual life. We cannot withdraw from the world and its temptations. There are numerous breaks, small and great, which are sure to appear in our lives and impair their usefulness, if not result in their destruction. Since with the utmost care " we cannot wholly obviate these little imperfections," we are most fortunate that it is our privilege to take refuge in the Holy Spirit, as truly as the induction coil can be immersed in the oil. And not only so, we may abide in Him, and there and only there are we safe; for only when we are thus abiding is it possible for us to be in close contact with the world and yet insulated from it.

This is the method by which we may be in the world and yet not of it. There may be such a consciousness of His enclothing presence, that fears cease to annoy and sins to blight the soul. And as the unseen window-pane protects the butterfly from the murderous pecking of the sparrow, so the invisible One presents an insuperable barrier between the weakest soul and its most mighty foes. The secret of its safety, however, is in abiding in Him.

It is possible for a charge of electricity itself to be the cause of the best kind of insulation. A charged Leyden jar affords such an example. This is a glass jar coated three-fourths of the

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way to the top inside and out with tinfoil. For convenience in charging and discharging, a wooden cap is fitted to it, through which passes a brass rod, terminating in a ball at the top, and to its lower end a light chain is attached which comes in contact with the inside coating. It is simply two good conductors with a good insulator, the glass, between them.

If the inside coating receives a charge, say of positive electricity, by being brought into contact with an electric machine, there will be induced upon the outer coating an equal charge of negative electricity. And although the jar may be in contact with the earth, or with any other good conductor, the charge on the exterior of the jar can in no wise be induced to leave the outer coating, so long as the charge within remains constant. The outer charge will always be in exact proportion to the inner one. The charge within may be said to induce an atmosphere of electrical energy equal to itself on the outside of the jar, and not only so, were there no exterior coating, it would create such an atmosphere in the earth, or in any other conductor it might touch.

The similarity of this to the spiritual life is apparent. One's life is best insulated from injurious contact with sin, by keeping his inner spiritual condition at high potential. Once men thought that this could be done best, by withdrawing from the world, and leading the life of a recluse, isolated from the deleterious en-

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vironment behind the barricaded doors of a religious retreat.

Lime cylinders are often used in the oxy-hydrogen light. When heated to a white heat, lime produces a brilliant light. But lime has a strong affinity for water, and so the only way these cylinders can be kept from disintegration through slaking, is to preserve them in air tight jars, or by hermetically sealing them in glass tubes. There they are safe from the attack of the moisture.

This may be a good way to preserve lime, but it is not the method by which God safeguards His children. He does not shut them away from temptation, but fortifies them against it from within.

Certain trees are subject to the ravages of worms, which in some cases entirely destroy their life, while other trees are wholly free from these pests. The difference is in the nature of the trees. One might preserve his apple trees by covering them with a gauze wire netting. This would be expensive. He might exercise vigilance in keeping the worms destroyed from the trees. But if he could change their nature to that of those not troubled by these pests, the problem would be solved.

This is what God does for men. We know that life is its own best spiritual insulator, as living tissue is antiseptic to the destroying germs which would attack it.

The sins which have such an affinity for us,

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and cling to us despite all our struggles, drop off, as worms from a tree, when God comes within to replace the old Adam nature.

The secret of the kept life thereafter, will be in maintaining a high spiritual tension within,—being filled with the Holy Spirit; for the outer invisible atmosphere, which insulates from the disappointments, cares and sins of life, will be in direct proportion to the divine potential within.

When the inner coating of a charged Leyden jar is brought into contact with a conductor, there is a discharge of its energy, and at the same instant the charge which was held as an atmosphere upon the outside of the jar is dissipated to the earth. And the only way this can be restored, is by recharging the interior of the jar.

We are leaky vessels. There are numerous imperfections in the insulation of our lives, and beside, our very contact with the world tends ever to disperse the energy within us, and to leave us impotent before the attacks of our numerous foes. Hence, we need frequent re-charging with divine energy, a perpetual infilling of the Holy Spirit, that we may be kept unspotted from the world.

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ELECTRICITY AND LIFE

UNOBSERVED ENERGY

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" Conception springs from Light; 'tis the same power
Creates, preserves, destroys; the matter which
It works on, being one ever-changing form;—
The living, and the dying and the dead."—*Bailey.*

" Life is a pure flame, and we live by the invisible sun within us.—*Sir Thomas Browne.*

" Thou Sun, of this great world both eye and soul."
—*Milton.*

" Sunshine, broken in the rill,
Though turn'd astray, is sunshine still."—*Moore.*

" Whatever amount of power an organism expends in any shape is the correlate and equivalent of a power that was taken into it from without."—*Herbert Spencer.*

" That they should seek God, if haply they might feel after him, and find him, though he is not far from each one of us; for in him we live, and move, and have our being; as certain even of your own poets have said, For we are also his offspring."—Acts 17: 27-28.

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VIII

ELECTRICITY AND LIFE

UNOBSERVED ENERGY

THAT was a hapless day for poor Dryope when, with her infant in arms, and her sister Iole, she wandered along the water's edge in search of flowers for the forming of garlands for the altars of the nymphs. She gathered some and gave them to her babe. Iole was about to do the same, when she perceived that blood was dripping from the stems which her sister had broken off. The plant was none other than the Nymph Lotis who had been changed into this form while fleeing from her base pursuer.

Dryope, horror-struck, would have fled from the spot when she saw what she had done, but it was too late. Her feet were rooted to the ground, and she was fast being converted into a lotus-tree. The woodiness crept upward, and by degrees invested her whole body.

Iole bewailed the fate of her sister, and in vain embraced the growing trunk, as if she would stay the advancing wood. At this junc-

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ture, Andræmon, the husband of Dryope, with her father, arrived, and when they asked for her, Iole pointed to the newly formed lotus.

Of sad Dryope there was now visible only the face, down which the tears flowed, and fell upon her leaves as she uttered her touching farewell message: "I am not guilty. I deserve not this fate. Take my child and give it a nurse. When he is old enough, teach him to call me mother and say, 'My mother is hidden under this bark.' But warn him to be careful of river-banks, and to beware how he plucks flowers, remembering that every bush he sees may be a goddess in disguise. Farewell, dear husband and father and sister."

"She ceased at once to speak, and ceased to be,
And all the nymph was lost within the tree;
Yet latent life through her new branches reign'd,
And long the plant a human heart retained."

Numerous are the tales which Greek and Roman parents related to their children concerning the transformation of men and goddesses into plants and animals, and even into rocks and streams.

And so touching were these accounts, and so vividly were they painted, that they clung with unyielding tenacity to the minds in which they lodged, even after reason had dethroned superstition.

So Daphne, pursued by Apollo, was metamorphosed into a laurel-tree; and the blood of Pyr-

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amus, the graceful youth, and Thisbe, the beautiful maiden, gave colour to the berries of the mulberry-tree; while the dog Lelaps and the fox, in the very attitude of life, were turned into stone, that neither should conquer. Jupiter, fearing a curtain-lecture from Juno, changed Io into a heifer; and Syrinx escaped Pan by becoming a tuft of reeds sighing their plaintive melody in the breezes.

Juno placed the hundred eyes of Argus, as ornaments, on the tail of her peacock, and transformed Callisto into a bear. By the power of Diana, Actæon became a stag, and was chased and torn to pieces by his own dogs. At the angry command of Latona, the Rustics assumed the form of frogs in the pool of water which they had denied her. The Heliades and Baucis and Philemon, were transformed into trees, Arethusa into a fountain, Glaucus into a fish, Scylla into a rock, and Hyacinthus into flowers.

Is it any wonder, then, that in that pristine period, nature should have been regarded as the embodiment of divine and human life to such an extent, that Dryope is thought to have closed her tender good-bye with the injunction, "Remembering that every bush he sees may be a goddess in disguise?"

And yet the most fanciful idealism of those times does not surpass the poetic beauty veiled in the scientific verities of these matter-of-fact days. The doctrine of the conservation of energy

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is the hand which draws aside the curtain, and discloses the hidden glories.

The energy of the sun is radiated through the ether of space by means of vibrations far into the hundreds of trillions per second, reminding one of the fiery steeds of Apollo dashing through the sky. When this comes into contact with the gross matter of the air and earth, it is transformed into light, heat and electricity.

And clad in these habiliments it quickens and modifies every living thing, and finally, Dryope-like, becomes itself metamorphosed into vegetable and animal forms. And thus it is that the furious chargers of the sun, in their mad race through space, becoming entangled in the reins of matter, are slowed down, and ere they are aware, their feet take root in the earth, and they are turned into trees and flowers and animal bodies.

Plants and animals in their physical properties, are largely the embodiment of the electric energy of the sun. We shall not be surprised, therefore, to discover that they are most susceptible to electric influences; and, in a marked degree, are dependent upon them for their health and development, and even for life itself.

The earth, and all animals and vegetables, are frequently designated as engines, in that they are able to convert energy into mechanical power.

Every time we light a lamp or kindle a fire, we

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build an engine which is capable of doing work. The draft of cold air rushes in over the floor to the fire, there to be united with the carbon liberated by the flame, and this rarefied product is carried up the chimney, the up-rush of which, with considerable velocity, produces mechanical effects.

This is frequently seen exemplified by toys suspended in an ascending current of heated air, which turns a wheel, causing the tiny figures attached to it, to go through various maneuvers, such as bowing, sawing and pulling.

The earth is an instance of such an engine. The equatorial regions, under the direct rays of the sun, are the furnace. From the polar regions, the air rushes in along the surface of the earth, while that at the equator, becoming rarefied, rises, producing currents in the higher strata of the atmosphere.

The display of energy by this earth-engine, is often prodigious, as is witnessed by the sweep of cyclones, and in the freightage of thousands of tons of watery vapour to fall as rain. The mariner who hoists his sail, and likewise the miller who grinds his corn, whether by wind or water-power both utilize this earth-engine.

