The Truth about High Frequency

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The Truth
about
High Frequency

A Digest of
High Frequency Electric Currents
Their Nature and Actions

By
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New York

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Manufacturers of the World Renowned
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"High Frequency Currents in Medicine
and Dentistry"
By S. H. Monell, M. D.

FOREWORD

IN offering this epitomized edition of Monell's "High Frequency Currents" to the thinking public we believe a word in explanation may not be amiss. The American X-Ray Journal in speaking of the author has said "Dr. Monell is regarded as one of the foremost thinkers of the medical world, and in electro-therapeutics has done more for static electricity than any other living man. His voluminous writings have made for him a living history. His books on the uses of electric currents . . . in electro-therapeutics have had an enormous sale. As author, teacher, scholar, he is at the top."

As manufacturers of High Frequency Outfits for both the home and practicing physicians it is our desire to spread abroad the real truth about High Frequency. It has been so long misunderstood or so little understood that we believe it high time that the public be better informed of its real mission and value.

We know of no better way to accomplish this aim than by putting this volume of excerpts from Monell into your hands. You will find it at once scientific, informative and intensely interesting.

We have not taken up the application of High Frequency to specific diseases in this book. But to those who are interested we shall be glad to send our treatise on the subject upon application.

When you have read this volume we should be glad to have you pass it along to some interested friend. Or, if you will send us the names of friends whom you know are interested we shall be glad to send them copies of "The Truth About High Frequency" without cost.

Western Coil & Electrical Co.
Manufacturers of the World Renowned "Vi-Ray-O" High Frequency Outfits for the Home and Practicing Physicians.

A FABLE

Dedicated to His Colleagues
by the Author

A GREAT Musician, wandering in the Forest with his $10,000.00 Violin, fell Fast Asleep beneath a Tree, and the Animals gathered in discussion. One said, "What is the Box the Man has?" "It is a Mystery," said Another. "No one Knows What it is; It is Very Mysterious!" said they all.

"It is a New Discovery," remarked the Ostrich. "I was the First to See it," said the Lynx-Eyed Lynx. "I was the First to Describe it!" cried the Giraffe. "I Mentioned it First"—"I Improved it"—"I Modified it"—I Invented the Wood of Which it is Made"—"I Devised the Hole in the Handle"—Shouted the Quartette of Claimers with one Voice.

"The Method of Making it Go Originated with Me!" Clamored the Camel. "Not So," said the Learned Fox; "I had been Using it a Half-Hour before you came," "It is in its Infancy," said the Cautious Turtle, "and Should be Thoroughly Investigated." "I long ago Abandoned It," said the Sacred Ox. "And I," repeated the Roebuck; "And I," echoed the Buffalo; "And I," Chimed the Chorus of Independent Scientists in the Back Seats.

"It is a Music Box," spoke the Conservative Owl who was Up a Tree. "What will it Play?" asked the Lion. "A Whole Lot," answered the Owl, who had Traveled and heard Paganini and Ole Bull.

"I Do Not Believe It," said the Animal from Alice's Wonderland. "It is entirely Empty, it Cannot Make a Sound," said One who stepped Close and Looked into It; while another gave the Box a Knock and Confirmed his Colleague's report.

"Let us Try it," said the Kangaroo, whose wits had been Remarkably Sharpened. "Yes! Let Us Try It," said they All; but on Reflection the Conservative said, "We do not Accept it as a Universal Orchestra: it Has not been Scientifically Demonstrated as Yet."

At length Several Extremists, noted for Pursuit of the New, exclaimed with Enthusiasm, "We have No prejudice Against Scientific Music; Let Us Try It!"

So the Moo-Cow rubbed the Strings of the Violin with her Nose, and they Moaned; the Elephant drew his Trunk across the Strings and they Groaned; the Hippopotamus Gently Stroked them with Her Tail, and they Wailed; and at the Scratch of the Leopard's Claws they gave a Sharp little High-Pitched Cry.

The Koodoo Africanus swept a Triumphant Glance around: "I Told You So! this is Not a Universal Piano Player, it will Not play Everything!"

"It Evidently has its Limitations! it is Not an Orchestrion," declared the Close Observer who had Watched the Proceedings with Professional Distrust of the Exaggerated Claims Being Made on Every Hand. Taking this Cue, "It is Obviously a Quack Thing!" called the Owl from the Top of the Tree.

"I do not Regard it as a Giasticutus," uttered the Deprecatory Voice of a Critic, and All Agreed that its Value was Greatly Overestimated by Enthusiasts. "As it will not play Every Tune we Cannot Unqualifiedly Endorse it as an Unfailing Harmonicum," was the Sage Verdict of the Wise in the Convention.

"I would Not Advise its Use," spoke the Emu looking on at the Conclave. "Nor I," said Another; "Nor I," vouchsafed a Third.