The fuel of this engine is derived directly from the sun in the form of electro-magnetic waves. And thus to them we are indebted for the winds which blow over the earth, dispersing its poisonous gases, and purifying the air; for the rains

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which water the earth, and make it bring forth and bud, and give seed to the sower and bread to the eater; for the snows, those beautiful feathery fallen stars, flowers from heaven, which come tumbling through the air, falling softly, eddying sporting, rising and sinking ere they drop like downy wool upon the tender plants, spreading over them a mantle of white, so that they can nestle beneath its warm folds, next the heart of mother earth in a temperature from twenty to forty degrees higher than the unprotected soil; for the rivers and streams which afford easy and cheap transportation for commerce, turn the million wheels in factory and mill, forge and loom, and fill the reservoirs, for the thirsty millions of the great cities, with the beverage of life, brewed by the heavenly Father in beautiful places, in yon grassy dell, or away on the granite mountain peak which glitters like gold in the sunlight.

All these, and countless other necessities, as we shall presently see, are supplied us by the benignant electro-magnetic waves from the sun, which impinge upon us so gently that they do not even awaken our consciousness of the source of our blessings.

Various writers have called our attention to the fact that man may be rightly regarded as an engine. The food consumed is analogous to the fuel put under the boiler of the steam engine, and serves similar purposes. As fuel produces heat and performs work in the steam engine, so the

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food partaken, by its gradual oxidization, keeps up the temperature of the body, and is also used as a source of energy on which to draw for the performance of work.*

Many have been the attempts to measure the efficiency of the man-engine by weighing the food consumed and measuring the work done, but these have proven unreliable because the transformations of the food are so subtle and so varied, that it is difficult to trace them. Nevertheless, it is generally true of man, as of the steam engine, that the amount of the work which is capable of being done, bears a certain proportion to the fuel put into the furnace.

"It is interesting to notice that in the modern practice of medicine, the conservation of energy is recognized. Heat is supplied to invalids in order that the human engine may not be compelled to supply this animal heat," so that as much as possible of its energy may be directed toward restoring the equilibrium of the constructive and destructive processes which is indicated by the health of the body. For this reason, also, too great an output of heat in the case of fevers is checked by cooling applications.

The source of the food supplied this engine is vegetation, the ultimate origin of which is the electro-magnetic radiation of the sun. This is true even if the food be animal. The only difference being that the vegetable has passed

* "The Conservation of Energy," Balfour Stewart.

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through the animal first. "The animal has eaten the grass, and we have eaten the animal."

And thus we are brought to view a further relation which we unconsciously sustain to the electro-magnetic influences that weave themselves into the warp and woof of our lives.

The sun is vastly removed from us, being many millions of miles away even at its nearest approach, and yet its all pervading influence is not exerted upon us at a distance. It is able to shoot out some mysterious part of itself, in the form of electro-magnetic waves, which we term sunshine. And while the earth receives less than the two thousand millionth part of the energy given out by the sun, it nevertheless receives as much heat in a year as would melt a hundred feet thick of ice, or boil sixty miles deep of water all over the globe.

The particles of a pound of coal, when burnt, fall to the mineral state, and give out power enough to raise from 2,500 to 5,000 tons a foot high. And according to Lord Kelvin, the heat hourly given out by each square yard of the surface of the sun is equal to the combustion of 13,500 pounds of coal, and yields a force equivalent to 63,000 horse power. At this rate the total heat radiated from the sun would be sufficient to raise from freezing to boiling 700,000,000,000 cubic miles of water each hour, a body more than two and one-half times the size of the earth.

It is a significant fact of Scripture that Christ,

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the Son, is announced as being the radiation or effulgence of the Father. God does not exert His omnipotent control over us at a distance. He comes to us in the Son. And the word describing that advent in Hebrews 1 : 2. is ἀπαύγασμα, "radiation," from ἀπό "from," denoting separation from, and ἀυγάζω "to shine" or emit brightness, which is a perfect picture of the energy of the sun winging its way to us, and flooding the world with its glory and vivifying power.

What this is to the physical well-being of the earth, that Christ is in the spiritual sublimation of mankind. And it is as impossible to trace the lines of this influence to their termination in the lives of men, as it it is, "with thy scalpel eyes to lay bare each vital wave more fine than air," of that energy which has built the cells and woven the organized structure of plant and animal life on earth.

In darkest Africa, suspicious China, meditative, famine-stricken India, and the debased islands of the sea, in the hearts of men everywhere, His holy impulse is being felt. And it is none the less actual and potent in that it is often wrought by secondary agencies, reaching men's lives through their fellows, whether from those contiguous, or from those in distant quarters of the globe, whom this effulgence of God has illuminated.

The gentleness with which the mighty magnetic energy of the sun is poured down upon us

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is most beautiful. And yet its force displayed all over the earth is incomprehensible. It unlocks the minerals and builds them into living cells. It fans the face of the globe with gentle zephyrs, and sweeps it with tornadoes. It lifts the vapour of the seas, lakes and rivers high into the air, to fall as rain. And the work done in a year in our land alone in this one phase of its manifold operations, is equivalent to lifting a hundred thousand tons a mile high each second, or to that of one billion nine hundred and twenty million horsepower, or to the work of five billion horses working ten hours a day,—perhaps a thousand times as many horses as there are in the United States." *

The power of Zeus, the father of gods and men, as conceived by the Greeks, was child's play compared with the might of this giant force overspreading the earth, and ruling from his throne in the sun. The thunderbolts hurled from the top of Olympus were toys, beside the energy which is flashed upon us with lightning speed. And yet all this is not manifest to us in the display of awful power, but so benignantly and mildly that its world-wide supremacy is unsuspected.

How beautifully this illustrates the unconscious energy, and the moulding influences of the Spirit of God in our lives. He is almost wholly unrecognized, and unknown, as the new-born

* "United States Weather Bureau, Bulletin C," 1894.

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babe fails to apprehend its loving mother. Yet He continues to be the life and strength of all men, despite their ingratitude and sin. "In Him we live and move and have our being." This is the sense in which every one is a child of God. His life is due directly to God.

The electric energy of the sun exerts an indirect and subtle influence upon us through the vegetable products upon which we rely for food.

The so-called chemical rays, that is, the shortest waves of light at the violet end of the spectrum, are most effective in decomposing carbonic acid in the leaves of plants, and as a consequence, these rays disappear, or are absorbed into the leaves. And it is because of this that very few such actinic, or chemically active rays are either reflected or transmitted from a sun-lit leaf; and hence a photograph of a landscape usually reveals the leaves as black, because they have not reflected enough light to impart their image to the photographic plate. In other words, the rays which would have produced a chemical change on the plate, have all been used up by the leaves for peculiar purposes of their own.

Every green leaf is really a storage battery in miniature. We are not to understand by the word "storage" that electricity is stored up any more than is the case in an ordinary storage cell. What is stored up in both cases is the chemical action due to electric energy.

In the usual form of storage battery, a current

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of electricity decomposes the dilute sulphuric acid into oxygen and hydrogen, and forms chemical compositions which again give out electricity, motion and heat, when the poles of the battery are connected, and according to the way the resultant energy is utilized.

In the leaf-storage battery the radiant energy of the sun corresponds to the electric current. This enables the leaf to decompose carbonic acid into oxygen and carbon, and to form chemical compositions, the carbo-hydrates, which are stored up until they are again transformed into heat, electricity or motion.

In this connection some experiments in plant physiology by R. Kohn, as given in the "London Electrician," are interesting. He proves that all vegetable cells show potential differences,—that is, some have more electrification than others,—which regularly appear in the course of cellular activity. All plants are pervaded by a connected system of electric conductors whose conductivity is many times higher than the conductivity of their insulating surroundings. The chief conductor lies to the right and left of the mid-rib of the leaf, and is two cells deep.

We can understand, therefore, why it is that electricity is beginning to play an important part in farming. And so great are its possibilities that one hardly dares to speculate what it will yet accomplish in this direction.

Under certain favourable conditions, green

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leaves show an electric response to light, consisting in the establishment of a potential difference between the illuminated and the non-illuminated portions of the leaf, which may amount to as much as 0.02 of a volt.

For many years it has been known that electricity, when properly administered to vegetation, quickens and stimulates it. Portions of planted fields have been charged, storage battery-like, with electric energy, while others have been left untreated. Nearly twenty years ago, Spechneff, the Russian savant, demonstrated that electricity greatly stimulates both plants and seeds. In a short time he raised radishes of an abnormal size, some attaining a length of seventeen inches, and a diameter of five inches. Similar have been the results of experiment farms in France.

Cornell University also has had a plant-forcing house in operation for some time, where remarkable results have been obtained. "Some plants respond quickly to electric light. Spinach, radishes and lettuce could be so forced that under the effect of the arc light, they would grow twice as fast as in the ordinary garden." Flowers show similar responsiveness to the effects of the electric rays, and in many cases, their colour has been greatly intensified. Violets have been made to blossom in three weeks when exposed to the electric rays at night, and to the sunshine in the day.

"Tulips of the richest colours have been produced. The deep colours of the flowers, such as

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dark red, blue, scarlet and pink, presented a handsome appearance for a few days, and then faded." *

Mr. A. F. Brinckerhoff of Cornell concludes the results of their experiments as follows: "Electric light promotes assimilation, hastens growth and maturity, is capable of producing natural flavours and colours in fruit, often intensifies the colour in flowers, and sometimes increases their production, and shows that periods of darkness are not necessary to the growth and development of plants. In fact, there is no such thing as a plant becoming worn out or tired out because of the stimulating influence of continuous light. This overthrows the old belief that plants, like animals, require periods of rest."

All plants show a remarkable attraction toward the electric light. They will lean toward it, as they do toward sunlight, and then straighten up in the daytime.

This response of vegetation to electric energy is what we might expect from our knowledge of the structure of plants, with their marvellous net-work of conductors and insulators, so prepared by the divine Hand as to facilitate the transmission of energy through them, and also from observing the influence of radiant energy upon plant life; for electricity, from whatever source we may obtain it, is simply stored-up sunlight. It has been mysteriously locked in all our

* "Electric Review, Oct. 10, 1900.

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vegetable products, in the forests and coal beds, which are vast reservoirs of energy upon which we may draw as occasion requires, and transform it again into heat, motion or electricity.

This is beautifully suggestive of that ocean-atmosphere of divine energy with which we are unconsciously surrounded, and upon which we are ever drawing. It is the vital energy of God, in which "we live and move and have our being," the raying forth of the Father in the person of the Son, and through Him, of the Holy Spirit. And from whatever source we may receive good, its origin can be traced to God through Him, as actually as all electric phenomena lead back up the path-way of electro-magnetic waves to the sun.

Men are storage cells, charged, for the most part unconsciously, with God's life and loving favours, and the blessing they give to others is of Him. So that not a hand dispenses charity, not a lip lisps helpful words, but it is "the life of Jesus manifest in our body."

It was hard on poor Dryope to be changed into a living lotus-tree, but it was the glory of the tree, investing it with an interest which it could have possessed in no other way.

It is the grandeur of plants and animals that they are so largely the embodiment of the energy winged to them from the sun, which they have harnessed into willing service.

An incomprehensible condescension it is that

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the Spirit of God should join Himself to dust, that He might quicken it into life, as He does every thing that lives. But it is the glory of the creation, and especially of man, investing him with a dignity and importance little less than divine, making him the offspring of God.

This should cause everyone to reverence himself. He is not common, and therefore should live an exalted and uncommon life. Here too, is the ground for reverence for every man. God lives and moves in him. It likewise makes us bare our heads in the presence of nature; for we have but to put our hand upon its pulse to feel the throb of the divine life within.

Most abasing it was to God that He should descend to our low estate, robe Himself in the humanity of Jesus, and live our life with all its limitations and privations; but it is our glory; for that perfect life which He lived, and now lives, in union with our nature, is an indication of what it is possible for every one to be.

A magnetic needle when suspended so that it is free to move in any direction, as in the compass, takes a particular position with reference to the earth. It does not point due north and south, and from this fact it has been discovered that the magnetic poles of the earth do not coincide with its geographical poles.

The north magnetic pole lies just within the Arctic Circle in Lat. 70° 46′ W. Toward this par-

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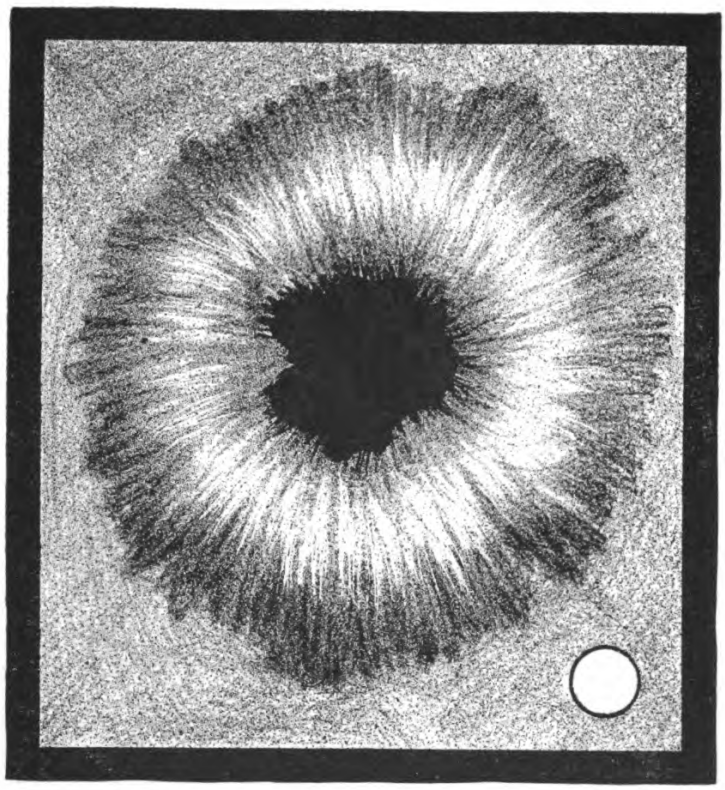

"A typical sunspot, showing a circle of darker shade about its periphery and high lights upon its crown which are accentuated by the dark center, and the center in turn, made to look black by those very high lights. The apparent vortexial motion seems to indicate that these spots are enormous vortex rings composed of whirling matter of the sun's corona." *The Electrical Age.*

The smaller body indicates the comparative size of the earth.

(See page 150.)

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energy is developed, and these unusual phenomena are the consequence." *

These magnetic storms occur at intervals of about ten or eleven years. The one of November 1882, extended round the globe, and was felt wherever there were telegraphic lines. Many such storms were recorded in 1892, those of July 16th and August 12th being especially severe. The former lasted several hours, with varying intensity, but at 12:20 P. M. "a tremendous wave struck the wire, which sent the galvanometer needle whirling around the scale, and prevented further measurements being taken." †

The storm of August 12th was even more remarkable for its intensity, and for the wide range of territory disturbed. At 12:01 P. M., the earth current at the New York end of a Buffalo wire indicated a current strength of 240 milliamperes, and an electro motive force of 768 volts, more than five times the amount needed for ordinary signalling purposes.

There seems to be no reason for doubting that these marked magnetic disturbances, which periodically occur on the earth, are due chiefly to similar disturbances on a vast scale in the photosphere of the sun, which become manifest through their ruptures in its gaseous envelope, revealing the dark interior, and are termed sunspots.

* "Nature's Miracles,—Electricity," p. 37, Elisha Gray.
† "Electrical Engineer," July 27, 1892.

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Balfour Stewart, in his article on Meteorology in the Encyclopedia Britannica, quotes numerous observers at various places and at different times, covering many years, who state that the forces which give rise to the movements of the atmosphere, appear to be more energetic in years of maximum than in years of minimum sun-spots.

Others reported greater rain-fall in the years of maximum sun-spots. G. M. Dawson concluded that the level of the great lakes is higher at the maximum of these spots; while Dr. Hunter has shown from records, that the famines in India have been most frequent about the years of minimum sun-spots,—years associated likewise with a diminished rainfall. Other observations covering a period of thirty years show that there are more storms and cyclones on the ocean during the years of maximum sun-spots, but that terrestrial heat is greatest near the minimum of such spots.

Hence the conclusion is that the meteorological motions and processes of the earth, like the magnetic phenomena mentioned above, are most active during the times of maximum of sun-spots.

By a series of very interesting experiments, Professor Elmer Gates of Chevy Chase, Md., has shown how the varying conditions of the weather are due to the electric condition of the atmosphere. As a large fluffy ball of cotton, charged with electricity, immediately increases its size, the fibres repelling one another, so the charged

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particles of air expand, diminishing the pressure, and cause a fall of the barometer.

Two currents of air are drawn by an electrical fan into a room through windows at its opposite sides, and mingle without any unusual results. When the two currents, however, are charged with positive and negative electricity from a static machine, and come into contact with each other, a slight mist is formed, and soon the floor is quite wet, but the moisture ceases when the currents of electricity are turned off.

During a shower of rain it is well known that a far greater quantity of water falls in one place than could possibly be contained in the air covering that area. This is explained by another experiment in which moist air is made rapidly to commingle with dry air, when the two are charged with positive and negative electricity respectively; showing that moisture is transferred from one point to another by currents of electricity.

With equal facility portions of air, oppositely charged, become miniature cyclones; while water is made to assume the form of water-spouts, ascending with the positive current in its effort to leap up to meet that of the negative.

It is not infrequent for nervous persons to complain of an increase of their ailments, pain, nervousness, etc., during a thunder storm which is thousands of miles distant. This led to experiments by F. Larroque in which he discovered

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that the Hertzian waves emitted by thunder storms are propagated over enormous distances.

During the great atmospheric disturbances of June, 1901, he made several series of nocturnal observations with a simple receiver which he constructed. It was earthed by a fine wire, and had a spark gap in the cellar. Though the sky was serene at the place of observations, he received decided electric impressions, one of which coincided with a blizzard in the Grampian Mountains in Scotland, and the other was recognized during a thunder storm over Corsica which was visible from the Department des Alpes Maratimes, France.*

We have seen the electro-magnetic effects which the sun produces on the earth and the atmosphere, and now we wish to consider atmospheric electricity in its relation to plant and animal life. Dr. Schliep of Baden Baden has made a study of this subject for many years, noting carefully the phenomena.

His observations and conclusions are thus summarized by Professor John P. Perry, F. R. S.: "Atmospheric electricity is generally positive. It is greater on high altitudes, such as high mountains. Negative electricity is tiring and positive is exciting. Positive is favourable to progress of oxidization, increases metabolism, circulation and secretion. The increase of ozone has this effect also.

* "Electric Review," Oct. 19, 1901.

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Like a skilful weaver, our life intertwines the silken rays of radiant energy into the warp and woof of our being, forming a perfect and harmonious pattern. But if we will look a little deeper, we shall discover beneath that weaver, the Spirit of God, who, in some mysterious way, becomes its power, enabling it to perform all the processes of metabolism of the body, and the activities of the mind. And the marvel of this union is, that man is ever himself, as truly as is God, in whom he has his being.

It is thus, as impossible for us to compute the debt of gratitude due to God from us, for our very life, as it is for us to put our finger on every particle of radiant energy of the sun now resident in our bodies, or in the numerous vegetable and animal forms about us.

One may shut himself away from the rays of the sun, and think that he can escape from contact with that sovereign energy, which comes with benediction in its wings, to vitalize, to heal, and to bless him in body, mind and spirit. He may creep into some dark cellar. Yet he cannot wholly free himself from its beneficent manifestations. It will reach him in the air he breathes, in the water he drinks, in the food he partakes, in the clothing he wears, in the light of his lamp, in the book he reads, and in the flame of his fuel; and yet he may fancy that he owes absolutely nothing to the despised object of his aversion from which he would flee.

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"How much owest thou unto my Lord?" For no single instant has He failed to be the energy behind your every act and thought. He has been unseen, and perhaps until now, unthanked for blessings, in every form, flowing from Him unceasingly.

One may be wholly devoid of desire to obey the voice of the Spirit of God, choosing to be freed from His favours rather than to accept them, and yet, unconsciously, be a perpetual pensioner upon His power, as are all men.

If despite one's wishes, and even contrary to them, the Holy Spirit confers such unceasing favours, what will He not bestow upon the one who has an honest desire to obey His spiritual laws; as electricians earnestly seek to observe the laws of electricity that it may serve them?