Thus it was Demonstrated by the Most Scientific Tests (and was the Consensus of Scientific Opinion among the Leading Animals, especially Among the Older and Superior Heads) that "the Alleged Orchestra (or So-called Universal Music Machine) while AdmittedlySuggestive, and Possibly Able to Render Certain Tunes Through the Agency of Suggestion, is not yet Thoroughly Understood and its Employment is not Recommended. The Few Sounds it can make are such only with Respect to a few Notes, and these of No Great Consequence or Significance."

This Preliminary Report was therefore Submitted to the Convention by the Committee of Investigation and Approved and Carried.

Whereupon the G. M. awoke, much refreshed, took his Stradivarius under his arm and that evening at the opera house entranced an immense audience by his interpretations of Beethoven, Mendelssohn and Liszt.

PREFACE

IN a plain and conservative way this book will aim to show what high frequency currents of electricity can do.

Their value in many acute and chronic conditions which are common in medical practice has become so marked that mere acquaintance with the results obtained by others should prompt a desire to employ them by all who read of their work.

* * * * *

If the equivalent of this great pain reliever, antiseptic, and promoter of metabolism, had been a new serum, or antitoxin, or some psychic fad half pseudo-science and half quack religion, the fame of it would have swept around the world in three months. But this remedy—more far-reaching for good than exploited catarrh and cough cures, and vaunted "vegetable compounds", and all the combined "best sellers" of patent medicine factories, in which the American Public invests some hundred million dollars and twenty per cent of its health per year—happens to be only one phase of an electric current, modest, reticent and conservative, the study of skilled men, the subject of a decade of scientific investigation; and so it has patiently crept into quiet recognition during the past ten years, tested by progressive physicians here and there, and more in Europe than here, yet never losing ground once made, ever gaining increased confidence, and now slowly coming into its own.

CHAPTER I

High Frequency Current—What It Is—Tesla's Startling Demonstration

When street lighting by electricity was introduced a generation ago, the currents employed and the only commercial currents known, shot through their circuits like streaks of searing flame, so "heavy" in quantity that a live wire would destroy life almost as quickly as a stroke of lightning. They were "dangerous" currents, and workmen touched them carefully, or were careless at their imminent risk

On a memorable night in May, 1891, Nikola Tesla, the Slav, young and enthusiastic, with a poet's mind and the aspirations of genius, stood before the American Institute of Electrical Engineers and lighted lamps with currents passing harmlessly through his own body and heated wires to incandescence by the touch of his conducting hand.

With smiling countenance and without physical sensation he placed himself in circuits that by all the laws of alternating or continuous currents should have brought the lecture to a close by the death of the daring lecturer. Yet he went sweeping on, astonishing his audience by demonstration after demonstration of unfamiliar discharges, new-born into electrical science and christened with the name "High Frequency." That lecture sent the fame of Tesla around the world.

It was the beginning of the wireless wonders of telegraphy and telephony, and the flight of harnessed motor power through the air; and it created a new weapon for the healing art.

Now, what was it that Tesla had done to the ordinary "heavy" current that robbed it of danger and produced its extraordinary characteristics? In the simplest words, he had practically nebulized it with a transforming atomizer, diffused the heavy stream of current into a discharge of mist, transformed the thick flow of low-voltage current into a myriad of minute particles of tremendously high voltage, imparted to the primary low-pressure volume of the street mains the penetrating velocities of hails of miniature bullets. These alterations in the character of the commercial current made possible its new actions.

In transforming the primary current into high-frequency discharges Tesla took from it some of its former properties. For instance, it lost its electrolytic energy, it would no longer exert the same power through the same motor, it ceased to sear and burn in its track, and contact with it no longer struck the muscles with a paralyzing and deadly shock.

High Frequency "Pulverizes" Current

To comprehend the change is to grasp the explanation of the effects. We can fancy a man beneath a falling cliff, crushed by the mass and stunned to instant death. But if, by an ingenious device, the mass in falling becomes finely pulverized and drifts down upon the man in a cloud of dust, we can imagine that he will still stand erect and can move in and out of the cloud harmlessly.

In effect, and according to the different nature of electricity, Tesla made a somewhat

analogous transformation in the relations of the elementary component phenomena of the current he employed. With its greatly multiplied pressure raised from 110 volts to hundreds of thousands, it easily broke the bonds of ordinary insulators, moved on open circuit and discharged from a single pole.

With particles now infinitely smaller than our blood-corpuscles or the pores of the skin, it passed through the body as sunbeams pour through a keyhole, not stopping anywhere long enough to set up ordinary sensation or stimulate any muscle-fibre to contract.

But the gentlest dew feeds plants with moisture and grass grows rank in fogs as well as in the rain. A mist will saturate the leaves of flowers and furnish drink to thirsty soil; and this nebulous, all penetrating, tremendously energetic but marvelously gentle high frequency current will saturate the human tissues from head to foot and feed them with potential vitality from which a new increase of physiological nourishment is derived.

The mechanical devices which regulate amperage, voltage, interruption, and resistance, in medical currents of electricity, have now added to these common and fundamental factors of dosage the fifth and revolutionary factor of "frequency." And it is this new factor acting with certain others which lends to this new phase of electricity the properties which enable the average person to use it in ways that obtain certain therapeutic results which were previously unknown.

This word "frequency" is a distinctly modern term. The galvanic current does not alternate between positive and negative poles, and hence has no "frequency". The term is not applied to faradic currents at all. They are "interrupted" currents which are relatively low in the scale of volume, voltage, and number of breaks per second. The alternating street current for light and power is usually a 110 volt, 60 cycle current, oscillating only 120 times per second, and this low rate does not call for distinctive consideration.

But when alterations rise above 10,000 per second and voltage mounts beyond the hundreds of thousands, these twin features put such currents into a class by themselves and they are called "currents of high frequency and high potential."

They can be made to attain a voltage above a million and a frequency above fifty billions per second, but with these extremes their medical actions diminish and in practical use a range of from 5,000 to 500,000 and frequencies between 200,000 and ten million is employed.

The greater part of medical treatment is probably done at this time with medium frequencies under two million.

An Electrical Spray

Treatment with this agent presents one novel feature not formerly employed with any other medical current; namely, the administration through a Geissler vacuum tube electrode. The glass and the vacuum act as a "resistance" which, inserted at the end of metallic conduction, acts upon the current something as the resistance of the small outlet against which a vigorous pressure drives the fluid from the bottle of an atomizer—it atomizes it. It turns the denser current into a spray discharge.

It has long been the plaint of the scornful that "we do not know what electricity is", and there has been a demand from such that we should have a definition in set words—as, a cane is a stick; or a quart is two pints—before their confidence could be asked by this agent.

We shall present the modern accepted definition of electricity in a moment, but first take heat—common, familiar heat. The Century Dictionary defines heat as "the energy of molecular motion." It seems plain, but let a stranger from the north pole who has never felt heat enough to know it, take this definition home with him—what help would he get out of it? Could he search, anywhere around him and identify the "energy of molecular motion" close enough to tell his wife what to use it for? What help is the definition of heat to the cook? or to the blacksmith? or to us?

The fact is, that in doing the world's work we use the tools at hand first, and scholars sit down and define them afterwards. It may be doubted today if one in a thousand of the highly educated surgeons who daily use a steel knife know what iron ore is, or can define it. We have lately read that no one knows. If that is true, the incomputable millions of tools made out of iron ore and used without a definition make the alleged need of a definition of electricity ridiculous. The main thing is the use.

Electrons The Foundation of Matter and Force

Nevertheless, here follows the scientific information that you have been asking for, and the perusal of it should leave no further objection to the employment of electric currents.

It is now, since the enunciation of the electron theory some years ago, the conception of science that electricity consists of electrons, the electron corpuscle being the structural unit of all the

phenomena of matter and energy, the smallest entity in existence, complete in itself.

The corpuscle electrons repel each other, but form alliances, and when they unite in groups of from 800 electrons up to 200,000 these groups constitute the atoms of the various chemical elements, seventy-odd in all, which make up the known forms of matter. The number of electrons in a given group (the 800 group is the hydrogen atom) determines its physical and chemical properties and its atomic weight, through all the solids, fluids and gases of the material world.

These units (each one being a corpuscle of negative electricity) are held in the harmonious relations of their atomic grouping by the attracting force of positive electricity; for, just as every magnet and each part of a magnet down to the smallest, has a north and south pole and every stick two ends, so every electrical charge has two signs—positive and negative. The attractions and repulsions of the positive and negative signs are the essence of electronic phenomena in all their manifestations.

This double property of electrons makes them sources of matter and sources of force as well, the dissociation of stable forms of matter furnishing the intrapatomic energy of the unstable forms of matter which we call heat, light, electricity, etc.

Science now deems that manifestations of what we call energy are vibrating waves discharged from electrons acting individually or in collected units. These waves propagate with different lengths, swiftness, frequency, etc., ranging all the way from the infinitely limited motion of the electrons composing the densest of solid metals up to the nearly 2-quadrillion vibrations per second of the highest ascertained ray of light. It is the constant dance of substance, for inert matter does not exist.

Therefore, according to the most advanced thinkers of present-day science, the primitive world-forming unit is the electron, and electricity itself (in particular) is the specific form of the agitation of electrons which manifests itself in decomposition, magnetism, heat, light, etc,—and measured by the total kinetic energy of such agitation.