Did Franklin "steal lightning from the clouds?" Decidedly not. He merely obeyed one of the simplest laws of electricity, affording it a path, and it eagerly rushed down to do his bidding. Through obedience to our Lord and Master He becomes our servant. By this means, which we shall next consider, we step out of the unconscious into the conscious influences of the Spirit of God, which is like translation into a new world.

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ELECTRICITY AND LIFE

ENERGY RECOGNIZED

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"From soul to soul, o'er all the world, leaps one electric thrill."—*Lowell.*

"A friend is most a friend of whom the best remains to learn."—*Lucy Larcom.*

"O Friend! O best of Friends! Thy absence more
Than the impending night darkens the landscape o'er."
—*Longfellow.*

"And we are witnesses of these things; and so is the Holy Ghost, whom God hath given to them that obey him."—Acts 5: 32.

"If ye love me ye will keep my commandments. And I will pray the Father, and he shall give you another Comforter, that he may be with you forever, even the Spirit of truth: whom the world cannot receive; for it beholdeth him not, neither knoweth him: ye know him; for he abideth with you, and shall be in you."—John 14: 15-17.

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IX

ELECTRICITY AND LIFE

ENERGY RECOGNIZED

WE are in a new and exalted realm. We have left behind electrical energy in its indirect and unconscious bearing upon our life, and stand looking out upon a scene which we have come to recognize as the product of beneficent forces.

With marvellous dexterity their hidden hand has woven the fabric of life. But we have discovered the hand that wrought. We know the source of our blessing, and hence, eagerly search out its laws, and endeavour so to subject ourselves to them, that we shall be able to utilize them in the furtherance of our well-being.

Electric energy was as truly in the world during the scientifically dark ages, when men were grossly ignorant of its nature and laws, as it is at present. Then they knew it chiefly as the thunderbolts of the gods hurled at the earth, filling men with dismay, and scattering destruction in its path. Its benefits, however, even then, all unconsciously received, were incalculable. But what transcendently greater blessings it has

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bestowed upon humanity since its presence all about us at all times is recognized, and its modes of manifestation studied.

The benefits which the Spirit of God bestows upon all men, regardless of their character and despite their failure to recognize Him, transcends human conception. And yet the blessedness which becomes the heritage of the one who possesses a heart-knowledge of Him, is as much greater than the blessings unconsciously received as our knowledge of electricity exceeds that of the savage, or as the most exalted being before the throne of God is higher and holier than the one who grovels in sin, with no life of Christ in his heart and no light of God in his eyes.

It is important for us to remember this; for it is quite the fashion at the present time to emphasize the fact that the Spirit of God is in every man, creating a universal brotherhood, and constituting us all the children of God; and that the recognition of this fact would bring heaven down to earth. But with equal truth it can be affirmed that He is in every animal and every plant, and is the force which binds the universe together, giving it gravitation, cohesion and chemical affinity. And so we are as truly brothers to the plants and animals, the stones and the stars.

But the reception of Him as the life of our spirit, and the recognition of Him as our Comforter and Friend, through faith, constitute an-

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other and vastly higher relationship to God, and to men through His Spirit. May He illuminate us as we pursue the subject.

We have already considered the penetrating nature of the Röentgen and Becquerel rays, but it is likewise true that radiant energy in its other forms, such as electricity, light and heat, is able to penetrate the human body to a remarkable degree.

Well equipped hospitals are now provided with ovens into which the body of certain patients, in whole or in part, may be inclosed, while the temperature is increased. This heat enters the body, lessening the necessity for it to transform its vital energy into heat, and affording it an opportunity to increase its vitality, and thus to regain its normal functional activities.

That light is capable of penetrating the body, can be readily demonstrated by one holding his hand between his eyes and the sun or a lamp. It will be found to be quite transparent. When light is concentrated upon the body of a person, it so perfectly passes through it, that if a sensitized photographic plate, with a negative in front of it, be placed upon his back, a perfect positive picture of the negative is reproduced and that in a few minutes, through the body of a full grown man. "The rays of light pass through the integuments with considerable difficulty, more readily through muscular tissue, and much more readily through bone. In producing a picture

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through the cheek, the light passes through but a single thickness of the skin, and the picture is produced almost instantly." *

That electric energy in the form of X-rays, is capable of penetrating the body, and of producing upon the nerves a most unpleasant sensation, is indicated by an account given in the American X-Ray Journal of some experiments made upon larvae of certain insects. †

A box was made half of wood and half of lead. In the wooden half a number of larvae of flies, bees, beetles, and other insects was placed, and the box was then put into the field of the X-rays. The insects at once became greatly excited, and after crawling to and fro, finally every one emigrated to the leaden half of the box, where they were sheltered from the rays. Similar experiments were tried with blind larvae of a certain species of beetle. No sooner were the rays turned on than the insects showed signs of distress. Their uneasiness increased, and in a little while they all sought refuge in the metal half of the box. As they were entirely sightless, their perception of the rays must have taken place through the nerves of the skin.

Men may shut their eyes to the truth until they become blind. And yet nothing can conceal from the Holy Spirit. He is able so to impress the mind with a sense of His presence that one is not only

* "Scientific American," Sept. 29, 1900.
† "Electrical Review," August 10, 1901.

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conscious that God is near, but that all things are open to His view, the profoundest secrets, and the most deeply hidden sins. He can so turn the vision of the soul in upon itself that, with a shudder, one discovers himself, the secret selfishness of his heart, his low and unworthy motives, while he shrinks from the hiss of the vipers that have taken refuge in the holy of holies of his being. He sees himself clad in filthy rags, standing in the presence of God, and how awful is the contrast between His glorious holiness and the soul's sinful defilement.

It is strange, but nevertheless, true, that those who have such an appalling view of their own heart, are not the most sinful, but rather are the purest in their lives, and cultivate the most intimate acquaintance with God.

The reason for this is forcibly illustrated by certain facts in electricity. The body is incased in a sheath, the epidermis, which offers great resistance to an electric current. By a series of investigations, this resistance has been found to be no less than three hundred thousand ohms, upon the first application of a galvanic current. But it has been discovered that in consequence of the current itself, this initial resistance soon falls to a minimum of about three thousand ohms, and remains constant no matter how much longer the current may flow.

This great reduction in the resistance of the body through the action of the galvanic current is

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due in part to the physiologic action of the current, and in part to the physical effects. "The physical action is cataphoric, carrying from one pole to the other, and thus impregnating the skin and increasing its conductivity; the physiologic action causes vascular dilation, hyperemia, increase of secretion, and thereby rise of temperature." *

The soul of man is incased in a sheath of self-will, which offers enormous resistance to the ingress of the Spirit of God. In consequence of this, the soul may remain in darkness for years, being left ignorant of its true condition, and in this state, self-complacency will be one of its most marked characteristics.

But when the Holy Spirit has once found admittance, the resistance falls, the door remaining open to Him, and illumination succeeds ignorance, or darkness. Man now sees himself by the light borrowed from heaven. And the freer the access of Him who is the Light of the world, to every part of the being the more its imperfections are seen, and the more appalling are its contrasts to Him, until the sins are seen to be covered by the redemption of Christ.

If Christians have a more acute consciousness of their sin than others it is because the Holy Spirit has more perfect access to them than others

* "Electrotherapy," Vol. II, p. 20, George W. Jacoby, M.D.

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accord Him. Paul felt himself to be chief of sinners only because he saw more of Christ, and had a clearer revelation of His holiness than others, and afforded the Divine Illuminator of souls a fuller control of his life than they.

It was when Isaiah saw the Lord that he cried out, "Woe is me! for I am undone; because I am a man of unclean lips, and I dwell in the midst of a people of unclean lips; for mine eyes have seen the King, the Lord of hosts." The multitudes of Israel had no such sense of defilement; why should he, the devoutest of them all, have such an opinion of himself? The light of heaven had illuminated him.

The less one knows of himself the more he will think of himself, and the more he thinks of himself the less he will think of God. We need more introspection, such as used to mark the experiences of devout believers in other generations. This deficiency has made our lives shallow. The truth does not take hold of us as it did of them. It went to the bottom with them, while with us it stops at the surface, and as a result, we have lost the intensity of spirit which so characterized them. And we shall never feel the truth deeply, concerning our sin or the holiness of God, until we yield a more humble obedience to the Spirit of God. And in proportion as we allow ourselves to come under the spell of this age, we shall fail to know Him or ourselves; for they

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who are of the world cannot receive Him, for they behold Him not, neither know Him, and not knowing Him, they know not themselves.

The elaborate system of conductors and non-conductors which ramifies the body, as is true of plants, would indicate that it was made to bear a very intimate relation to the electric energy by which it is surrounded, and in which it is swathed, as in an atmosphere, and by which it is penetrated. These conductors and insulators of the body are so arranged as to form the most effective channels, enabling the energy upon which it is to depend, to reach one portion, while it is diverted to or insulated from other parts, where its excess or absence, as the case may be, would prove destructive rather than constructive.

" Lines finer than a spider's web, the nervous filaments of the senses, are our avenues of communication between the world without and the world within. Spread over a little space at the roots of the tongue, they make the savours of nature tributary to our pleasure. Unfolded and ramified over tiny spaces in the olfactory organs, and the hollow of the ear, they enable us to catch the perfumes of every fragrance, and to attend to the many voices of nature. The insect and the song-bird, the roar of the thunder, the rush of the cataract, the murmur of the ocean, are the earth's orchestral service in the cathedral of the universe.

" Within a small spot, on the eye's interior, is a

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chamber of representation where are gathered the glitterings of constellations, very remote, even on the verge of space; and there the beauties of every fair landscape are painted quick as thought, and with a flash of light. By a series of pre-established harmonies, our outer man makes our inner man to know the things in heaven and the things on earth. Millions of lines, more wonderful than any telegraphy of man, converge in focus for our organs; and are inlets of light and knowledge from the past, the present, and what we know the future will be." *

When any of these nervous filaments, which form our means of communication with the exterior world, are stimulated by an electric current, for example, those of the eye, light is seen; or of the ear, a noise is heard; or of the tongue, a taste is recognized. And thus, in addition to traversing the body, building up its cells and tissues, electric energy ministers in no small degree to our sensations of hearing, seeing, smelling, tasting and feeling.