Electricity Man's Best Servant

A number of persons whose scientific attainments enable them to read a newspaper and absorb wisdom of Sunday Edition Symposiums on wonderful things are wont to stigmatize electricity as "mysterious", and as a claim to credit and proof of their own superiority, they assert that "they do not believe in it." "They"

thus besmirch its character and place it in the list of those who are no better than they should be. This is keeping electricity back. But in the light of nature's physical laws it possesses the same mystery as fire, water, wind, acid, alkali, friction, cold, grass, atmospheric pressure, or a beefsteak; but no more.

It is the expectation of men who have lived through the development of instruments of refinement which commenced with the first galvanometer of the late great genius, Lord Kelvin, that still further advance in delicacy of research and yet undiscovered apparatus will, in due time, determine the exact electrical conditions of physiologic activity in man, and will enable us to command and apply to the diseased organism the precise administration of electrical energy required by nature to restore to normal the physiologic balance of the cellular functions, the particular unbalancing of which is manifesting itself as a disease.

The past forty years have taken us far in this direction—much farther than the non-posted reader suspects—and we need not neglect the potent resources of the present while waiting for the revelations of the coming twenty years.

Electricity will some day stand revealed to patients and physicians alike, as the most variously helpful and faithful servant ever heaven-sent to earth to be the hand-maiden of the healing art.

CHAPTER II

Life Phenomena and Electricity

The word "physical" means "pertaining to nature or to the body." The word "physiologic" signifies, "pertaining to the normal (natural) functions of the body and organs." The applications of the one to the other—going on all the time in the human organism—is nature's way of keeping us alive and well. Mechanical instruments for intensifying and directing dosage and action permit us to copy nature's own means to an important and growing extent.

To enable us to follow in her footsteps with what skill we can, some knowledge of nature's internal processes is necessary, and as a key to unlock part of the problem before us, we shall now point out how nature shows the way.

Internal electrical stimuli of various wave lengths are known to excite not only the functions of motor nerves and to induce the contraction of muscle-fibres, but they also operate the special senses, the work of glands, and the processes of nutrition. In short, according to

some authorities of the present day, the whole machinery of life's movements is electrically driven. It was once ridiculed, but now it is so plain that it is obvious that no other means of inducing motion could by any possibility be applied to the internal human mechanism. Steam or compressed air certainly could not, nor could a clock spring be wound up to advantage within the intricate organism of the body. Yet, something must act as a motive power to maintain the ceaseless motion of living cells or they would no longer be living cells—they would be stilled in death.

"Vital Force" Electrical

The electron theory of vibrations more and more throws light upon the once dark places of physiology. It is held that different nerve centers and different cells are tuned to impressions of different wave lengths, as in wireless telegraphy a tuned receiver will respond only to a similarly tuned impulse. Many years ago inductive reasoners argued that electricity and what they called "vital force" were identical, but for lack of modern instruments of demonstration the early physiologists rejected the idea that electricity and life had much in common. Now it is accepted that the workers of the body, the tireless energies of living matter, every cell and nerve in the breathing engine called man, sustain their marvellous toil under an electric drive.

The old aphorism that "labor is life" is expanded to disclose that electricity is the laborer which distributes the released energy of our foods, the combustion of which in the system by union which oxygen supplies the initial fuel and the heat for conversion into force—phenomena very closely analogous to the conversion of heat into force by the combustion of fuel in the steam engine and the generation of electricity by the engine-driven dynamo.

The elementary tissues of which the body and its organs are built up consist of four structural groups—epithelial, connective, muscular, and nervous. The supreme importance of the cell, the fact that cells are the living units of the organism, the growth of the body from cells, the dictum of Virchow, "every cell from a cell," intensifies our interest in the fact that cells respond to electrical stimuli.

The power that certain tissues possess of responding by some change to the action of an external agent—taking up the external energy and transforming it into their own energy—is called "irritability" or "excitability", and this power is especially manifested in which blood-corpuscles, ciliated epithelium, muscle-fibres,

nerves, and the secreting glands. The agent which thus acts is called a stimulus. Such physical stimuli may be mechanical, chemical, thermic, or electrical, and they are regarded as "liberators of energy." As the disturbance of irritable structures by a stimulus is some form of movement, either visible or molecular, a stimulus is considered as added motion.

Living material is in a continual state of unstable chemical equilibrium, building itself up on the one hand, breaking down on the other, and the term used to express the sum total of these intra-molecular re-arrangements is metabolism.

Electricity Stimulates Cells

The body is composed of cells. A cell possesses the power of breathing, that is, taking in oxygen; of nutrition, of building itself up from food materials; of excretion, or the getting rid of waste material; but the most obvious characteristic of most cells is their power of movement.

The physical energy of these powers of cells can be acted upon by the directed energies of physical agents; and beneficially so when applied in accordance with the physical laws of life. The protoplasm is therefore sensitive or irritable to stimuli, and shows its irritability by contraction or movement of its mass.

Moderate heat acts as stimulant. Weak electrical currents stimulate the movement of cells, while during the passage of a strong current the cells assume a spherical form and become motionless. When a gentle current is passed through water in which a number of tadpoles are swimming about they are seen to all fall in line and head in the direction of the current-flow. The relation of cells to various forms of physical and chemical stimuli, especially electricity and light-rays, has been recently very extensively studied. Cells move either from or toward the stimuli, according as they are electro-positive or electro-negative to it.

Cells must eat to live, and we know that electricity can promote appetite. They are nourished in the following way: When the blood is circulating through the thin-walled smallest blood-vessels certain of its fluid constituents escape by osmosis, or filtration, through the minute orifices which exist for this purpose, otherwise our digested foods could not reach the cells. The fluid part of the blood which thus leaves it to be eaten by the cells is called "lymph". It penetrates to all parts of the cellular elements of tissues and nourishes them. Electricity promotes the osmotic energy

of electrolytic fluids such as the blood, by imparting "added motion" to the cells stimulated by it.

A Word About the Blood

During life the blood is in constant movement —circulating; leaving the heart by large arteries which divide into diminishing branches and reach their smallest size in thin-walled microscopic capillary hairs of vessels which leak out the lymph nutriment to the tissue-elements and remove from them the waste products of their activity, namely, the ashes left from the combustion of food-fuels burned up in the body in work.

The ashes are carried to the various excretory organs to be eliminated, and the excess of lymph, minus its deposited food materials, is collected again by lymphatic vessels which converge to the main thoracic duct which opens into the large veins near the heart. The lymphatic portion of the blood and the main blood stream returned from the arterial capillaries by the veins, now join in the heart and with fresh cargoes of oxygen and nutriment begin the same wonderful round all over again.

The blood is saline, faintly alkaline, a perfect electrolyte in itself, and is one of the best conductors of electric currents, after metals. By means of rightly directed electricity we can cause it to increase its intake and output of oxygen, accelerate osmosis (a most important factor in nutritional exchanges in all parts of the body), can also increase or decrease the amount and rate of blood-flow through a given part, and in some degree regulate the blood-pressure when it is either abnormally low or high. These responses to electrical stimuli are exceedingly useful.

Nervousness Controllable

Almost every woman is aware that she has "nerves" and some of the teachings of physiology about them will assist us to understand and relieve a good many "nervous" conditions.

The central stations of our two-fold nervous system are the nerve cells in the nerve centers of the brain and spinal cord, and the ganglia of the sympathetics. Our voluntary activities are dominated by the cerebro-spinal centers, and the "sympathetics" preside over the processes of functions which are beyond direct control of our will. When we speak of centers we mean central cells; when we speak of nerves we mean simply the nerve-fibres which are the conducting portion of the nervous system. There are two directions that impulses must be carried—in and out—hence we have two main sets of

nerves. Afferent (sensory nerves and nerves of the special senses) conduct impressions from the surface to central cells. The afferent nerves (those which conduct impulses from centers to other parts of the body) are classified according to function, as follows:

1. Motor nerves, which supply muscles and muscle-tissues in the walls of arteries and intestines.
2. Accelerator nerves, which control increases in the rate of rhythmical action, an example being the accelerators of the heart.
3. Inhibitory nerves, which influence slowing of the rate of rhythmical action, or its complete arrest. The inhibitory nerves of the heart are a typical example, but many of the involuntary muscles have them also.
4. Secretory nerves, which supply secreting glands, such as the salivary, gastric, and sweat glands. A stimulus to one of these nerves causes secretion in the gland it supplies.
5. Trophic nerves, which preside over the nutrition of the parts they supply.

When a nerve is stimulated the propagation of some change is evident from the resulting effects—movement, secretion, sensation, etc—but the only alteration in a nerve which can be readily detected as evidence of molecular change is the electrical one. All tissues which can be excited to their characteristic action by a stimulus, have internally generated "action-currents" of electricity, those of nerves, muscles, secreting glands, ciliated epithelium, having been especially studied and demonstrated by Waller and numbers of his followers.

Electricity the Best Counter Irritant

Du Bois Reymond demonstrated that the spinal cord, like the nerves, exhibits an electric current. Gotch and Horsley investigated the currents of the cord very thoroughly. Electromotive changes also occur during activity in the cortex of the brain. In fact, throughout nature it is almost impossible to have action without electricity. Atmospheric electrical discharges occur on an enormous scale, as every one knows but every one does not remember that even the cleavage of atoms is an action that results in an electrical discharge. Friction produces electrical phenomena, and in every direction we see the processes of nature identified with electrical manifestations.