It will undoubtedly yet be proven that all our sensuous experiences are due to the stimulation of our nerves by electrical energy in some form or other. At the present time scientists are being attracted by a theory wrought out by Dr. A. F. Matthews. By it he explains nerve and muscle stimulus, the transmission of nerve and muscle influence, muscular contraction and expansion, the

* "The World To Come," p. 60, J. W. Reynolds.

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operation of anesthetics and the phenomenon of intoxication as being entirely electrical in their character.

He believes that he has proven that chemical stimulation is identical with electrical, and according to the electro-magnetic theory of light, it must also be identical with stimulation with light waves.

Dr. Fredric S. Kolle says, " We might say that man is built up about an intricate system, representing as it were, an entire electric plant. The brain may be compared to the condenser, or storage station; the special nerves of sense, to the phase branches; and the nerve terminals to the generating part of the apparatus." * And thus we see the wonderful adaptation of the human body to electrical energy.

Here is an impressive illustration of the adaptation of the Holy Spirit to the needs of the soul. Man was made for God. He may seek to satisfy the longings of his heart with something else. It will be a vain search. God is his complement as he is God's. They are like the two halves of a bivalve scallop shell. The radiating ribs and hollows of the one will exactly fit into those of the other, because both halves are the product of the same creature. If one were destroyed, you might search among the hundreds of thousands of shells on the sea-shore, and not find one whose corru-

* " The Electric Age," January, 1902.

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gations would exactly fit into those of the half you possessed.

Forgetting that he is the offspring of God, one may seek for years to satisfy the cravings of his deeper nature, in the accumulation of wealth, in the applause of his fellows, in the gratification of debasing habits, or in the acquisition of knowledge.

John Ericsson is reported to have refused the request of his friend Ole Bull to hear him play, saying that he had no taste for music. The great violinist visited the inventor's office. He displayed his violin, and said that there was some difficulty with it. After talking of wood-fibres, tones and semi-tones, he casually took his bow and drew it across the strings and began to play. Ericsson was entranced, and when the music ceased, with tears in his eyes, exclaimed, "Play on, play on, I never knew what was lacking in my life before."

He only cares for noise of wheels,
And has no love for childish strains;
And he who has, he sometimes feels,
Is much like him, but only feigns.

The master takes his matchless bow,
And draws forth strains of music sweet,
Which smite the mute chord soft and low,
And soon the heart lies at his feet.

My heart was dull to things Divine,
So far controlled to earthly powers,
For thoughts of God I scarce had time,
And deemed them best for dying hours.

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One day I heard the Saviour's voice;
It thrilled with life and charmed my heart;
And now I make Him first my choice,
And joy that we no more shall part.

From the foregoing consideration of the adaptation of the body to the passage of electric currents, it might readily be conceived that electricity would exert a most salutary influence upon the body in its abnormal and diseased conditions.

The danger, however, of powerful currents has long been recognized; and they have been feared and shunned, because of the painful experiences which result from coming into contact with them in certain uncongenial forms.

The vast majority of mankind know nothing of the Spirit of God except in the unpleasant experience wrought by Him, in the conviction of sin. As they shrink from this reproof, so they shun its Author. "Every one that practiseth ill hateth the light and cometh not to the light lest his deeds should be convicted." The accusing conscience pictures God as a dreadful being, whose wrath must be appeased by costly and bloody sacrifices, severe penances and bodily suffering. This is the condition of mankind throughout the heathen world.

In numerous nominally Christian countries, Christ is chiefly regarded as our Judge, whose uplifted blows must be averted by the intercessions of all merciful souls in this world and the next.

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By most Protestant Christians such a view of Him is considered as a gross misrepresentation, if not a caricature, and yet many of them entertain the idea that He is a Saviour who is wholly absorbed in fitting the soul for the next world, and does this by forgiving the past, but leaves one to fight his own battles in the eradication of evil from his heart. And as for provision for the believer's temporal needs and bodily health, they are entirely outside the sphere of His mission. For these, one must not ask expecting to receive.

No doubt all such views of God, varying from His severest condemnation of the guilty, to a mild form of unwillingness to grant much needed favours, bring the soul into some kind of contact with Him. They are better than none, however; but they are like the recognition of electric energy in the forked lightning in the heavens, and in the terrorizing currents on the earth, while in its multiplicity of life-giving and health-restoring forms, it remains unknown.

The effects of electricity upon animal tissue are numerous and most interesting. Of late, so many surprises have resulted from its use in therapeutics, that the study of its effects upon the body has been greatly stimulated; while medical works on the treatment of disease by electric currents are rapidly multiplying, and every medical or electrical journal recounts some recent discovery of its results as a remedial agent.

Time will sift these conclusions, and will doubt-

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less prove that many of them were too hastily formed. But deducting all that are doubtful, still enough remain to make the practice of electrotherapy of great importance to humanity.

We have previously called the reader's attention to the fact that the rays in the spectrum of sunlight beyond the red, are most powerful in heat effects; and that, by means of his bolometer, Professor S. P. Langley of Washington, has explored and mapped out that end of the spectrum extending it many times the length of the visible spectrum.

At the other end of the spectrum also, are rays which are invisible. These are especially powerful in producing chemical effects.

Sunlight is the most universal, the most economical and the most active agent which we can employ for the rapid destruction of microbes. And on this account, solar light becomes most salubrious in its effects. But it owes this entirely to the disturbing action of its chemical radiations.

"Hence the idea that it might be possible in certain eruptive affections to diminish the irritation of the skin, even when such irritation proceeds so far as to suppuration. This idea is the origin of the treatment of smallpox by red light. In fact, by allowing only the calorific radiations to reach the skin of the smallpox patient, we suppress the exciting and disorganizing action of the chemical rays, and, as a few experiments have demonstrated, the inflammatory effects of the

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eruption are reduced to a minimum. But a still further advance was made, and the question asked whether it would not be possible to treat and cure certain skin diseases considered as parasitic, and microbian, by the exclusive use on the contrary, of the chemical violet radiations, which are so active in the destruction of microbes. It is to Professor Finsen, of Copenhagen, that is due the honour of having been the first to call the attention of the medical world to the benefit that might be derived from the phenomena above mentioned.

"It is to him that we owe the treatment of smallpox patients in rooms in which the chemical rays are excluded by filtering the light through thick red curtains or through glass of the same colour." *

On the contrary, lupus and other skin diseases, which are of a microbian origin, require the concentration of the chemical rays upon them for the purpose of destroying the microbes which produce them. This is done by using hollow lenses filled with water coloured blue by an ammoniacal solution of copper. This acts as a filter, allowing nothing to pass but the chemical rays which produce the desired therapeutic action.

The spectrum of the electric light being much longer than that of sunlight, it is largely used as a curative agent.

Since the announcement of Dr. Finsen's dis-

* "Scientific American Supplement," May 18, 1901.

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covery, numerous physicians in Europe and America have been employing radiant energy in various forms for the cure of disease.

Dr. H. Strebel of Munich, recently published a communication in the Deutschen Medizinischen Wochenschrift in which he says that he has proven that invisible rays of a powerful induction spark are capable of killing strong cultures of bacteria within a short time, say twenty minutes. The induction spark is naturally rich in violet rays, but by employing aluminum and cadium as electrodes, and a Leyden jar as a regulator and accumulator, the richness of the spark in ultra-violet light is enormously increased, and likewise its bacteria killing-power.

Dr. S. Cohn of New York, makes a specialty of electrotherapy, and has successfully treated cases which he regarded as hopeless by the use of drugs alone.

Dr. J. H. Metzrott, Washington, D. C., says, "With several applications of the Finsen Light, and several of the X-rays, I cured, and I believe permanently, a case of lupus of the nose of twenty-seven years standing which all other forms of treatment had failed even to temporarily relieve. If you ask me what I think of this therapy, I will tell you candidly that I believe that it is the biggest thing in medicine to-day."

Dr. J. Henry Barbat, San Francisco, Cal. says, "My experience with the X-ray as a therapeutic measure has been rather limited, being confined to

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a few cases of lupus and psoriasis and two cases of pulmonary tuberculosis. . . . The two cases of phthisis are apparently cured, and are working every day, and have been for the past four years."

Dr. A. E. Smith, Olean, N. Y., says, "Rightly applied I consider X-ray a specific to lupus. I have now treated some twenty-two cases and the way they get well, the smooth velvety scar left, are features that convince the observer that something extraordinary is taking place in the diseased area, and that the healing is permanent."

Dr. J. N. Scott, Kansas City, Mo., says, "I can truly say I could hardly believe the results so far obtained would be possible, had I not watched their progress."

Dr. Edward E. Darby, Boston, Mass, says of his work with static currents, "Special efforts were made to cure tuberculosis. Successes were almost beyond expectation." He then mentions a serious case of consumption which was cured in a few months. "As she expresses it, 'I was never so well in my life, and never weighed so much.' After nearly two years now, absolutely without treatment in her own Massachusetts home, she can say the same thing.'"

Dr. Thomas D. Hulme, Commerce, Iowa, says, "I have had what I call wonderful results from the use of cataphoresis in goitre, and tubercular diseased bone, indeed I have cured every case of this nature, which are holding good after one to

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two years. In the case of joint sprains I never used or saw any form of treatment which gives such quick results. I am more and more convinced that we do not know more than a tithe of the ocean of results that are ahead of us in the use of this giant therapeutic agent."

Dr. W. F. Buck, Grand Rapids, Mich., says, "I believe there are many diseases that can be cured with the X-ray and static current, and could not possibly be cured without it. I use the electric spray for removing tumours, and had only one failure in this line."

Dr. A. Curtright, Chillicothe, Ohio, says, "I have treated several cases of lumbago successfully. I believe it relieves pain quicker than morphine."

Dr. T. E. Comstock, St. Louis, says, "For three years past I have had a favourable experience in the therapeutical use of the static current. I have also found it admirable in rheumatic affections and asthma."

By means of the galvanic current, fluids can be carried into any part of the body, along with the flow of the current from one pole to the other. This is called cataphoresis.