Waller regards the current of action of any excitable tissue as an index of the magnitude of action, and while we can see a muscle contract and witness the results of secretion, yet in a nerve the only available index we can demonstrate is the electrical sign of activity.

In speaking of action currents Howell observes: "This phenomenon of a negative electrical condition traveling over the nerve or muscle and giving us an active current when led off through a galvanometer is of the greatest physiological importance, particularly in the study of nerves. It is an invariable sign of the passage of an excitation, or nerve impulse. A nerve cannot enter into activity without showing an electrical current, that is, a moving electrical charge."

The actions of tissues may be in response to a direct nerve stimulus or to a reflected nerve impulse. The latter action is called "reflex." It starts from a stimulus applied to the terminal filaments of sensory nerves on the surface of the body (or a nerve of special sense), travels inward to its central station and there propagates an outward impulse which sets up its action in the tissues that the "outward" connecting nerves supply. Thus deep organs as well as superficial tissues can be influenced by reflex action.

In medicine the theme of the reflexes is wonderfully fruitful of inspiration to the student of both medical and physical therapy. It is a great field for the application of the teachings of physical. The skin is full of starting points of reflex action and the entire skin is accessible to our reach. Modern scientific hydro-therapy is wholly the utilization of reflexes. Every good treatise on materia medica and therapeutics contains a section devoted to treatment by counter-irritation." Electric currents can be easily dosed and directed in their discharges so as to become the swiftest, best and most effective or counter-irritant agents in the whole of medicine. And that is only one phase of their comprehensive usefulness.

Electricity Commands Universal Admiration

Professor Elihu Thomson says: "I am quite convinced that ether is the electrical medium, light and radiant heat electrical, and the chemical and mechanical properties of matter in all probability electrical in essence; that matter itself is an electrical phenomenon."

Physiology states that the elements found in the body are carbon, nitrogen, hydrogen, sulphur, phosphorus, fluorine, chlorine, iodine,

silicon, sodium, potassium, calcium, lithium, iron, manganese, copper and lead. From this supply Nature has ample choice from which to equip her infinitely miniature "chemical cells." A battery cell the size of a thimble can generate enough current to cable an impulse across the Atlantic and Nature does not require a horse-power dynamo for the processes of her metabolism. Myriads of her nerve fibres are too small to be seen with the most powerful microscope.

It is therefore no longer difficult to comprehend the sources of internal self-generated, or self-liberated, electric currents of small magnitude to act as stimuli for the protoplasm and as conductors of impulses from nerve centers to all parts of the body.

Physiology has long stated that the human body is a great "electrolyte" (which means, "any substance decomposable by electricity") and from this knowledge to its logical sequence that having the requisite conditions for the liberation and action of electric currents we therefore have the natural result, must be the unavoidable conclusion of science.

There is no doubt that Nature has the currents for use in the living body. The question is, "What does she do with them?"

Skepticism and prejudice against high frequency electricity can mostly be resolved down to a case of "I didn't know" on the part of the non-posted majority. Admiration for this very exquisite ally of medicine increases with one's knowledge about it, and the authoritative facts cannot fail to impress even the most uninformed with the magnitude and dignity of this physiologic agent.

CHAPTER III

Life Phenomena and Electricity Continued

From nerves to muscles is a natural step. Muscle, the flesh of the body, makes up 42 per cent of our weight. Its great physiological function is contraction, with the disuse of which all other functions stop. With the normal exercise of muscle-function all functions flourish and strength grows.

Muscle undergoes many changes when it contracts. The chemical changes are more energetic than at rest and more heat is produced and its temperature rises. It also undergoes a change in its normal electrical condition. It first becomes electro-positive and then falls back to electro-negative, and in a succession of contractions (in all our work and movements) this electrical activity is going on in the muscles all the time. Hermann, in particular, has demonstrated and explained the action-currents of muscle tissues.

In the living animal, muscles are always in a state of "tonus," ready to contract when called on without losing time or energy in taking up slack. This important tonus is under the control of the nervous system, and it can be "toned up" (when weakened) by an electric current externally re-inforcing its own. We may demonstrate the immediate action of this by having a patient hold out his arm with a weight in hand until it is ready to drop. With the added tonus of an electric current he can continue to hold it out much longer without fatigue. In the treatment of debility no other means of energizing muscles and nerves, and thereby invigorating all other functions, can be compared with high-frequency electricity.

The Cause of Tired Muscles

The chemical changes in a contracting muscle consist in an increased consumption of oxygen, and an increased production of heat by oxidation, together with an increased output of waste materials. By electrical exercise of muscles we favorably affect the activity and amount of these chemical changes. The extraordinary physiologic beauties of the skilled exercise of muscles by this tonic stimulus and promoter of all functions, remain for the most part to the medical profession and the public, as the Garden of the Hesperides to a host of blind men. Yet in health or disease we may benefit by it.

To every person who has ever been "tired" the subject of fatigue, or the way to get rid of it, possesses intrinsic interest. We are apt to say that our muscles or our nerves are tired, but that is not so, as we shall now see.

The sense of fatigue in a muscle as the result of prolonged work is due to the combustion (burning up) of the substances available for the supply of energy in the muscle—but more acutely due in particular to the accumulation of waste products of contractions, which collect faster than they are carried out of the tissues.

By the method of "graphic tracings" the "curve" of a normal muscle is ascertained. Then it is studied under continued contractions. Fatigue gradually reduces the curve, prolongs the latent period of relaxation, and if carried to the end, makes further efforts at contraction impossible. If the arm muscles have been thus taxed the arm drops as if paralyzed and can no more be forced to further work in chronic fatigue than we can push on a string. This is

the heart-breaking and wage-destroying condition that overtakes the telegraph operator when he has "writers' cramp." There are fifty thousand cases of it in this country.

Fatigue Really Muscle Suffocation

The question of absorbing interest is, where is the seat of fatigue? The present writer puzzled over this question for many years, during which he personally treated more victims of writers' cramp than perhaps any other physician in this country. Is the fatigue in the nerve, the muscle, or the end-plates?

By tests and processes of exclusion physiologists have determined (and our own practical experience confirms them) that:

1. The muscle itself is not to any great extent the seat of exhaustion.
2. The seat of exhaustion is not in the nerves. This cuts out two of the three local possibilities and there is only one left, therefore:
3. The localized seat of fatigue is in the nerve end-plates but
4. The fatigue toxins (the products of muscle metabolism during work) still more speedily jade the nerve centers and diminish their power to send out impulses. The central cells are far more sensitive to the toxins than are the working ends of the nerve-fibres, and hence they are first to express fatigue.

It is Nature's way of protecting us from overdoing. The chief waste products of muscle work are carbonic acid and sarco-lactic acid. Carbonic acid will stupefy any tissues that breathe an excess of it. Carbonic acid poisoning is asphyxia, and persons overcome by gas suffocate. It is a matter of common experience that one's mental state influences markedly the onset of fatigue and the amount of muscular work one can do.

What we call fatigue of our muscles is in reality an expression of too much carbon dioxide or carbonic acid in the motor centers, making the cells dull with the heavy drowsiness of narcotic. The remedy is to drive out the toxins and refresh the cells with oxygen, and fortunately we can make electricity do this, and do it easily and quickly.

The reason why the seat of fatigue is not in the nerves is still better. It is practically impossible to fatigue nerves. Waller, the great investigator of the nervous system, showed that nerves are not fatiguable, not because no

metabolic changes occur in transmitting impulses, but because the change is so slight and the possibilities of repair so great—the resupply of energy so inexhaustible—that fatigue in the ordinary sense of the word cannot be demonstrated in nerves. It is demonstrable only in the nerve cells of nerve centers. One of the greatest physiologists remarks: "When one considers how many of the nerves are in constant action throughout life we should hardly expect nerves to be peculiarly susceptible to real fatigue". This should be comforting to the thousands of people who have been told that they were suffering from "nervous prostration." It is something else.

High Frequency Current Energize All Bodily Functions

We now come to the great function of Respiration, of which a philosopher has said: "You live as long as you breathe."

In the central nervous system there is a small district called the respiratory center which gives out impulses that travel down the cord to the spinal centers that innervate the muscles of respiration. For breathing is a muscular process and our lungs are enabled to breathe only by the muscular work of their environment.

The importance of this physiological fact in this study of nature's methods arises from the readiness with which we can make high frequency electric currents stimulate, energize, and strengthen the contractions of every muscle concerned in the respiratory mechanism.

The respiratory center also receives various afferent nerve fibres which exert reflex influences. In the vagus nerve are two sets of nerve fibres, one of which increases the activity of inspiration and the other of expiration. The vagus can be readily stimulated by an electric current and the function of respiration energizes. It is one of the simplest things to do.

We can therefore direct high frequency electricity so as to make it functionate the respiratory muscles, re-establish their energy in debilitated states, enhance a diminished breathing capacity to as near normal as the essential damage (if any) to the air cells will permit, and (when there is no organic damage) completely and rapidly restore the whole mechanism—chest and lungs—to a sound state.

Examples of this action may be witnessed in the treatment of all stages of ordinary bronchitis, in the swift restoration of the organs after pneumonia, and is also demonstrated with great beauty in the treatment of incipient

tuberculosis. In any case of tuberculosis not too far on the way to the third state, we may at least offer the help that a fresh horse gives a tired team on a hill, and this uplift alone is often the support and comfort of a few more years of life. In grave, though an incurable disease, the help of high frequency electricity is never to be despised. In purely functional inhibitions of part of the respiratory capacity we have over and over again in scores of cases made it release the center from its incubus and restore full breathing power, almost as the crack of a whip makes a small boy let go a hitch on the back of a wagon.