The tanning of hides by electricity became quite general when it became known that the tanning solution could be carried by an electric current into the hides and tanned in four days, while by the ordinary methods it requires from ten to twelve months to complete the process.

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Since an electric current produces a flow of fluid from the positive toward the negative pole, "a constant current may be utilized to aid the natural osmatic flow of fluids by producing an electric flow in the same direction, or to retard the osmatic current by producing a movement in the opposite direction." *

"The effect of the positive pole upon the sensory nerves in the immediate vicinity of the pole is that of a powerful sedative. The effect of the positive pole upon the blood-vessels in the immediate vicinity of that electrode is that of a vasoconstrictor," compressing the blood-vessels.

"Destruction of pathogenic bacteria occurs at the positive pole as the result of the accumulation of salts of the metal electrode employed. At the negative pole a current of sufficient density causes the liquefaction of the tissues. A galvanic current forced through a portion of the body acts as a general tonic to the whole system. A faradic current stimulates general nutrition and muscular contraction." †

"Electricity appears to effect its curative results first, in acting as a general tonic to the entire organism. It will build up a reduced system better and quicker than any other means. It restores tonicity to enfeebled or paralyzed muscles, evokes nerve and muscle reaction, softens indurations, resolves exudates, breaks down ad-

* "Electrotherapy," Vol. II, p. 31, Geo. W. Jacoby, M.D.

† "Electricity in Gynecology," F. H. Martin, M.D.

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hesions, relaxes contracted muscles and tendons, stimulates the functions of the central nerve cells, and is the great alterative and regulator of nerve and muscle function, and functions of the visceral organs. It gives most brilliant results in the increase of vital power. It is 'Nature's own remedy,' and restores vitality by its constitutional effects, and prolongs life in comfort and enjoyment." *

There is no doubt that if we had a perfect knowledge of and could apply all the laws of radiant energy in its relation to the laws of physical life, we would discover that that energy is so corrective in its nature, and so meets all the needs of the human body, that all diseases would be eradicated, and a continuous, healthy organism would result. The machinery of life would never wear out; for every lack would be supplied as rapidly as deterioration occurred, and so an eternal physical well-being would result.

For this key of knowledge, lost through sin, scientists are earnestly seeking, and who can doubt that some progress is being made in the search? But fallible creatures cannot hope to attain to perfect knowledge; and perfect skill in the application of the knowledge they have attained, is also an impossibility.

Had we infallible knowledge of the Holy Spirit, the energy and life of God; and perfect willing-

* "Electro-Therapeutics and X-Rays," Chas. S. Elliott, M.D., p. 64.

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ness to suffer Him to meet our every need, not only the last evil of the heart would be eradicated, but an eternal bloom and freshness would characterize the soul, which we know are now resident in God.

And in this there is cause for good cheer, in that we are not hopelessly locked in with our own weakness; for He who knows the soul's sin, likewise knows every spiritual law, and is a Physician of unerring skill in applying the remedy to the disease.

The perfect balance of the metabolic processes of the human heart is found in Him. He is the source of the energy required to meet every emergency in life. The correction and recuperation of the soul are wrought by Him.

The method, then, is not to struggle to be our own physician; but since He is the complement of our spirit, we should long to know Him more fully, and seek to be in more perfect accord with His will. This would issue in life, the eradication of disease, and the perfecting of holiness in the fear of the Lord.

The cure of the ills of the soul lies in His healing touch. There is no spiritually diseased condition which His presence will not rectify. Hasty tempers, evil thoughts, wilfulness, covetousness all disappear, and God's will is done in the heart, even as it is done in heaven, when He has full sway.

Here too, is the remedy for the ailments in the

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body of Christ, the church. It is not in wider social intercourse, not in more earnest activity, or in increased efforts to be courteous and considerate. All these are good, but they do not reach the root of the difficulty. More of the Holy Spirit, who eradicates every vestige of the disease, is the need of the church. When she discovers that she can utilize this Power, only as she becomes subject to it, and so turns with whole heartedness to seek it from Him, and to refrain from violating His will, or grieving Him, then she will put on her garments of beauty and glory, and will go forth "fair as the moon," and will be to sin in every form "terrible as an army with banners."

THE WILL OF GOD

Like storm tossed barks without a helm are they,
Who when they hear His voice will not obey;
What e'er they have or do, they cannot rest;
And so to do the will of God is best.

Lie, heart, upon God's altar, then. The whole
Must yield to Him, or die from self control.
His face I see, and that dispels my night;
And thus to do the will of God is light.

When first I heard His voice within me call,
To yield to Him my will, my life, my all,
I feared the cost, and there was bitter strife,
But now I see to do God's will is life.

It was the Son's full joy God's will to do;
And other will the angels never knew;
While saints in bliss, at one with Him above,
Have learned, to do the will of God is love.

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Know then, my soul, no will but God's while here,
Turn first to seek His wish in each new sphere;
And thus shall reign within His perfect peace,
Until He come; and then, a glad release.

Living animal tissue manifests a striking response to electric currents. If a current be sent through tissue, which is then connected with the poles of a sensitive galvanometer, a back rush of current is indicated if the tissue be living, while no such current is perceived if it be dead.

In experimenting with electricity upon eggs, Dr. Augustus Waller discovered that "no exception was found to the general rule that a non-incubated, sterile, or putrified egg gives no back rush of current, indicating the presence of vital phenomena, while an egg containing an embryo in a state of development always gives the indication which showed vitality.

"In the case of certain animalcules, which, when dried, seem to possess no sign of life, but in which upon exposure to moisture, the vital activity is developed, the current indications follow the same order; in the first case, no current is given but upon the development of vital activity, the characteristic current is always given. In the case of tissues, it was found that tissue which had been rendered insensible by anesthetics gave no reaction, thus likening it to dead tissue. When the anesthetic action was removed and vitality became apparent, the characteristic electrical reaction followed in all cases observed." *

* "Scientific American," March 16, 1901.

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The response of the nerves and muscles of the body to electric currents is no less characteristic. For example, in case of paralysis from pressure on the large nerve of the upper arm, called musculospiral because pursuing a spiral course around the muscles, the excitability of the nerve and the response of the muscles to electricity become reduced in proportion as the process of degeneration proceeds, until after several weeks, the diseased or injured nerve shows complete loss of excitability to both the galvanic and faradic currents. The characteristic symptoms of degenerating nerves are the slow and lazy contractions of the muscles under electric stimulus.

"As the nerve begins to regenerate, its response to the current increases likewise, and the excitability of the muscle returns along with it. At last it loses its torpid mode, and finally the quick and fulgurating quality is restored." *

If instead of an increase of response to electric stimulus, the contrary is true, and finally no contraction of any kind is obtainable, even with the strongest current, nerve regeneration is impossible.

That soul is dead which manifests no response to the Spirit of God; for the distinguishing characteristic of the one quickened with the Divine life, is his answer to the touch of the Author of that life. It is the soul's echo to the Father's voice; its blush at His whispers of love.

* "Electrotherapy," Jacoby, p. 47.

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The lack of response of the paralyzed or dead spirit to the Spirit of truth is indicated by Jesus in the words, "whom the world cannot receive; for it beholdeth Him not, neither knoweth Him." But it is not thus with the one in whom He dwells. And the extent of his acquaintance with the Holy Spirit will be in proportion to the welcome accorded to Him in the heart, and surrender to His will.

The soul may become so sensitive to His presence that it will thrill at His approach, much as the gold leaves of an electroscope will flutter when a body but slightly charged with electricity comes near to them, or as the bolometer is susceptible to changes in temperature, noting it is thought, near to the one hundred-thousandth of a degree, and causing a deflection of the galvanometer needle by the heat radiated from the operator's hand five feet away.

John Wesley, Lady Maxwell, and others state that they have experienced a conscious acquaintance with the Holy Spirit. And this is a most exalted privilege of the believer. "Ye know Him; for He abideth with you and shall be in you."

To know Him as a friend who is close at hand, who whispers His counsel to the soul at every turn; to feel such an acquaintance with Him that one can say, "He is my blessed Holy Spirit;" to love Him who bears so patiently the rebuffs He meets; to share with Him a loving communion which is too deep for the mind to formulate into

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words; to receive from Him life, and health and suggestions and directions; to know His voice so well that there is no doubt when He speaks; to wait at the parting of the ways until His familiar impression is given and the direction is heeded, and then to look back and see how He lighted up the path and led the way, what on earth can be more blessed and comforting?

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THE BREATH OF SPRING

"For, lo, the winter is past,
The rain is over and gone;
The flowers appear on the earth;
The time of the singing of the birds is come;
And the voice of the turtle is heard in our land
The fig tree ripeneth her green figs,
And the vines are all in blossom,
They give forth their fragrance
Rise up, my love, my fair one, and come away."
—Song of Songs 2: 11-13.

The land is cold and dead and bare,
And silence reigns supremely there,
While rain and sleet oft fill the sky,
And winter's winds go moaning by.

But Spring comes in. His vital breath
Dispels the frost and scatters death,
And dries the rain from off the land,
And makes the buds with life expand.

Now flowers appear upon the earth,
And birds in song proclaim their mirth;
The vines are pruned by friendly hand,
And ripening fruits soon grace the land.
Thus winter-gloom reigned o'er the race,
Till rose God's Sun with truth and grace;
His healing beams dispel the night,
And sow the earth with life and light.

Despotic silence rules the souls
Unbroken, save by death-knell tolls
Of those not having God's Spring there,
To bud and bloom with fragrance rare.

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His beams of Spring upon men shine,
When Christ comes in with life divine;
Then birds sing out their joyful lay,
And former night is turned to day.

But winter drear steals o'er the heart
Of all who from their Lord depart
For lust of sin, or ease, or gain,
While blindly led in Satan's train.

O Lord, Thy Spring breathe into me,
That this cold heart may softened be,
And blossom like fair Sharon's rose,
And scatter fragrance as it grows.

Soon, soon shall come the happy day,
When chilling frosts shall break away,
And feeble faith give place to sight,
And we shall walk with Thee in light.