High frequency currents can be made to stimulate the functions and secretions of the cells of glands, the impulses of nerves, and the contraction and movements of muscle fibres. The physical conditions affecting digestion and under which nature carries it on can therefore be influenced by high frequency electricity.

Mechanical excitation of the stomach produces no secretion of gastric juice but electrical stimulation of the vagus nerve usually results in an abundant secretion of the gastric juices.

Conclusion

Of late years we have heard much about "Preventive Medicine." To some it seems to be the supreme mission of medical science, for an ounce of prevention is held to be better than cure—unless one is sick.

But what is preventive medicine? It is not a remote idyllic dream, nor altogether an abstruse problem in the higher mathematics of sanitation that nobody can understand but the Health Board. It is practical common sense. It begins right at home. Every breath of fresh air and every good square meal properly eaten is preventive medicine. So is a pair of dry stockings when the feet are wet.

Obviously, this is an important subject from all standpoints. We think it possible to put the gist of it in a few words. Practice intelligent discretion and common sense in the habits of daily life and always keep up to par. But if the system falls below par promptly restore its normal energies by the aid of high frequency currents. Lastly, if disease approaches, threatens attack, or makes an assault whether fierce or feeble, seek treatment at once.

The "refreshing" effect of a high frequency current on the tired body has spread its repute as a quick-rest tonic wherever it has been used. Said a gentleman recently—a gentleman of solid proportions and dignified age—"As the results of using it lately I feel like throwing

out my chest, expanding my lungs, and taking a deep breath. I feel buoyant, exhilarated, and like running and jumping." And here we have the keynote to the tonic action of this agent and its power to neutralize fatigue.

Sleep knits up the ravel'd sleeve of care and is nature's sweet restorer, but there are times when it is hard to get when most needed, and it can neither be forced nor condensed at will. As to drugs, we know of no medical prescription that antidotes fatigue.

As a mere demonstration of the power of a high potential current to create the full sense of physiological rest we have taken a desk-worker at the limit of endurance, so fatigued and fidgety that he could no longer push upon his brain, applied a swift stimulus to the back of his head and upper spine, and in less than the lapse of three minutes he has been restored to condition for renewed and competent effort.

We have taken men on the verge of acute break-down from days of strain and anxiety in business and in a single and short treatment with a high frequency current have enabled them to face the crisis and fight back their fears. We have seen electricity put buoyancy into the steps of men sinking under cares of sleepless anxiety at home and high-pressure labor at their office. We have seen it take the drawn look from the face and the heaviness from the heart of women worn to the very edge of exhaustion. We have seen it release the tired teacher from the jaded mind of her routine, the tired scholar from the useless over-tax of examinations, the lecturer from the results of combining an editor's toil with his tasks of speaking, men attempting to double their salary by ending the day with eight hours duty at night and all these and many others we have rescued and given new vigor for their work.

There is a marked difference between the fatigue-effects of a brief period of over-work or strain and the effects of a slowly acquired worn-out state, and this difference must be taken into account in treatment. There is also a difference in the restorative needs of the person who is stiff and lame from extreme and unusual muscular exterion, and the needs of the brain cells that have been sleepless and irritable from excitement, worry, or mental tax. And we meet also a third class of fatigue resulting from mental and physical exhaustion combined. For all these states there may be other means of restoration (though for some of them time is not a cure) but the one swift and decisive tonic and quick means of rest is an electric current.

Taking high frequency currents in their entirety and their various modes of administra-

tion we have in them a powerful tonic to all nerve cells, nerve centers, nerve endings, and nerve functions, both of the sympathetic and cerebrospinal nervous systems and the nutritive energies of the trophic nerves; a potent tonic to the tonicity of muscle-fibres, the walls of blood-vessels, the force of the heart, the peripheral blood-pressure, the functions of vasomotors, capillaries and veins, an ozonizing tonic to the blood, to the red cell pigment, to the number of red cells, to the production of oxyhaemoglobin, to the activity of its absorption in metabolic exchanges, and the activity of phagocytosis; a tonic to the energies of respiration, the intake of oxygen, the activity of oxidation, the conversion of protein waste into urea and the destruction of uric acid; a tonic to the completion of combustion in the tissues, the production of heat energy and the maintenance of normal temperature; a tonic to the functional activity of the lymph vessels and absorbents and all the processes of absorption; a tonic to the secretions of glands and the excretory functions of all the organs of the body from liver and kindeys to skin; a tonic to nature's exercise and energy; a tonic to appetite and relish for food; a tonic to the elementary processes of metabolism, and physiologic stimulus to the living human machine.