Till then, dear Lord, let us not sleep,
But earnest vigil ever keep;
That when Eternal Spring appears,
It may not cause us griefs and fears,
But be the end of all our tears.

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ELECTRIC ENERGY AND ITS TRANSFORMING EFFECTS

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"And all the multitude sought to touch him; for power came forth from him; and healed them all."—Luke 6: 19.

It is Thy Holy Spirit's power,
That meets the need of every hour;
Imparts a life which is Divine,
And fills with peace and love like Thine.

Endue us with Thy Spirit, Lord,
That we may see Thy holy Word,
Run through the earth like beams of light,
And robe Thine own with heavenly might.

"Was not our heart burning within us, while he spake to us by the way, while he opened to us the Scriptures?"—Luke 24: 32.

"And by the hands of the apostles were many signs and wonders wrought among the people . . . insomuch that they even carried out the sick into the streets, and laid them on beds and couches, that, as Peter came by, at the least his shadow might overshadow some one of them."—Acts 5: 12 and 15.

"And God wrought special miracles by the hands of Paul: insomuch that unto the sick were carried away from his body handkerchiefs or aprons, and the diseases departed from them, and the evil spirits went out."—Acts 19: 11-12.

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X

ELECTRIC ENERGY AND ITS TRANSFORMING EFFECTS

THE electro-magnet is an impressive illustration of the new power which is imparted to one's life by the Holy Spirit.

Electro-magnets are usually made by bending a piece of soft iron into the shape of a U, and then winding a coil of insulated wire around each of its arms. When a current of electricity is sent through the wire, the U-shaped soft iron becomes a powerful magnet. But the magnetism remains only so long as it is surrounded by the current in the wire.

Before the current is sent through the coils, if the magnet be presented to pieces of iron or steel, it will not attract them. Now bring the two ends of the coils of wire into contact with a battery, and what a change! A piece of iron will leap toward the poles of the magnet, where it is held with great force. Such magnets are sometimes constructed so that they are able to sustain a weight of several thousand pounds.

We often hear people say that they would become Christians if they were sure that they could

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hold out. Their confidence in their ability to persevere in the Christian life is not sufficient to give them courage to make the start to live such a life. Doubtless this suspicion is well founded; for it is a fact that apart from the power of the Spirit of God which worketh in us, we are utterly unable to hold on to Christ by faith. He taught us that apart from Him we can do nothing. But so long as His power is in us, we abide in Him and He in us, nothing shall be able to separate us from the love of God; not tribulation, or anguish, or persecution, or famine, or nakedness, or peril, or sword. In all these things we are more than conquerors through Him that loved us.

But now let these wires through which the current of electricity is passing, enabling the magnet to hold its heavy load, be separated from the battery by even so much as a hair's breadth, and the strength of the magnet is gone. The iron falls from it to the floor with a crash. It could hold on to the suspended weight so long as the electric current passed through it and surrounded it. But the smallest break of contact with its source of power is fatal to its strength.

While the believer remains in intimate contact with Heaven's battery, he can do all things through Christ who strengthens him. But the instant that he separates himself from that source of power his strength is gone. Like Samson, he may not be aware of this until the Philistines are upon him, and then he will go out as at other

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times, and discover to his shame and sorrow, that he is powerless.

The secret, then, of holding out in the divine life, is to abide in the atmosphere of the Holy Spirit, to remain an unbroken channel of His energy.

The theory of the action of electro-magnets is most interesting. It is this. All substances are known to be more or less magnetic, that is, they possess the peculiar attractive and repelling properties of loadstone. It is supposed, for instance, that every atom of a bar of iron is a little magnet, having its positive and negative pole; and that all these magnets, so tiny that "100,000 million million million of them can be put into a cubic inch of space," have their attraction satisfied among themselves by the opposite poles of each atom turning toward those of its neighbour, and so forming magnetic completeness among themselves that when the iron is in a natural or unmagnetized condition it does not attract other metals.

When the electric current is turned into the coils, the iron becomes magnetic because the current has power to break up this mutual attraction of the atoms, and to turn all their like poles in one direction, so that their attractions are no longer satisfied among themselves and thus they reach outside and attract any piece of iron within reach.

"It must be kept in mind that it takes power

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to develop this magnetic power from its state of neutrality and that something is never made from nothing. When this power is developed it will do work. . . . The millions of little natural magnets have been forced to combine their attractions into one whole and to exert it on something outside themselves. They are under a strain in this condition, like a bent bow, and there is a tendency to fly back to the natural position, and if it is soft iron and not steel, they will fly back as soon as the power that wrenched them apart and is holding them apart is taken away. This power is the electric current. Now break the current, and the little natural magnets, that have been so ruthlessly torn from their home circle attachments, fly back to them again with the speed of lightning, and the iron as a whole is no longer a magnet.

"The permanent magnet is made of steel and hardened, before it is magnetized. It retains its magnetism; for even though its molecules tend to fly back the same as those of soft iron, they are unable to do so because the hardened steel is so much finer grained than soft iron, and the molecules are so close together that they are held in position by a friction that is called its cohesive force. Soft iron is comparatively free from this cohesive force, because its molecules are free to move on each other, so that when they are wrenched out of their natural position they fly back to their own attractions as soon as the force

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holding them apart is taken away. The molecules of hardened steel are unable to fly back, although they tend to do so.

"Let us use a homely illustration that may help us to understand. Let ten boys represent the molecules in a piece of iron. Let them pair off into five pairs and each one clasp his mate in his arms; each one, say, is exerting a force of ten pounds, and it would require a force of twenty pounds to pull any one of the pairs apart. The five pairs are exerting a force of a hundred pounds, but this force is not felt outside themselves. Now let them unclasp themselves and take hold of a rope that is tied to a post, and all pull with the same force that they were using, to wit, ten pounds each, and all pull in the same direction, and they would pull a strain of one hundred pounds upon the post, the same power that they were exerting upon themselves before they combined their efforts on something outside themselves. So with the magnet. So long as the force of each molecule is wholly spent upon its neighbour there is nothing left for exterior use. But so soon as they all line up and pull conjointly in the same direction their combined force is felt outside. The analogy may not be perfect, but it will help one to see what takes place in iron when it is magnetized." *

Until the Holy Spirit dwells within and is manifest through one, he is quite likely to be so

* "Nature's Miracles—Magnetism," Gray, p. 30.

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absorbed with himself and his own interests, that he is powerless. It is only when we forget ourselves and suffer the Spirit to so possess us that He shall turn all our latent abilities to ends outside ourselves that we become spiritual magnets, attracting and uplifting others by the power that worketh in us.

Although the atoms of a permanent steel magnet ever tend to return to their former state, and so to leave the steel non-magnetic, it will nevertheless, keep its power so long as we give it something to do, up to the measure of its capacity. And so we may make other magnets with it, thousands or even millions of them, and it not only does not lose any of its power, but may even become stronger for having done this work.

"Like the magnet the man who uses his powers to help his fellows up to the measure of his limitations, not only has been a benefactor to the race, but is himself a stronger and better man for having done so. But again, like the magnet, hung up without its 'keeper,' if he allows these God-given powers to lie still and rust for want of legitimate use he gradually loses the power he had and becomes simply a moving thing without influence or use in a world in which he vegetates." *

If a wire be held in the hands, and passed back and forth before a magnet, a current of electricity

* "Nature's Miracles—Electricity and Magnetism," Gray, p, 27.

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will be developed in the wire. This can be proven by taking a long wire, and attaching its two ends to a galvanoscope, an instrument for detecting the presence and direction of electric currents, and placing the instrument well away from the magnet.

When a portion of this wire is moved before the magnet, the needle of the galvanoscope swings to one side, indicating the presence of an electric current in the wire, although it is not connected with a battery, and does not touch the magnet. As the wire is moved up and down before the magnet, the needle is seen to swing first to one side and then to the other, showing that the current moves first in one way then in the other.

These are termed alternating currents, by which we mean first a positive and then a negative current impulse. And in producing them we have illustrated the principle of a simple dynamo.

An electric current will exert the same mysterious influence upon our wire, as did the poles of the magnet before which we moved it. Suppose we attach the two ends of a wire, a hundred feet long or any other length, to the poles of an ordinary battery, and in the wire place a circuit breaker, a common telegraph-key. Now bring our other wire near to this one, and we notice no movement of the galvanoscope needle; for though the new wire is attached to the bat-

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tery, no current is in it, for the circuit is not closed. When, however, we press down the key, a current will pass through the wire, and at the same time, the needle of the galvanoscope in the other circuit moves, indicating the presence of a current there also, although it is connected with no battery and does not touch the wire in which moves the current from the battery, except through the air which is a non-conductor. As we open and close the circuit, by alternately pressing the key and releasing it, the galvanoscope needle moves first to one side and then to the other, as in the former experiment.

In both these cases, whether by moving our wire before a magnet, or by bringing it near to a wire in which a current of electricity is passing, we have what are termed induced currents. These are among the most important of all electrical phenomena.

What are such currents? The theory concerning them is as follows: When heat motion reaches a sufficiently high rate of vibration, it throws the ether into a vibratory motion which we term light. "However, this vibratory motion of the ether is set up long before we reach the luminous stage; in other words, there are dark rays of the ether." In the experiments described above, the magnetism of the magnet and the electric current in the battery-wire, are also dark rays which throw the surrounding ether into a peculiar state of strain which is called magnetic or electric lines

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of force. When these ether waves strike the second, or galvanoscope-wire, they produce in its molecules a sympathetic movement from a state of rest to a state of static strain, which is indicated by the deflected needle of the galvanoscope. But when the current is broken, the strain is suddenly released, and like a bent steel bow, the molecules react, causing a corresponding swing of the needle as far in the opposite direction.

These induced currents of electricity are manifest all about us in numerous ways; indeed, apart from them we would be almost, if not altogether ignorant of this mysterious energy which so interlocks itself with all our concerns in life.

Before there is a discharge of an electric current, as between the poles of a frictional electrical machine, or from the clouds in atmospheric electricity, it is always preceded by induction along the whole path between the conductors. In no other way can a discharge take place.

It is possible also to telegraph or telephone, for a considerable distance by induced electric currents without direct wire connection. Mr. Preece says, " There is little doubt that two wires ten miles long (running parallel) would signal through a distance of ten miles with ease." This is the method used in telegraphing from moving trains. A circuit is completed on the train. That is, a wire extends from one pole of a battery along the car outside, parallel with the wire on

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the telegraph poles near the train, and returns into the car, and is joined to the other pole of the battery. When the key is pressed, and a current is sent through this train-wire, it induces a corresponding current in the wire on the telegraph poles, and vice versa. And thus messages can be sent and received at will.

Telephoning without wires has also been done to some extent by means of induced currents. It is these currents which cause one when telephoning to hear the voices of other persons with whom he is not conversing, and with whom he has no wire connection. His wire chances to run parallel with one which is in use at that particular moment, and the current in that wire induces one in his, and enables him to hear the conversation passing over the wire at a distance from his own.

It is by means of these to and fro, or induced currents, that the energy of the sun is transmitted to the earth. Indeed, every electrified body exerts this invisible influence, extending to a certain distance in every direction, upon all objects within its sphere.

The application of electrical induction to spiritual things is so aptly presented by Rev. Wilton Merle Smith, D.D., that I give his words: " Now, my friends, the whole question of moral influence in life is the question of induced currents. Why is it that when you stand before a friend whom you know to be selfish and worldly, you

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instantly have to fight the same temptation in your own heart? The strong current of selfishness with which that life is charged induces a similar current in your own heart for the moment, and you have to fight against it. Just so when you stand before any friend who is pure and holy, and whose purposes are consecrated, there comes into your own heart the induced current of those same holy aspirations.

"No life is so pure that it does not feel some induced current when standing before that which is base and ignoble, and no life is so ignoble that it does not feel some aspirations to holiness when standing before a life that is pure, and true, and Christ-like. I fear that we fail utterly to appreciate the tremendous power of this influence. It is all the more powerful because unconsciously exerted, and unconsciously received; but every day, ministers of Jesus Christ, what you are is preaching far more powerfully to your people than what you say. And every day, Sunday-school teacher, Christian in the ranks, whoever you may be, the power of your character is telling for more than the power of any words you may speak or write. 'Some nameless influence,' says Bishop Huntington, 'goes out from your least conscious hours that alters and shapes in its little measure every man, woman or child that you ever knew.' 'If thou knewest,' exclaims Richter, 'how that every black thought of thine, or every glorious thought, took root outside of

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thee and for half a century pushed and bored its healing or poisonous roots, oh, how piously wouldst thou choose and think.' " *

There is one other interesting thing that we will notice, and that is the way that living animal tissue frequently manifests electricity. It not only responds to electro-magnetic energy, as we have observed in the chapters on " Electricity and Life," but is able so to transform that energy that it manifests it in its electrical forms to everything that may be brought into contact with it.

It is well known that certain fish are able to deliver electric shocks. This is true of the Gymnotus electricus, or electric eel, inhabiting marsh regions and shallows in South America. It grows to a length of six feet, and is armed with a powerful electric battery, by which it is able " to impart a shock equal to that of a twelve-jar battery, and may give several discharges before its store of electricity is exhausted."

The Electric Ray, or Torpedo vulgaris, is another fish which is able to transform its food into electric energy. " It weighs upwards of a hundred pounds, and stores its batteries between its gills and the pectoral fins. It has entire control of the exercise and severity of this electric shock. It is sufficiently strong to magnetize needles, decompose certain chemical substances, and even to produce the electric spark of the Leyden jar, requiring similarly the completion of

* " The Influence of a Life," A Northfield Address.

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the circuit. The positive pole of this natural battery is dorsal, and the negative pole is ventral."*

The Electric Cat-fish of the Nile, called Malapterurus electricus, likewise possesses the ability to impart electric shocks. In the Proceedings of the Royal Society Messrs. Gotel and Burch describe some experiments on this fish. "The electrical discharge of an excised piece of the electric organ taken from a freshly killed fish were excited artificially by stimuli applied to it through the nerve. The piece experimented on contained approximately 530 disks. The maximum electro-motive force of the discharge was a little more than twenty-five volts. By calculating the total number of the disks in the entire organ of the fish, it is estimated that the electro-motive force of a discharge of the whole is about 200 volts; but as the fish was artificially cooled to five degrees for the experiments, it is believed that the maximum discharge at normal temperatures would be higher than this. The shocks felt by one of the experimenters during the dissection of the fish support his measurements of the electro-motive force." †

It is claimed that some men possess the peculiar ability, by rubbing, to impart an unusual degree of magnetism to others, and so to lessen pain and cure ailments, much as is done by electric

* "Natural History, Living World," J. W. Buel, p. 82.
† "The Electrical Review," August 22, 1900.

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machines. To what extent this may be done, we cannot say, but it is doubtless a fact that every living organism manifests electric energy in some measure.

In his "Practical Muscle Testing," W. S. Hedley, M. D. of London, says that local injury to a muscle produces an electric current from the injured to the living part; that local action produces a current from the active to the resting part. "It is by some regarded as proved that the white columns of the spinal chord give electric signs of nerve action, and that even action currents are manifested by the grey matter of the nerve centres. The skin of all animals is traversed by an electrical current from within outward. The action of the light upon the retina causes an electrical change; in other words, a current accompanies retinal activity as it does muscle activity. Indeed it is probable that electrical phenomena always accompany vital action."*

This holds good in the moral realm. Wherever there is life there holy influences will be felt. And this will be true in proportion as the life of the Spirit abounds in one. Virtue will issue from him as it did from Jesus, and from Peter and Paul in the passages referred to above.

It is well known that there may be such a condition of the physical system that it changes all

* "Therapeutic Electricity and Practical Muscle Testing," p. 92.

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the food received into poison to work its deleterious effects in the destruction of the body.

So it is morally. Some natures transform everything into that which debases the soul. But there is a state of heart in which everything heard, read or experienced is turned into a blessing, and makes for holiness. The soul becomes a storage-battery, which transforms all that it touches into divine energy, holding it in reserve until contact is made with human need, and then its heavenly dynamic is imparted to other lives, there also to fulfil its mission in the production of the flowers and fruit of the Spirit's grace; only again to be released to continue its work of spiritual transformation, until at last it returns to its home in the heart of God.

The divine energy which thus resides in the heart of the contrite one, and radiates in blessing from it, is none other than the Spirit of God. As He is the life of everything that lives, so is He the indefinable something in energy of whatever kind; that which the microscope cannot discover and chemical science fails to analyze, lying beyond the reach of algebraic equations and fine spun theories; but as truly the potency of the atom or corpuscle, as of the cohesion, chemical affinity and gravitation of the universe.

At the same time He is the Friend and Counsellor of all who will trust Him, embracing them in the tenderest love, drawing them into unity with Himself and one another, and so rearing a

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spiritual temple which shall be eternally resplendent with the glory of God. The necessity for His transforming work is beautifully typified in the old Arabian legend related by Reis Hassen.

It states that "there was in Paradise a temple built up of precious stones. Man dare not utter its splendours. Deep in the midst of the plains of Eden it stood, angel-built, a dazzling sanctuary. Our first parents sang their vesper songs in the twilight shadows of its courts; for there were pillared halls and cloisters of emerald and pearl, where fountains sprang aloft in the silent moon; and long luminous vistas where, hand-in-hand, those two first lovers walked in sinless beauty. Then there were pinnacles and domes of sapphire, blazing in the sunlight by day, and glittering in the starlight by night. From court and terrace waters welled out, and iris-crested cascades fell down to cool shady dells of asphodel below; for the temple was placed far within the privacies of that valley of Eden, whence the four rivers flowed eastward.

"However, sad to relate, upon the day Adam fell, this glorious temple was shattered into a million of fragments, and sown broadcast over the earth. These fragments we now light upon and gather up with cost and care, and call them rubies, emeralds, sapphires, and diamonds; but they are after all, only parts of that primeval palace.

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THE RUIN, REARING AND REVEALING OF GOD'S CHURCH

"Behold, I lay in Zion a chief corner stone, elect, precious."—1 Peter 2:6. "Unto whom coming a living stone . . . ye also, as living stones, are built up a spiritual house." Verses 4-5. "Her light was like a stone most precious, as it were a jasper stone, clear as crystal."—Revelation 21:11.

God's jewel-temple in Eden, built up in years gone by,
By sin was broken and scattered, and now the debris lie
Beneath the soil of self. The Heavenly Dove has flown.
No resting place on earth He finds, so broods aloft again,
As when the darkness reigned, and earth was free from men.
Those gems shall not thus ever lie, with sin o'er grown,
For in the love of God, a Corner Stone is laid
In Zion, and forth to it lost gems are drawn, and made
To live again. Yet not inert, an idle mass
They lie; but filled with life, He casts each one
Against the rocks of sin, that for His house may come
More stones to shine and live. And thus without a loss,
His temple grows from day to day in holy unity;
But not from fear or force. 'Tis by His own vitality,
Until the long lost Church a single gem becomes,
And throbs with light and life and love—His holy Bride,
And there upon a throne is seated by His side.
His Life now breathes through us, to change dead stones to sons,
The Power is His, but our's the work, and soon the joy shall be,
For when the Morning comes, He'll call, and then His face we'll see.

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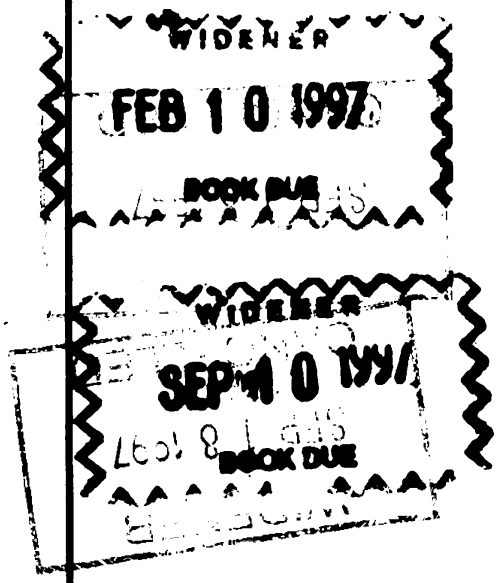

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